2011 C-MORE Summer Course Cruise Collective. Center for Microbial Oceanography: Research and Education (C-MORE), Honolulu, USA, jwilson34@u.hawaii.edu

SCALES OF VARIABILITY AT STATION ALOHA

An educational research cruise conducted at Station ALOHA (A Long-term Oligotrophic Habitat Assessment) in June 2011 measured a suite of physical, chemical, and biological parameters on a Lagrangian approach, sampling over daily and diel cycles. Nutrient and suspended particulate stocks were largely invariable over the sampling period, but estimates of primary production varied by as much as 221 mmol C m⁻² d⁻¹. Bacterial production rates in the upper euphotic zone were 3-5 times lower than average, at 8.73 pM Leu hr⁻¹ and 4.53 pM Leu hr⁻¹ in light and dark respectively. Sinking particle flux measurements calculated from sediment traps deployed over 7 days were high compared to the Hawaii Ocean Time-series (HOT) dataset (1.5 σ over ALOHA mean state); we hypothesize we were sampling the decline of a diatom bloom, as evidenced by high particulate silica export (3.1 σ over ALOHA mean state) and low dissolved silica (~1.6 σ below ALOHA mean state). Time-series, like HOT, provide an essential context for irregularly spaced but ecologically relevant perturbations in addition to providing a platform in which to train young scientists and spark collaboration. (Abstract ID 12750)

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COMPARATIVE GENOMICS OF RHODOBACTERACEAE SP. HIBM11 REVEALS METABOLIC SPECIALIZATION IN A COASTAL, MARINE ISOLATE

The planktonic, marine bacterium Rhodobacteraceae sp. HIBM11 is a member of the ubiquitous and versatile roseobacter lineage of the alphaproteobacterial family Rhodobacteraceae. Strain HIBM11 was isolated from surface seawater collected off the coast of Oahu, Hawaii in the subtropical Pacific Ocean, and its genome was sequenced using a 454 GS FLX Ti platform to 121x coverage. Analysis of the 3.1 Mb genome, comprising 3,182 protein-coding genes and 57 functional RNA genes, reveals strain HIBM11 to be a motile, DWSP-degrading, aerobic anoxygenic phototroph (AAnP). While members of the roseobacter lineage are typically considered ecological generalists, features of the strain HIBM11 genome indicate a more specialized lifestyle. Compared to 39 other roseobacter genomes currently sequenced, strain HIBM11 harbors a low number of both sugar and amino acid transporters and an unusually high number of antibiotic/drug and secondary metabolite transporters. We hypothesize that HIBM11 may rely on a more limited suite of substrates for growth, possibly in association with a reluctant phytoplankton host. (Abstract ID 12266)

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TRANSFORMATION OF TERRESTRIAL POLYCARBOXYLATE COMPOUNDS: THE “FORGOTTEN” COMPONENT

Despite the significant studies done to understand the chemical transformation of terrestrially distilled organic matter (tDOM) to the open ocean, surprisingly little is known about the flux and transformations of carboxyl compounds that comprise a major fraction of tDOM. To date, most studies of the transport of tDOM have focused on the aromatic signatures. By studying the chemical transformation of HMW-DOM along a salinity transect, we observed a decrease in the carbon contribution of the carboxylic-rich alicyclic molecules (CRAM) component as we move offshore. However, a significant amount of the CRAM component could reach the open ocean, which could explain the high carboxyl content in both tDOM and deep ocean DOM. In contrast to what has been suggested previously, our combined results of 13C-NMR, 1H-NMR, and FTIR spectroscopy indicate that the CRAM component consists of at least two different components classes (aliphatic polycarboxyl and lignin-like compounds). The preliminary results of a long photo-oxidation experiment of Dismal Swamp DOP shows nearly constant ratio between tDOC and carboxyl carbon during the entire irradiation experiment, which indicates the potential of using polycarboxylate compounds as tDOM tracer. (Abstract ID 12886)

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USING FLUORESCENCE SPECTROSCOPY TO INVESTIGATE THE TEMPORAL PERSISTENCE OF HYDROCARBONS IN THE WATER COLUMN FOLLOWING THE DEEPWATER HORIZON OIL SPILL

Fluorescence spectroscopy has been utilized for decades to characterize colored dissolved organic matter (CDOM) in the marine environment. More recently, researchers have used this method for the identification of complex aromatic mixtures. While many in situ fluorometers were used to collect water column data following the Deepwater Horizon spill, most of those instruments were tuned to wavelengths that might not clearly capture hydrocarbon signals indicative of petroleum. We utilized a Horiba benchtop spectrofluorometer to produce 3D excitation/emission matrix (EEM) spectra, which enabled the identification of fluorescence characteristics of petroleum hydrocarbons, in addition to CDOM signatures. Water samples were collected in May 2010 onboard the R/V Weatherbird II, and follow-up cruises were conducted in August and December of 2010 and in February and May 2011 to collect and analyze water samples from the DeSoto Canyon region to the northeast of the Deepwater Horizon wellhead. Individual EEMs as well as depth profiles of fluorescence intensities will be presented which will show the temporal changes in hydrocarbon signatures found in the northeast Gulf of Mexico in the year following the Deepwater Horizon spill. (Abstract ID 9476)

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GLOBAL ESTIMATES OF EDDY MIXING RATES AND IMPLICATIONS FOR TRACER UPTAKE

Mesoscale eddies can influence the uptake of heat and tracers by driving an eddy-induced circulation (i.e., bolus transport). In the subtropical gyres, this eddy induced transport acts to partially cancel the downward Ekman pumping, modulating the rate that heat and tracers enter the ocean. The extent of this cancellation, and whether it is a significant effect, is heavily dependent on one’s assumptions about eddy diffusivity. We use satellite observations (AVISO) to quantify surface eddy mixing rates in the global ocean using the effective-diffusivity method of Nakamura. Large values (~3000 m²/s) in the subtropical gyres indicate that climate models may be underestimating the eddy-driven upwelling and therefore overestimating the rate of tracer uptake. (Abstract ID 10311)

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THE USE OF NEXT GENERATION SEQUENCING AND BIOINFORMATICS PIPELINES TO BUILD INFORMATIVE ALLELIC NETWORKS FOR INFERRING DEEP-SEA MIGRATION.

With the growing capabilities of next generation sequencing, we are able to gather an enormous amount of data from single individuals. This is critical in deep-sea research where the number of individuals used for migration analysis is restricted by the difficulties of collecting samples. The study of migration in deep-sea systems is critical to understanding how patchy communities like seeps or hydrothermal vents are connected throughout space and time. The connectivity of these environments is one of the forefront considerations in the effort to conserve them during mining endeavors. Our bioinformatics pipeline will link SNP’s together to determine alleles for several thousand genes from a few individuals. These alleles are the equivalent of additional individuals in mitochondrial studies, and will enable us to infer migration and connectivity from sparsely sampled populations. To test the effectiveness of this approach we will employ it to build allicic networks for a species of limpet being analyzed by other molecular and bioinformatics methodology. By taking advantage of new high-throughput techniques we hope to overcome the issues that arise from sampling in the deep-sea. (Abstract ID 10039)

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BOTTOMS UP! EXAMINING THE BASE OF THE FOOD WEB IN SHELF SEAS

Shelf seas are a key interface in the global carbon cycle, contributing significantly to ocean carbon fixation and acting as an export pathway for terrestrially-derived material. In shelf seas the fate of carbon fixed as particulate organic matter (POM) by primary producers is poorly understood. Here we examine the base of the shelf sea food web by examining suspended POM (sPOM) from the Irish and Celtic Seas. Physical water column characteristics directly impact organic sPOM composition. Hence, lipid biomarker and isotopic compositions show significant spatial variation across the shelf. Water column dynamics influence nutrient distributions as shown in nitrogen isotopes and lipid biomarkers. The strength of pelagic-benthic coupling is also reflected by these parameters. Close coupling in the mixed region of the Irish Sea is observed though isotope and biomarker properties. At the shelf break, internal mixing and nutrient upwelling influence community composition with zooplankton biomarker signals at the deep chlorophyll max (DCM) and heavier δ15N values than might be expected at the DCM. Changing physical conditions and their impact on sPOM distributions appear critical for ecosystems in shelf seas. (Abstract ID 10216)
The small size, short lifetime, and rapid advection of submesoscale phenomena present considerable observational challenges to both in situ and remote sensing measurements. Innovative measurement methods allow for the observation of submesoscale features, particularly spiral eddies in January 2010 and April 2011. Real-time ocean-surface radiative temperatures are recorded with both an airborne infrared camera and an altitude and heading reference system. A 10x20 km area is mapped consecutively in 2-3 hours to produce a georeferenced map of SST with high spatial (10 m) and temporal (10-15 min/track) resolution. Using multiple overpasses of the features and tracking algorithms, we derive surface currents on subsequent SST maps. The measurements are compared to sun glint images and interpreted in the context of the background mesoscale velocity field. Preliminary results confirm large rotational velocities and large Rossby numbers, indicating significant ageostrophic dynamics. (Abstract ID 12056)

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USING NASAS GIOVANNI SYSTEM TO SIMULATE TIME-SERIES STATIONS IN THE OUTFLOW REGION OF CALIFORNIA'S EEL RIVER

Oceanographic time-series stations provide vital data for the monitoring of oceanic processes, particularly those associated with trends over time and interannual variability. There are likely numerous locations where the establishment of a time-series station would be desirable, but for reasons of funding or logistics, such establishment may not be feasible. An alternative to an operational time-series station is monitoring of sites via remote sensing. In this study, the NASA Giovanni data system is employed to simulate the establishment of two time-series stations near the outflow region of California's Eel River, which carries a high sediment load. Previous time-series analysis of this location (Ackler et al. 2009) indicated that remotely-sensed chl a exhibits a statistically significant increasing trend during summer (low flow) months, but no apparent trend during winter (high flow) months. Examination of several newly-available ocean data parameters in Giovanni, including 8-day resolution data, demonstrates the differences in ocean parameter trends at the two locations compared to regionally-averaged time-series. The hypothesis that the increased summer chl a values are related to increasing SST is evaluated, and the signature of the Eel River plume is defined with ocean optical parameters. REFERENCE: Ackler et al. (2009) Time-series analysis of remotely-sensed SeaWiFS chlorophyll in river-influenced coastal regions. EARSeL e-proceedings, 8(2), 114-139. (Abstract ID 11210)

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USING THE NASA GIOVANNI DICCE PORTAL TO INVESTIGATE LAND-OCEAN LINKAGES WITH SATELLITE AND MODEL DATA

Data-enhanced Investigations for Climate Change Education (DICCE), a NASA climate change education project, employs the NASA Giovanni data system to enable teachers to create climate-related classroom projects using selected satellite and assimilated model data. The easy-to-use DICCE Giovanni portal (DICCE-G) provides data parameters relevant to oceanic, terrestrial, and atmospheric processes. Participants will explore land-ocean linkages using the available data in the DICCE-G portal, in particular focusing on temperature, ocean biology, and precipitation variability related to El Niño and La Niña events. The demonstration includes the enhanced information for educators developed for the DICCE-G portal. The prototype DICCE Learning Environment (DICCE-LE) for classroom project development will also be demonstrated. (Abstract ID 11251)

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OCEAN OBSERVATORIES: EVOLUTION AND FUTURE DIRECTIONS

Ocean observatories (systems of coordinated ocean sensors and platforms providing real-time observations across multiple temporal and spatial scales) have advanced in complexity and purpose over several decades, integrating hardware, software, and people networks and employing fixed, drifting, and mobile components. These advances have provided interactive access to persistent, real-time, high-frequency, multi-disciplinary observations representing even the most extreme environmental conditions from the coast to the deep sea, resulting in unprecedented descriptions of ocean processes and inspired scientists and students to investigate increasingly complicated problems. Combined with traditional ship-based and remotely sensed observations, ocean observatories have yielded new knowledge across a broad scope of earth-ocean scales including global and regional circulation, ecosystem and carbon dynamics, air-sea interaction, ocean acidification, and ocean floor substrate-fluid processes. This overview will discuss the evolution of ocean observatories, summarize key science accomplishments, and muse about future directions. (Abstract ID 11170)

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HIGH- TO LOW- FREQUENCY VARIABILITY OF MOORED TEMPERATURE, CURRENTS AND DISSOLVED OXYGEN ACROSS CENTRAL OREGON'S COASTAL OCEAN

Contrasts between inner- and mid-shelf dynamics drive cross-shelf variations of nutrient and water mass gradients and transport on the shelf. These contrasts are of central importance in the productive central-Oregon coastal upwelling environment where physical drivers such as wind-driven upwelling, tides, and diurnal forcing vary across the shelf, setting the stage for...
biogeochemical responses. Temperature, current and dissolved oxygen measurements from moorings deployed during the upwelling seasons of 2009-2011 off the central Oregon coast are analyzed to explore the relationship between mid-(70 m) and inner-shell (15 m) dynamics, and their effect on dissolved oxygen. Cumulative displacements calculated from overlapping current records (2009-75 days) paint a picture of a more wind-driven inner shell and a retentive mid-shell. Along-shell tidal current variations (K1) south of a submarine bank (Stonewall Bank) are similar between mid- and inner-shell sites and nearly three times higher than sites north of the bank. We also explore the relationships across frequency bands between inner-shell and nearby rocy intertidal zone temperature measurements to understand the tie between oceanic and local influences on intertidal measurements. (Abstract ID 9983)

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COASTAL MONITORING PARTNERSHIP BETWEEN A UNIVERSITY SCIENTIST, A LOCAL HIGH SCHOOL, AND A MUSEUM USING THE BASIC OBSERVATION BUOY (BOB).

Partnerships between university scientists, local schools, and informal science centers can strengthen our coastal monitoring coverage; benefiting both the observing community and research programs of participating scientists as well as engage students and community members in the nature of science through data collection. Students learn first hand about environmental issues like the importance of water quality in our coastal ecosystems and the importance and role of technology in scientific research all while contributing data from their waterfront. These monitoring relationships often develop into community networks that positively affect all involved. Such a relationship began in 2010 between Kennesaw State University, Hilton Head Preparatory School, and the Coastal Discovery Museum, where students begin monitoring a local tidal creek using the Basic Observation Buoy (BOB). BOB is a small, inexpensive buoy made of PVC that can be assembled and deployed by students. The buoy is designed to serve as a platform for a suite of sensors that continuously measure parameters like temperature, pH, dissolved oxygen, and salinity levels in protected watersheds. Doug Levin designed BOB, while working at NOAA Chesapeake Bay Office in 2008. Due to the student friendly nature of BOB, COSESEF and SECOORA have adopted BOB and supported its growth and implementation throughout the east coast and great lakes. (Abstract ID 10677)

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A SUBMERSIBLE OPTICAL VSF SENSOR WITH POLARIZATION

A new autonomous instrument that measures the VSF of water is described. It covers the entire frequency response of the optical sensor, and is designed for observation of water turbulence, and also for the global carbon cycle. The estimate of this parameter is still uncertain, and the processes that control aerosol Fe dissolution in seawater are poorly understood. Here we present dissolution experiment results from aerosols collected during the 2010 US GEOGRAFCES North Atlantic section cruise, and discuss the physicalchemical speciation of iron after dissolution and the influence of various leaching protocol vs. aerosol origin on dissolution estimates. (Abstract ID 12382)

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IDENTIFICATION AND ANALYSIS OF INTERNAL POINCARÉ WAVES STRUCTURE IN LAKE MICHIGAN

Near-inertial internal Poincare waves are one of the dominant responses of Lake Michigan due to basin-wide wind forcing. Poincare waves tend to be ubiquitous over the whole basin, generating modes that resonate with the wind field. Since the wind field is composed of several frequencies, it generates several modes that span the basin. Data from field observations shows that vertical mode 1 and barotropic mode are the dominant modes in the vertical in the near-inertial (super-inertial) region. Identifying the horizontal modes of Poincare waves from field experiments is difficult, because of the difficulty in covering the whole basin. To address the role played by actual bathymetry, numerical simulations are carried out using the 3D hydrodynamic model SUTANS. Results showed generation of higher modes with time. In addition to highlighting currents and thermal variability induced by the Poincare waves, the associated distributions of cross-thermocline velocity shear and bottom stress are also investigated. Field data from various Lake Michigan field experiments are also compared with the numerical results. (Abstract ID 12331)

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MERGING MULTI- & HYPER-SPECTRAL POLARIZED MEASUREMENTS FROM LONG ISLAND SOUND COASTAL OBSERVATORY: VALIDATION OF SATELLITE OCEAN COLOR SENSORS & IOP RETRIEVALS

To support present and future multi- and hyper-spectral calibration/validation activities for coastal waters for Ocean Color Radiometers (OCR) satellites, and for development of new measurement and retrieval techniques for coastal waters, City College along with the Naval Research Laboratory (Stennis) has established a scientifically comprehensive observation platform, the Long Island Sound Coastal Observatory (LISCO). LISCO uniquely combines a SeaPRISM, part of the NASA AERONET – Ocean Color Network, with a co-located a hyperSAS for multi and hyperspectral radiometer measurements. The efficacy of LISCO for satellite validation is evaluated for the three main OCR sensors, MERIS, MODIS and SeaWiFS, against datasets of quality-checked measurements of SeaPRISM and HyperSAS. It is shown that the merging of the multi spectral SeaPRISM and HyperSAS data significantly improves the overall data quality making LISCO highly suitable for satellite data validation purposes, as well as providing interpolation possibilities for wavelength coverage of gaps between SeaPRISM channels. Two recently added HyperSAS polarization channels, now permit polarized hyperspectral measurements of water leaving radiance, that are shown to provide insights to inherent optical properties and glint effects. (Abstract ID 11067)
SURFACE MASS TRANSFER IN LES OF LARGE SCALE AND SMALL SCALE LANGMUIR CIRCULATION

Surface scalar (mass) transport results from large-eddy simulation (LES) of wind driven flow with Langmuir circulation (LC) are presented. Wave-current interaction gives rise to Langmuir turbulence characterized by LC consisting of a spectrum of scales of counter rotating vortices roughly aligned in the direction of the wind. The typical crosswind length scale of the smallest observed vortices is on the order of several centimeters when the wind begins to blow over a quiescent interface and short capillary waves first appear. Large scale LC typically spans the upper ocean mixed layer depth. In shallow coastal shelves, large scale LC may engulf the entire water column. Two flows will be analyzed. The first flow is characterized by small scale (centimeter scale) LC and the second flow is characterized by large scale, full-depth LC in shallow water. Both flows exhibit increases in surface mass transfer velocity (efficiency) due to the presence of LC. Various parameterizations of surface mass transfer velocity will be evaluated by comparison with exact values obtained through direct measurement of vertical gradient of scalar concentration at the surface. (Abstract ID 12626)

INTER-ANNUAL SEA-SURFACE SALINITY ANOMALIES IN THE KURISHIO EXTENSION REGION ADVECTED FROM THE EAST OF THE PHILIPPINES

Sea-surface salinity variations in the Kuroshio Extension (KE) region are responsible for the salinity variation of the subtropical mode water that occupies a large part of the subsurface layer of the North Pacific subtropical gyre. By using the Argo data during 2004-2010, the salinity anomaly from the seasonal mean in the KE region was calculated. Tracing the region of the lag-correlation coefficient over 0.6 relative to the anomaly in the KE region, the anomaly in the top 100 m layer was found to be advected with a six-month elapsed time from the variation of the east coast of the Philippines to which the westward interior flow of the subtropical gyre is directed. Also, seven high-resolution hydrographic surveys across the KE During 2008-2010 were performed. The analysis of the data indicates that the salinity anomalies advected from the upstream region of the Kuroshio outcrop just south of the KE in winter. Through the advection and outcrop, the inter-annual salinity variation of the mode water is connected to that in the tropical region. (Abstract ID 9581)

LINEAR RELATIONSHIP BETWEEN CARBON AND NITROGEN ISOTOPE RATIOS ALONG SIMPLE FOOD CHAINS IN MARINE ENVIRONMENTS

To examine the relationship between carbon and nitrogen stable isotope ratios of zooplankton, we analyzed samples collected bimonthly from March to October 2009, from the A-line in the western North Pacific. Isotopic ratios of higher trophic levels such as predatory zooplankton and/or long-lived zooplankton varied little with season, while those of short-lived zooplankton were variable on the δ15N-δ13C map. We also analyzed preserved samples taken from the warm-core ring 86-B which derived from the Kuroshio extension region. Although the δ15N-δ13C slopes for each ecosystem do not show significant difference. Statistical analysis conducted together with previously published data from the Antarctic Ocean and the Gulf of Alaska suggested commonness in the δ15N slope throughout the four regions. We attributed this common slope to physiological aspects of feeding processes (e.g., the kinetic isotope effects inherent in the processes of amino acid synthesis). The common pattern for all four oceanic regions suggests that stable isotopes may be used to elucidate general patterns in ecosystems and biogeochemical cycles. (Abstract ID 10151)
commonly assumed in ecological studies. (Abstract ID 11225)
and processes at the scale of an individual we show that K might behave opposite to what is
this quantity relates to properties, i.e. traits, of the organism. By resolving the environment
K is a measurement of the bulk concentration in an experiment and it is not evident how
evolutionary dynamics, and ocean ecosystem models. Here, the rationale for this is questioned.
was adapted to characterize microbial nutrient uptake in bulk experiments. The half saturation
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THE ARCTIC BOUNDARY CURRENT FROM EDDY-PERMITTING AND EDDY-RESOLVING OCEAN MODELS
Observations and high-resolution eddy-resolving ocean models both suggest a fast flow along
the continental shelf in the Arctic Ocean. Thus far, this flow, termed the Arctic Circumpolar
Boundary Current (ACBC), has been seen as comprising the Fram Strait Branch (FSB) and
Barents Sea Branch (BSB). This study describes a new third branch, the Arctic Shelf Break
Branch (ASBB), forced by buoyancy loss and non-local wind that create high pressure
upstream in the Barents Sea. The potential vorticity influx through the St. Anna Trough
dictates the cyclonic direction of the ASBB. Numerical simulations show the continuity of
the ACBC all the way around the Arctic shelves. The ASBB is the most energetic large-scale flow
in the Arctic Ocean and transports Arctic halocline water, comparable in volume to the Bering
Strait inflow. The ASBB exhibits a robust seasonal cycle with a summer minimum and winter
maximum. The Alaskan Shelf Break Current (ASC) is analogous to the ASBB and is forced
by the local winds and by the drop in sea surface height between the Pacific and Arctic Oceans.
(ABstract ID 11012)

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CALIBRATION AND VALIDATION OF MODIS-BASED OC3 MODEL FOR RED TIDE DETECTION AND MONITORING IN THE ARABIAN GULF
Red Tide occurrences in the Arabian Gulf have increased in the last few years. It damaged
the aquatic life and the economic side of the region. Red tide is the presence of algae blooms
(phytoplankton) which can be harmful, toxic and affects human health. MODIS (Moderate
Resolution Imaging Spectroradiometer) satellite, on board of Aqua and Terra satellites, has
been used recently to detect and map harmful algal blooms in different regions. Chlorophyll
concentrations and fluorescence measurements were collected at 3 different depths in 64
stations in the Arabian Gulf and the Gulf of Oman. This data was collected by ROMPS
Oceanographic cruise during a 24-day period in winter 2006. The collected data was used to re-
calibrate OC3 Model using both Aqua and Terra images. Different red tide related parameters
were derived: OC3-derived Chlorophyll-a concentration (μg m-3), fluorescence line height
(FLH W m-2 μm-1 sr-1), floating algae index (FAI), secchi desk (SD cm) and turbidity index
(TI). The correlations between these parameters were studied over the 20 selected stations.
High correlation was observed between chlorophyll-a concentration and turbidity index. The
effect of wind on the algal bloom activities near United Arab Emirates (UAE) coastline was also
studied during the cruise period. The short term variation of these parameters was also studied
by comparing morning (Terra) and afternoon (Aqua) scenes. (Abstract ID 10569)

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SHEAR TURBULENCE BELOW THE BASE OF THE WELL-MIXED LAYER.
The well mixed layer in the upper ocean is maintained by mixing due to turbulence generated
by the action of wind, waves and buoyancy fluxes at the ocean surface. Scaling laws for shear
and convective turbulence are well established. More recently large-eddy simulation has been
used to establish scalings for Langmuir turbulence, that is generated through the action of
wave induced Stokes drift. Regions of shear and low Richardson number often occur below
the base of the mixed layer. These regions are frequently turbulent and have been considered
to form transition regions between the mixed layer and the underlying ocean. Turbulence in
these shear layers has been characterised by eddy diffusivities that are taken to be functions of
the Richardson number. In this presentation large-eddy simulation (LES) is used to investigate
the nature of turbulence in these shear layers. The results from the LES are used to develop a
scaling for the shear turbulence based on the surface stress and mixed layer currents. A key
feature of this scaling is that it assumes that the boundary layer spans both the well mixed and
shear layers. It will be shown that the length scale of the shear turbulence is consistent with
this assumption. The interaction between the well mixed layer and the shear layer will also be
considered. It will be shown that this can be described using a non-dimensional parameter
based on the rates of generation of mixed layer and shear turbulence. (Abstract ID 11070)

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UNIVERSITY-NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM- THE CURRENT AND FUTURE FLEET
The Town Hall meeting will present an overview of the University-National Oceanographic
Laboratory System (UNOLS) fleet as well as new ships under construction. Highlights will
include the R/V Sikuliaq currently being constructed on behalf of the NSF. This ship’s primary
mission will be to support scientific studies in high latitude waters. The 261 foot global class
general purpose oceanographic vessel will be capable of breaking 2.5 foot thick ice at 2 knots
with an endurance of 45 days at sea and cruising at 11 knots. The R/V Sikuliaq will carry 26
scientists and a crew of 20. The vessel design strives to have the lowest possible environmental
impact, including a low underwater-radiated noise signature. A projected launch date of June
2012, delivery to the University of Alaska Fairbanks in June 2013 and scientific operations are
planned to start in January 2014. The Office of Naval Research is also building two new Ocean
class ships joining UNOLS in 2014/2015. Details on these ships will also be highlighted Possible
science opportunities will be discussed and a question and answer period will follow. (Abstract
ID 11547)
In the lower estuary clay mineralogy consists of 70% expandable minerals and chlorite, an the transport and deposition of suspended particles from the inner estuary to the outer estuary. The seaward-increasing excess 210Pb to 137Cs activity ratio documents porosity, fine-grained layers, thinner in the inner estuary and thicker in the outer estuary, Anadyr fluvial sediments are typically coarse-grained, with sand >90% and mud <10%. In antarctica availability of Fe and/or light. The Amundsen and Pine Island Bay polynyas in the Amundsen THE AMUNDSEN SEA (ANTARCTICA) Arrigo, K. R., Stanford University, Dept. Environmental Earth System Science, Stanford, USA, LowryK@Stanford.edu Lowry, K. E., Stanford University, Dept. Environmental Earth System Science, Stanford, CA, USA, LowryK@Stanford.edu Schofield, O., Rutgers University, Inst Marine and Coastal Sciences , School of Environmental and Biological Science, New Brunswick, NJ, USA, oscar@marine.rutgers.edu Sherrill, R. M., Rutgers University, Inst Marine and Coastal Sciences and Dept. Earth and Planetary Sciences, New Brunswick, NJ, USA, sherrill@marine.rutgers.edu Yager, P.L., University of Georgia, School of Marine Programs, Athens, GA, USA, pryag@uga.edu Arrigo, K. R., Stanford University, Dept. Environmental Earth System Science, Stanford, CA, Arrigo@stanford.edu IRON AND LIGHT EFFECTS ON PHYTOPLANKTON PRIMARY PRODUCTIVITY IN THE AMUNDSEN SEA (ANTARCTICA) Phytoplankton primary productivity in the Southern Ocean is considered to be limited by the availability of Fe and/or light. The Amundsen and Pine Island Bay polynyas in the Amundsen Sea are areas with the highest phytoplankton primary productivity per surface area in the Southern Ocean. This region is affected by a rapid increase in melt rate of floating glacier termini and ice shelves in the Western Antarctic. These melting ice shelves were the major source of iron fueling the highly productive phytoplankton bloom dominated by Phaeocystis antarctica during the Austral summer of 2009. During the NBP1005 (ASPIRE) cruise in the spring of 2010/2011 we encountered another massive P. antarctica bloom (40 g m⁻² Chl a). Bioassay experiments revealed that iron additions increased photosynthetic productivity as well as nitrate uptake in surface phytoplankton, indicating that Fe availability may limit phytoplankton growth despite the large Fe input from melting ice shelves. Moreover, Fe additions increased photosynthetic efficiency at low light intensities, providing an additional positive effect of Fe input on photosynthetic productivity in high biomass areas where strong light attenuation reduces light availability. (Abstract ID 12594) Alen Alexanderian, A., Johns Hopkins University, Baltimore, USA, alexanderian@jhu.edu Justin Winokur, J., Johns Hopkins University, Baltimore, USA, jwinokur@jhu.edu Ihab Seaj, I, Johns Hopkins University, Baltimore, USA, isaj@jhu.edu Ashwath Sinivasan, A., University of Miami, Miami, USA, sinivasan@msm.miami.edu Mohamed Iskandarani, M., University of Miami, Miami, USA, miskandarani@msm.miami.edu William Thacker, W. C., University of Miami, Miami, USA, Carlisle.Thacker@noaa.gov Omar Knio, O. M., Duke University, Durham, USA, knio@duke.edu UNCERTAINTY ANALYSIS AND QUANTIFICATION OF THE HYCOM SST RESPONSE TO HURRICANE IVAN USING POLYNOMIAL CHAOS EXPANSIONS The present study uses the method of Polynomial Chaos Expansion to quantify the HYCOM uncertainty in simulating the sea surface temperature response during the passage of Hurricane Ivan in the Gulf of Mexico. The sources of uncertainty were the values of the wind drag coefficient and those of 3 KPP mixed layer model variables. Sparse Smolyak quadrature was used to determine the PCE coefficients in this four-dimensional parametric space using an ensemble of 385 runs. The quality of the PCE representation was validated and than exploited to perform sensitivity and variance analyses, construct probability density functions, and compute the statistics of any quantity of interest without re-running the model. The model predicted an average cooling of 1 degree Celsius under Ivan's track with a standard deviation of 0.4 C, an estimate which is in-line with observations. The analysis showed that the main contributor to the uncertainty away from the storm was the background diffusion coefficient, a mixed layer variable, whereas the drag coefficient was the main contributor in the vicinity of the storm. The present application illustrates the efficiency of the PCE approach in exploring the entire parameter space and its usefulness in a posteriori sensitivity analysis. (Abstract ID 11881) Alexander, C. B., Stoddard Institute of Oceanography, Savannah, USA, clark.alexander@skios.usg.edu Windon, H. L., Stoddard Institute of Oceanography, Savannah, USA, hex.windon@skios.usg.edu Naidi, S. A., University of Alaska, Fairbanks, USA, sanaid@alaska.edu ESTUARINE PROCESSES IN THE ANADYR SYSTEM, CHUKOTKA, RUSSIA Geological and geochemical parameters, which can be used to track estuarine circulation processes, are examined in the Anadyr River and estuary in northeastern Siberia. Water and sediment samples from the Anadyr system were analyzed for texture, elemental geochemistry, natural and artificial radionuclides, POC/Chl a, clay mineralogy, and dissolved constituents. Anadyr fluvial sediments are typically coarse-grained, with sand >90% and mud <10%. In mud samples, silt dominates over clay. Estuarine samples, however, exhibit surficial, high-porosity, fine-grained layers, thinner in the inner estuary and thicker in the outer estuary, overlying firm sands. This distribution suggests that muds are delivered seasonally to the estuary and trapped there. The seaward-increasing excess 18O/16O or C13 activity ratio documents the transport and deposition of suspended particles from the inner estuary to the outer estuary. In the lower estuary clay mineralogy consists of 70% expandable minerals and chlorite, an assemblage distinctly different from the nearshore Bering Sea. The 8°C values (-25 to -27°C), reflect predominant terrigenous sources of POC. Our database suggests that the Anadyr estuary is an effective trap for fluvially derived material. (Abstract ID 12168) Alexander, M. A., NOAA/Earth System Research Lab, Boulder, USA, Michael.Alexander@noaa.gov Deser, C., NCAr, Boulder, USA, cdeser@ucar.edu Capotondi, A., University of Colorado/CIRES, Boulder, USA, Antonietta.Capotondi@noaa.gov Scott, J. D., University of Colorado/CIRES, Boulder, USA, James.D.Scott@noaa.gov THE INFLUENCE OF VARIABILITY IN THE NORTHERN PACIFIC AND TROPICAL WEST PACIFIC ON ENSO Vimont et al. (2001, 2003, J. Climate) proposed an extratropical-to-tropical connection termed the "seasonal fingerprinting mechanism" (SFIM), where internal fluctuations in the atmospheric circulation over the North Pacific during winter impacts a "footprint" on the ocean through changes in the surface heat fluxes. The SST footprint in the subtropical Pacific, impacts the atmospheric circulation including zonal wind stress and heat flux anomalies that extend into the western tropical Pacific in spring and summer. These anomalies can excite an ENSO response in the subsequent fall and winter. The heat content in the western equatorial Pacific also serves as a precursor to ENSO but is most effective in combination with SFIM-like anomalies (Anderson et al., 2006). Observations indicate that an anomalously deep thermocline in the western equatorial Pacific in summer, followed by anomalous westerlies over the subtropical North Pacific during winter, favors the development of El Niño events during the subsequent winter, 12-15 month after the initial thermocline anomalies. Here, we explore the joint impact of these precursors on ENSO using observations and CCSM4, NCAr's general circulation model. (Abstract ID 10940) Alfred, M. H., University of Washington, Seattle, USA, malford@apl.washington.edu Lukas, R., University of Hawaii, Honolulu, USA, rlukas@hawaii.edu Howe, B. M., University of Hawaii, Honolulu, USA, bhowe@hawaii.edu Pickering, A., University of Washington, Seattle, USA, apickering@apl.washington.edu Santiago-Mandujano, F., University of Hawaii, Honolulu, USA, mandujan@soest.hawaii.edu MOORED OBSERVATIONS OF EPISODIC ABBYSSAL FLOW AND MIXING AT STATION ALOHA Moored measurements of abyssal velocity and temperature are presented with a focus on episodic cold overflow events in the Hawaii Ocean Time-series (HOT), a 23-year-long time series of monthly CTD profiles at station ALOHA (22.75N, 158W). Three major cold events were observed in our 2.5-year record, of which we present one in detail. The event appeared in two pulses spaced by about two weeks, wherein potential temperature anomaly was < -0.015°C over the bottom 600 m. Flow was about 10 cm/s to the southwest, confirming earlier interpretations of the events as overflows from the Maui deep to the east. Between the two pulses, flow veered to the northwest, possibly associated with seiching. Speed decreased rapidly below the sill depth of about 4625 m, suggesting sheltering by the basin walls. The associated shear, even smoothed over 200 m and not including internal waves, was nearly unstable to Kelvin-Helmholtz instability. During this period, a large mixed region was observed wherein the temperature remained so for 14 hours (1.2 buoyancy periods). From Thorpe scale analysis, the implied diffusivity of the event was (0.5-4.5) x 10⁻⁸ m² s⁻¹. No other overturning events greater than 50 m high were observed in the record, suggesting that abyssal mixing is strongly intermittent. We suggest that such intermittency in abyssal mixing and flow is likely the rule rather than the exception. (Abstract ID 11628) Algar, C. K., Marine Biological Laboratory, Woods Hole, USA, calgar@mbl.edu Joseph Vallino, J. J., Marine Biological Laboratory , Woods Hole , USA, jvallino@mbl.edu A MAXIMUM ENTROPY PRODUCTION (MEP) BASED MODEL OF NITROGEN CYCLING PROCESSES IN LOW OXYGEN AND ANOXIC ENVIRONMENTS In low oxygen/anoxic environments re-mineralized nitrate may be lost as N₂ gas due to canonical denitrification and ANAMMox or it may be converted to ammonium by way of dissimilatory nitrate reduction (DNRA) and remain biologically available. As all three process are microbial mediated, a full understanding of nitrogen biogeochemistry in these environments requires an understanding of the functioning of the microbial ecosystem caring out these processes. Here we present a numerical model of nitrogen cycling based upon the principles of maximum entropy production (MEP), whereby the microbial community organizes in such a way so as to maximize its time integrated entropy production. Model simulations with varying carbon and nitrogen inputs, demonstrate switches between denitrification, ANAMMox and DNRA that are consistent with what has been observed in the natural environment. Simulations were also compared with results from a flow-through stable isotope labeling experiments. This work suggests that models based upon MEP theory may be a useful tool in predicting how microbial ecosystem functions and how the resulting biogeochemistry will respond to environmental perturbations of both natural and anthropogenic origin. (Abstract ID 11775)
High-resolution ocean–wave coupled modeling of the Adriatic Sea is explored using the Naval Research Laboratory’s state-of-the-art ESPM-based (Earth System Modeling Framework) Coupled Ocean and Atmospheric Prediction System (COAMPS). Recent advancements of COAMPS include the addition of both SWAN and WAVENUM3 components to the coupled system that allows full interaction of these wave models to both the atmosphere and the ocean model (NCOM). Ocean–wave interactions include the passing of NCOM ocean currents to the wave models and the wave models passing the Stokes’ drift currents, wave radiation stress gradients, and bottom stresses to NCOM. The validation period studied encompasses a portion of the DART (Dynamics of the Adriatic in Real-Time) field experiment that occurred in February–March 2006. Model comparisons to in-situ observations from several drifters and Acoustic Doppler Current Profilers (ADCPs) are analyzed to further our understanding of these ocean/wave model interactions and dynamic processes. (Abstract ID 10578)

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ANOMALOUSLY STRONG TIDES IN THE GULFY, A SUBMARINE CANYON ON THE NOVA SCOTIA SHELF

Two major submarine canyons: Monterey Canyon off California and Gaoping Canyon off Taiwan, have strongly enhanced ocean tides. Tidal amplification theories include focusing, trapping and local generation of internal waves. A very similar canyon, The Gulpy off Nova Scotia is also observed to have these enhanced tides but with a significant difference. The enhanced tides in Monterey and Gaoping Canyons are the semi-diurnal tides whereas in The Gulpy the most strongly enhanced tides are diurnal and are thus sub-inertial. We will show observations of the tides and present two coupled wave theories that explain the enhanced sub-inertial tides in the Gulpy. Comparisons between theoretical properties of the amplified tides and observed properties support the applicability of the theories. Limitations and future enhancements of the wave theory will be discussed. (Abstract ID 11488)

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DETECTING VIRAL INFECTION AT THE SINGLE CELL LEVEL WITH PHAGE FISH

Microbes drive the biogeochemistry that fuels our planet, and viruses cause 10-40% of microbial mortality in the ocean. In spite of this importance, interactions between microbes and their viruses (phages) remain poorly understood, primarily due to technological challenges. Here we apply gene-fluorescence in situ hybridization (gene-FISH, Moraru et al. 2010) to quantify the fraction of phage-infected host cells at the single-cell level, phosphate-FISH. Specifically, marine podovirus 10-kDa was introduced to one of its hosts, marine Pseudoalteromonas sp. H100 (Gannaproteobacteria) and monitored over time from phage entry to new assembly of phage particles using gene-FISH on phage and host genes. The fraction of infected cells and status of infection on the single-cell level (the phageFISH signal increases with increasing phage genome copy number) were validated against established population level metrics including the fraction of visibly infected cells by TEM, infective virus counts, and quantitative PCR of phage genes inside and outside of the host cell. Given the single-cell detection capability of gene-FISH, this work sets the stage for community level virus-host investigations that also detail cell-to-cell variability. (Abstract ID 10746)

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HIGH-RESOLUTION SEAFLOOR AND SUBBOTTOM MAPPING OF UPPER MISSISSIPPI CANYON: RESULTS FROM THE 2011 UTIG MARINE GEOLOGY & GEOPHYSICS FIELD COURSE

UTIG annually offers a field course that provides student training in seismic data acquisition, processing, interpretation, and visualization. As part of the Year-4 field course, we surveyed upper Mississippi Canyon using high-resolution seismic reflection (air-gun), CHIRP sub-bottom profiling, multibeam bathymetry, and sidescan sonar. This survey revealed a significant sediment connection with the adjacent Mississippi River mouth. The steep wall zone of the
canyon head and the eastern wall opposite the river mouth exhibit a channelized seafloor, with gently meandering channels that merge downslope. Subbottom records show recent eolian gravitational faulting on the walls. On the upper canyon floor, extensive fields are present of what have been described in other settings as migrating sediment waves. These waves appear to be modified in places by internal slumping and interrupted downslope by unstratified (debris flow?) regions. Acoustically transparent units may represent mud-rich turbidites on the canyon floor. Together, these features suggest the canyon is regularly swept by gravity flows of river-derived sediment that are channelized in steeper wall areas and downslope may provide a mechanism for sediment wave migration. (Abstract ID 10671)

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and exchange will be sought after. (Abstract ID 12826)

region. Ultimately, understanding the effects of the giant kelp forest on the cross-shelf transport data was collected to assess and analyze the forcing mechanisms and wave-current interaction internal bores, and wave-driven flows. The high spatial and temporal resolution hydrodynamic narrow shelf area of southern Monterey Bay, CA, a region influenced by persistent fronts, Leary, P. R., Stanford University, Stanford, USA, prleary@stanford.edu

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COOPER LIMITATION OF THE MARINE AMMONIA OXIDIZING ARCHAEOGEO- NITROSOPHILIALIUS MARITIMUS

Copper is a required and often limiting micronutrient for microorganisms in the ocean because of its role in electron transfer and redox reactions, including ammonia oxidation and denitrification. However, copper can also be toxic at high concentrations. Ammonia
oxidizing archaea (AOA) have recently been recognized as the primary nitrifiers in the marine environment, thus playing an important role in the nitrogen cycle. Available genome sequences of AOA show that Cu-dependent enzymes are essential for both ammonia oxidation and electron transfer in these organisms indicating a particularly high requirement for copper. However, our knowledge of the copper requirements of AOA and their contribution to copper species in the ocean is non-existent. Here, we report the copper requirements of the AOA Nitrosopumilus maritimus using a defined trace-metal buffered medium and show that the common chelator EDTA is inhibitory to growth and ammonia oxidation, an effect that appears to be due to direct inhibition rather than an indirect one via metal limitation. Instead, we use the strong copper chelator TETA to characterize copper limitation and toxicity and their underlying effects on ammonia oxidation in N. maritimus. In addition, we present preliminary evidence for the production of a strong copper binding ligand by N. maritimus. These results highlight the underlying importance of copper to the metabolism of AOA and the marine nitrogen cycle. (Abstract ID 12547)

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TRACING DISSOLVED ORGANIC CARBON FROM THE ARCTIC WATERSHEDS TO THE ARCTIC OCEAN

The Arctic Ocean receives about 11% of the global carbon discharge from rivers that drain vast regions in the Arctic and Subarctic climatic zones. We have used lignin biomarkers and fluorescence to trace terrigenous organic matter (TOM) sources in 6 large Arctic rivers and Ocean. The Siberian rivers, Lena, Yenisei, and Ob contribute 90% of the mostly forest-derived DOM. During low flow, lignin biomarkers indicate a larger contribution from peat bogs, soils and mosses. Within the Arctic, the Eurasian Basin (EB) has higher levels of TOM relative to the Canada Basin (CB) and highest levels of TOM are found in the halocline. The relationship of fluorescence and lignin phenols is strong in the EB but weak in the CB. This has to do with additional fluorescence sources and vertical partitioning of TOM in the CB. Our results indicate that sea ice formation plays a prominent role for the vertical distribution of TOM along isopycnals. The observed distribution of lignin and fluorescence in surface waters raises important questions for the Arctic carbon and freshwater cycle. (Abstract ID 12467)

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EFFECT OF GREENLAND ICE SHEET MELTING ON NORTH ATLANTIC CLIMATE VARIABILITY

Using a CGCM, we investigate the effect of the Greenland ice sheet melting on Arctic climate variability. The positive-degree-day (PDD) method was adopted to control the ice melting. The model with and without the PDD method produces rather realistic North Atlantic SST pattern on the decadal-to-multidecadal timescale, but the significant multidecadal variability is solely observed in PDD experiment. This quasi-oscillatory mode is attributed to two feedback processes: a leading density-driven positive feedback and a lagging wind-driven negative feedback. The reduced evaporation from the cold surface leads to the reduction of the density, and so the slowdown of AMOC, and the weakening of northward heat transport cools to cool North Atlantic. On the other hand, the surface low pressure over the north of the cold surface generates the northward warm advection though the Sverdrup adjustment, which reduces the cooling. Two feedback processes produce the interdecadal variation in North Atlantic. Finally, when the Greenland ice melting process is involved, the cold (warm) SST exerts to decrease (increase) the ice melting, which intensifies (reduces) the AMOC so does the warm (cold) advection. Therefore, the melting of ice sheet likely works as the negative feedback. So this negative feedback partly compensates the aforementioned density-driven positive feedback, which may result in the longer time scale fluctuation. (Abstract ID 9937)

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TOWARD UNIFIED APPROACH TO REMOTE ESTIMATION OF CHLOROPHYLL CONCENTRATION IN COMPLEX COASTAL, ESTUARINE AND INLAND WATERS

We present here results supporting the use of NIR-red algorithms for remote estimating chlorophyll-a (chl-a) concentration in complex turbid productive waters. We tested the potential of universal applicability of NIR-red algorithms, which were calibrated using reflectance and in situ data from Nebraska Lakes and data that were synthetically generated using a radiative transfer model. We used an extensive set of field spectrometer data from the Chesapeake Bay and several lakes in Nebraska (USA), Lake Kinneret (Israel) as well as MERIS imagery and in situ data collected in the Azov Sea and the Taganrog Bay (Russia) to test the accuracy of the algorithms. We found that the NIR-red algorithms gave consistently highly accurate estimates of chl-a concentration. The algorithms do not need case-specific parameterization and presents a strong case for the use of the NIR-red algorithms for real-time quantitative monitoring of chl-a in an estuarine, coastal, and inland waters. (Abstract ID 11666)

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IMPACT OF EXPERIENTIAL OCEAN SCIENCE EDUCATION ON SCIENTIST-VOLUNTEER KNOWLEDGE, TEACHING CAPACITIES AND NSF BROADER-IMPACTS Endeavors

Ocean Inquiry Project (OIP) — a strategic partner of COSEE-Ocean Learning Communities — connects ocean scientists and members of the public in deep and meaningful learning experiences, while doing rigorous, scientific data collection. OIP operates a boot-based education program to collect data and teach marine volunteers. K-12 and community college audiences about the Puget Sound ecosystem as well as about current ocean science research. In 2011 OIP sought to understand the impact of these experiences on the participating scientists. Since 1999 more than 70 scientists have served as volunteer instructors during day-long cruises on Puget Sound. The evaluation approach was to interview those who matched the criteria of serving during the COSEE-OIL era (2008 to present). The interviews focused primarily on how OIP experiences affected scientists’ teaching, scientific knowledge and NSF Broader Impacts endeavors. Key findings include that all scientists: 1) reported increased teaching confidence and skills with both formal and informal audiences, and 2) identified Broader Impacts as a critically important service to the public and a serious obligation for scientists, and 3) gained new scientific knowledge during the cruises. (Abstract ID 10785)

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HOW DOES PARTICIPATION IN EDUCATIONAL OUTREACH BENEFIT SCIENTISTS?

For almost a decade, scientists and educators have been collaborating on several education and public outreach initiatives as part of the Center for Ocean Sciences Education Excellence (COSEE). While the goals and strategies of the COSEE are multi-faceted, during this session we will share results from research conducted to learn about the impact of these collaborations on scientists. Analysis of survey and interview data has revealed several possible direct benefits to scientists: (1) support for accessing research funding through help in developing broader impact and EPO (education and public outreach) statements; (2) opportunities for the scientists and their graduate students to engage in education and outreach; (3) personal fulfillment and enjoyment of engaging in education and outreach; (4) change in attitudes about teaching, learning, and the role that public understanding of science plays can play in society; (5) change in their own teaching practice; (6) change in thinking about their scientific pursuits, (7) increased demand and support for science research funding through public understanding; and (8) developing more institutional support for scientist participation in education and public outreach. (Abstract ID 12766)

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ULTRA-VIOLET ABSORPTION SPECTRA: OPTICAL RETRIEVAL OF NITRATE CONCENTRATIONS IN HIGH CDOM WATERS

Understanding the role of nutrients in phytoplankton dynamics requires synoptic measurements of nutrient concentrations and phytoplankton biomass. The Satlantic ISUS nitrate sensor utilizes the ultraviolet absorption features of nitrate against a background of other dissolved species to estimate the nitrate concentration. This has worked well in open ocean settings away from temporally-varying high concentrations of colored dissolved organic matter (CDOM). Here we present an approach of deconstruction of the UV absorption spectrum into contributions by dissolved salts, terrestrially-derived organic matter and nitrate. A linear model is proposed that yields the concentrations of each component from simple spectrophotometric analyses. The model is tested in a dynamic coastal sound with strongly varying concentrations of salts, dissolved organic matter and nutrients. The sensitivity of the observations to the optical density of the samples in the ultraviolet is discussed. The utility of this approach is two-fold: (1) archival UV CDOM absorption spectra can be re-analyzed to retrieve nitrate concentrations and (2) tuning of the absorption reconstruction invoked by the Satlantic ISUS sensor can provide more robust estimates of nitrate in high CDOM coastal waters. (Abstract ID 9734)

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NATURAL AND ANTHROPOGENIC ORGANIC CHEMICALS IN THE ZANZIBAR
Using these instruments, high vertical resolution (<10 cm) data in the near-surface layer were acquired nearly all the way to the sea surface, allowing for an examination of the near-surface structure and variability usually not possible in the context of Argo floats. To date, twenty-eight Argo-type floats equipped with STS units have been deployed in the Pacific, Atlantic, and Indian Oceans. The vertical variability of temperature and salinity in the near-surface layer are characterized for each of these regions. Additionally, comparisons of STS and primary sensor CTD data are presented. Results show the upper few meters of the ocean to be well-mixed at most times, interrupted by significant and often short-lived warming/cooling and freshening events. These results can be compared and contrasted to results from the sea surface obtained from orbiting platforms. (Abstract ID 10701)

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ENSEMBLE DATA ASSIMILATION AND UNCERTAINTY QUANTIFICATION

Geophysical data assimilation algorithms combine a forecast from a model with observations of a physical system to get an improved estimate of the probability distribution of the system. Ensemble data assimilation algorithms are designed to produce a small sample of state estimates from this distribution. In the best of all possible worlds, estimates of uncertainty and sensitivity can be obtained directly from this sample. However, deficiencies in forecast models and the observing system coupled with limited computational resource lead to ensemble estimates that are far from optimal. An overview of ensemble algorithms is presented and possible problems with uncertainty estimates are discussed. Enhanced ensemble algorithms, for instance adaptive inflation of prior ensembles, that use observations to produce improved uncertainty estimates are discussed. (Abstract ID 11555)

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YOU ARE WHERE AND WHAT YOU EAT – SYMPATHETIC COMPETITORS AND DIET MAY DETERMINE THE EFFECT OF PHYSICAL HABITAT ALTERATION ON MERCURY IN FRESHWATER FISH

Freshwater fish accumulate toxic methyl-mercury in their flesh from the prey they consume. Because methyl-mercury is not easily released it bioaccumulates through the aquatic food chain and can reach levels of concern for human and animal piscivores. Considerable attention has been paid to understanding the determinants of mercury levels in fish and to the consequences of anthropogenic perturbation. Lake and watershed characteristics are known to play a significant role however; they do not explain all the intervariability. Biological and ecological characteristics such as growth rate and foodchain length have also been shown to influence mercury accumulation. Here we use a large dataset from over 100 lakes in Labrador, Canada to demonstrate how the presence or absence of sympatric competitors affect mercury accumulation either through changes in habitat use (longnose suckers) and/or prey selection (round whitefish) while diet choices may explain variations observed in opportunistic predators (brook trout). Predicting mercury in fish following changes to physical habitat within aquatic systems will therefore depend on species autecology and community structure through their influence the prey selection and availability. (Abstract ID 11481)

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AEROSOL SUPPLY OF SOLUBLE TRACE ELEMENTS TO THE OCEAN EVALUATED USING PAIRED THORIUM ISOTOPES

Aerosols (dust) supply dissolved 230Th to the ocean just as they serve as a source of micronutrients and other trace elements. Surface waters in regions downwind from major dust sources are enriched in dissolved 230Th, reflecting this source. The residence time of dissolved Th is evaluated by measuring the radioactive disequilibrium between dissolved 230Th and its parent, 234U. Assuming steady state, which is reasonable when dissolved 230Th inventories are integrated through the thermocline, the quotient of the dissolved 230Th inventory divided by the resulting time of dissolved Th provides the mean annual flux of dissolved Th from aerosols. Application of these principles will be illustrated using results from the NW Pacific, downwind...
of Asian dust sources, as well as results from the eastern tropical Atlantic, in a region of high Saharan aerosol flux. For the Atlantic, we will also show that surface concentrations of dissolved Th are positively correlated with concentrations of dissolved Al, a more traditional tracer of dust supply. (Abstract ID 11173)

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LAGRANGIAN OBSERVATIONS OF ACCELERATION IN BREAKING WAVES
A complete understanding of wave generation, propagation and transformation is necessary to correctly model nearshore processes. Among the most difficult problems is understanding the dynamics of breaking waves. In this presentation we will present preliminary results from synoptic observations of particle accelerations using a novel strategy that involves the development of new Lagrangian drifters equipped with sensors that can be deployed within breaking waves. The drifters measure particle acceleration and rotation with miniature inertial measurement units in an effort to reconstruct the 3D distribution of turbulence in spilling development of new Lagrangian drifters equipped with sensors that can be deployed within breaking waves using Lagrangian drifters. (Abstract ID 10728)

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examine, for the first time, the internal dynamics and temporal evolution of individual breaking and plunging gravity waves. The ultimate goal of this project is to develop the capabilities to
measurement units in an effort to reconstruct the 3D distribution of turbulence in spilling and plunging gravity waves. The ultimate goal of this project is to develop the capabilities to

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TOWARDS THE ATTRIBUTION OF RECENT TRENDS IN OCEANIC OXYGEN TO CLIMATE CHANGE AND VARIABILITY
Oceanic oxygen distribution responds to climate forcing, such that observed historical declines in O2 concentration across nearly all ocean basins are likely related to global ocean warming. Any long-term trends in O2 are, however, superimposed upon significant interannual to decadal variability relating to the dominant climate modes, which can act to mask any anthropogenic signal. Our study aims to better quantify the relative contribution of natural and anthropogenic forcing to observed oxygen changes. For this purpose, we used an ocean biogeochemistry model (PlankTOMS-NEMO) forced with a suite of atmospheric fields derived from reanalysis products and the CMIP5 model archive. We isolate the internal variability in marine oxygen from the long-term trends driven by climate change using targeted experiments. We compare our modelled oxygen changes with observations to determine whether natural variability or anthropogenic climate change as produced in the models can explain observed widespread decreases in sub-surface O2 between 1970 and 1990, and the long-term (50 year) declines in dissolved oxygen concentration of the tropical thermocline. (Abstract ID 10367)

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PARAMETERIZATION OF THE DARDALENES OUTFLOW IN THE AEGEAN SEA FROM THE BLACK SEA WATER BUDGET
The Black Sea Waters (BSW) outflow through the Dardanelles Straits is the strongest buoyant input for the Aegean Sea and determines significantly the hydrodynamic and physical characteristics of this region, with implications in the Eastern Mediterranean water masses. A new mathematical scheme is adapted to parameterize the large buoyant Dardanelles outflow that is not routinely monitored through the water budget of the adjacent Black Sea, which is available from atmospheric operational models. The scheme was applied in the 3-d hydrodynamic N. Aegean Sea HYCOM model (NAS-HYCOM, 1.5x106 cells). Validation of the parameterization approach showed higher correlation between model results and satellite and in situ data, in comparison to previous parameterizations that employed targeted experiments. We compare our modelled oxygen changes with observations to determine whether natural variability or anthropogenic climate change as produced in the models can explain observed widespread decreases in sub-surface O2 between 1970 and 1990, and the long-term (50 year) declines in dissolved oxygen concentration of the tropical thermocline. (Abstract ID 10367)

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RECONSTRUCTING ESTUARINE PALEOCLIMATE FROM MIDDEN SAMPLES: CHALLENGES OF TRANSPORTATION ACROSS SALINITY GRADIENTS.
Archaeological shell middens are increasingly utilized as sample sources for sclerochronological oxygen isotope paleoclimate reconstructions. Most middens are dominated by estuarine shell taxa. As such, uncontrolled and variable δ18O data profiles from the mid-Holocene Sapelo Island Shell Ring complex, 18Owater values confound interpretation of whether natural variability or anthropogenic climate change as produced in the models can explain observed widespread decreases in sub-surface O2 between 1970 and 1990, and the long-term (50 year) declines in dissolved oxygen concentration of the tropical thermocline. (Abstract ID 10367)
by site inhabitants may obscure underlying climate signals. This illustrates one factor that differentiates middens from non-anthropogenic sources of sclerochronology samples. The impact of transportation of shells from different habitats will be explored both in terms of how it contributes to incorrect interpretations of climate change and how such problems can be avoided. (Abstract ID 12066)

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INFLUENCE OF OCEAN COLOR DATA REPROCESSINGS ON SATELLITE-DERIVED CHLOROPHYLL CONCENTRATIONS IN THE PATAGONIA ARGENTINIAN SEA

A complete reprocessing of the entire satellite ocean color images is performed by OBPG-NASA when significant changes are made in algorithms, in processing schemes, etc. OBPG-NASA also performs a global scale validation and comparison of ocean color products after every reprocessing. In this work, we compared three distinct datasets: in situ, SeaWiFS and MODIS/Aqua satellite-derived chlorophyll data in the Patagonia Argentinean Sea, for two successive reprocessing (R2007 and R2009). Reports based on R2007 have pointed that SeaWiFS satellite data tends to overestimate chlorophyll concentration in zones of high pigment concentration in global scale. In R2007, the differences between SeaWiFS and MODIS/Aqua chlorophyll were dependent on concentration, with higher SeaWiFS/MODIS/Aqua values at low (high) pigment concentrations in Patagonian waters. Validation based on R2009, showed that SeaWiFS and MODIS/Aqua sensors underestimated in situ chlorophyll for concentrations above 1 mg m⁻³. Moreover, in R2009, the satellite-derived differences were independent on concentration, with higher MODIS/Aqua than SeaWiFS chlorophyll values. Therefore, changes in the differences between satellite/satellite and satellite/in situ chlorophyll concentrations caused by different reprocessing have also to be assessed at regional scales. (Abstract ID 12949)

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SEPARATING WHITECAP FRACTION OF ACTIVE WAVE BREAKING FROM SATELLITE ESTIMATES OF TOTAL WHITECAP FRACTION

As a surface expression of breaking waves, the oceanic whitecaps are manifestation of various air-sea interaction processes. Whitecap fraction observed from satellites-borne microwave radiometers provide the total whitecap fraction W, including foam generated during active wave breaking and residual foam left behind by these breaking waves. The total fraction is important for predictions of sea spray aerosol production and heat exchange. However, the active portion WA, is necessary for evaluating processes such as turbulent mixing, gas exchange, ocean ambient noise, and spray-mediated intensification of tropical storms. It is thus highly pertinent to be able to separate WA from W. Phillips concept of breaking wave statistics connects WA with the energy dissipation rate of breaking waves. We can estimate WA by combining the Phillips concept with dissipation rate values obtained from buoy measurements of the wave spectra. We will present the principle of separating WA from W; and preliminary results from one year buoy data matched in time and space with satellite observations of W. (Abstract ID 11665)

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VORTICAL MODE STIRRING, INTERNAL WAVES, AND THE INVERSE ENERGY CASCADE

Patches of well mixed fluid are spacial and ubiquitous in the ocean. The geostrophic adjustment of many mixed patches leads to vortical mode-stirring and is thought to enhance lateral dispersion. If vortical modes are densely populated, they interact, and an inverse energy cascade can occur. Numerical experiments were performed to study the effect of a large-scale internal wave on vortical mode fields and the associated inverse energy cascade. The internal wave shear does not disrupt the inverse cascade. Rather an internal wave can excite an inverse energy cascade by enhancing vortex interaction. Development of the instability of the vortices is quickened by the wave shear, and vortices split into propagating dipoles. If vortical modes are so densely populated that they interact even without the presence of a wave, adding a background wave enhances the inverse cascade. Continuous forcing of vortical modes and internal waves is necessary to maintain the inverse cascade. (Abstract ID 11738)

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GEOREGIONAL DISTRIBUTION OF DIURNAL AND SEMI-DIURNAL PARAMETRIC SUBHARMONIC INSTABILITY IN A GLOBAL OCEAN CIRCULATION MODEL

Simulations from a global ocean circulation model forced by atmospheric forcing fields and both semi-diurnal and diurnal astronomical tidal potential are used to investigate the presence of parametric subharmonic instability (PSI) arising from both diurnal and semi-diurnal tides. A previous investigation observed PSI in a global model due to the M₂ internal tide (Simmons, 2008). The model used in that case did not include atmospheric forcing, PSI was found in narrow regions around the critical latitude (CL) of the M₂ subharmonic (latitude ± 28.8 degrees). The atmospheric forcing included in the simulations presented here leads to horizontally varying stratification, and vigorous mesoscale and near-inertial fields. In the case of the semi-diurnal tides, evidence of PSI is found around the CL but occupying a broader range than previously observed. The PSI arising from the diurnal tides have, for the most part, comparable variances equatorward of their maximum critical latitude (± 14.5 degrees) and are not as localized around these latitudes. (Abstract ID 11281)

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BIOLGICAL AND ECO SYSTEM OBSERVATION OF THE DEEP OCEAN

The deep oceans are becoming an increasingly important source of food, energy, minerals, and genetic resources; but we still lack scientific concepts and societal regulations as to their sustainable use and protection. One reason for the large uncertainty as to human impact and the time scale and effect of global change on deep-water ecosystems is the lack of spatial and temporal studies with comprehensive approaches. There are only few deep-sea areas worldwide where time series and integrated ecosystem data exist, to define a baseline against which natural variation and human impact could be assessed. Hence, deep ocean observations merit renewed attention in the context of recent technological advances in underwater imaging, acoustics, in situ sensors and chemical analyzers. The range of autonomous, continuous measurements for assessing derived variables such as ecosystem function, biodiversity and biogeochemical processes are still a major technological challenge, often limiting the assessment of variation in deep water ecosystems to a few physical parameters. This presentation discusses the need for integrated ocean observation and new concepts enabling ecosystem assessment in the deep ocean. Examples are given from regional annual to decadal seafloor observatories in temperate and polar seas. (Abstract ID 12628)

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EUROPEAN PROSPECTS FOR A GEOSTATIONARY OCEAN COLOR SENSOR: THE “OCEAN COLOR ADVANCED PERMANENT IMAGER” (OCAPI)

The “Ocean Color Advanced Permanent Imager” (OCAPI) mission aims at hourly observations of ocean color in coastal zones and the open ocean from a geosynchronous (GEO) orbit, at a nadir resolution of 250m over the entire Earth’s oceanic and coastal areas as seen from a GEO position over Europe. This includes virtually the whole Atlantic Ocean, the Mediterranean Sea and European Nordic seas. The science domains that would benefit from a global GEO ocean color observation from a geostationary satellite over Europe. This includes virtually the whole Atlantic Ocean, the Mediterranean Sea and European Nordic seas. The science domains that would benefit from a global GEO ocean color observation are: ocean color biology and physics and biology and the consequences on primary production and carbon fluxes, the assimilation of coupled ocean physical-ecosystem models, the study of the dynamics of the coastal ocean ecosystems, the quantification of sediment and carbon transport and fluxes from land to ocean, the study of aerosol transport from land to sea, including dust or volcanic aerosols. We will present the preparatory scientific activities that underlay this mission proposal, as well as the status of definition studies for the mission and instrument concepts. (Abstract ID 11112)
The accident of the Fukushima Daiichi Nuclear Power Plant (TEPCO, Japan) caused radionuclide release in marine environment. Although total amount of radionuclide that has entered the ocean is unknown, the radionuclide, i.e. 131I, Cs-134, Ag-110m etc., was not detected before this accident, was detected in deposition, seawater, sediment and marine organisms. To investigate the long-term behaviour of radionuclide in the marine environment, several marine samples, i.e. seawater, sediments, biological samples were collected in the seas around Fukushima and their radionuclide activities were measured. The Cs-134 and Cs-137 activities in surface seawater off Fukushima on August were ranged from 0.02 to 0.2 Bq/L, respectively, and the Cs-134/Cs-137 activity ratios were almost 0.9. We will discuss the variation of radionuclide activities in marine samples to assess these effects in marine environment. (Abstract ID 11248)

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CREATING CONCEPTUAL DIAGRAMS WITH ADOBE ILLUSTRATOR: AN IMPORTANT COMMUNICATION TOOL FOR PRE-CAREER SCIENTISTS

Conceptual diagrams are a versatile tool for communicating scientific information in a straightforward and informative manner and are, as such, a valuable approach to increasing ocean literacy among non-scientist and informal audiences. Using Adobe Illustrator, we have developed an extensive symbol library that can be used to create conceptual diagrams that strengthen understanding of marine ecological processes. For educators, the interactive process of creating conceptual diagrams with learners improves their understanding of ocean science, as well as reveals prior knowledge and misconceptions, and is thus well-suited for a constructivist approach to concept development. For pre-career scientists, conceptual diagrams help simplify and visualize understanding of one’s own research and provide a valuable medium for communicating science in an accessible manner to a broad range of audiences. Our presentation will provide an overview of how to incorporate conceptual diagrams into COSIA courses and other pre-career scientist training. We will also provide concrete examples of how conceptual diagrams have been implemented as a learning and communication tool, specifically through modules created in collaboration with CONSE Coastal Trends. (Abstract ID 12638)

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EARLY DETECTION OF THE INVASIVE ASCIDIANS BOTRYLLUS SCHLOSSERI AND BOTRYLLOIDES VIOLEAUS UTILIZING TAQMAN ASSAYS

The ascuculture industry on the Atlantic and Pacific coasts of Canada is being threatened by the invasion of non-indigenous species. Two species that are particularly problematic for mussel aquaculture are the ascidians Botryllus schlosseri (SCH) and Botrylloides violaceus (VIO). Without early detection mitigation has been ineffective. The biggest challenge for early detection is that the eggs and larvae of many ascidian species are morphologically similar, making visual identification difficult. Thus, genetic techniques for identification are being developed. To date, partial sequences for the cytochrom c oxidase 1 (COI) gene of multiple individuals representing multiple colour morphs for VIO have been sequenced. COI sequence alignments have been performed to identify areas that are conserved intraspecifically but not interspecifically. From the intraspecifically conserved sequences, species-specific TaqMan real-time polymerase chain reaction assays were designed and tested. We aim to develop TaqMan assays that may be used to identify the presence of VIO and SCH larvae and fragments globally. The sequence data will also be used to gain insight into possible source populations of these ascidians in Newfoundland. (Abstract ID 10571)

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IMPACT OF INTERNAL TIDES ON THE WAVENUMBER SPECTRUM OF SEA SURFACE HEIGHT

The slope of the wavenumber spectrum of sea surface height (SSH) is used to infer the dynamics. Internal tides are ubiquitous high-frequency motions in the ocean, which can mask the variability from other types of motions. We utilize a new global simulation, which simultaneously contains both atmospheric and tidal forcing, to determine the impact of internal tides on the SSH wavenumber spectrum. We examine the spectra in regions of strong and weak internal tide in both 1/12 and 1/25 degree global simulations, and in 1 km regional simulations. With the hourly output all SSH can be separated into high- and low-frequencies. In regions near Hawaii the slope of the wavenumber spectrum of the low-frequency sea surface height lies near the predictions of surface quasi-geostrophic theory, but is buried underneath the much larger internal tide signal. The implication for the planned wide-swath satellite altimeter mission is that in regions of high internal tide activity the tidal corrections on meso- and submesoscales will need to be very accurate for non-tidal dynamics to be revealed. (Abstract ID 936)

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HUMBOLDT SQUID STATLITH MICROCHEMISTRY STUDY USING LASER ABLATION INDULECTIVELY COUPLED PLASMA MASS SPECTROMETRY (LA-ICP-MS)

The Humboldt Squid, Dosidicus gigas, is expanding its historical habitat range of the Eastern Equatorial Pacific both north and south. It has been sighted in Alaska and may have an established population in Monterey Bay, California. Although there is concern for fisheries species being decimated by this new predator, there is much about the population structure of Humboldt squid that is not well understood. In order to learn more about the life history and population dynamics of this species, we researched the microchemistry of small calcium carbonate deposits known as statoliths. Sample specimens were collected from three geographic regions. Statoliths are deposited in daily layers of aragonite and incorporate trace elements reflecting the individual squid’s behavior. We will present variations in microchemistry comparing the geographic groups as well as changes during the life of individuals as determined using LA-ICP-MS. Patterns in microchemistry may occur as the animals grow, mature, and migrate. Differences between populations may show how the sample groups utilize opportunistic strategies to survive in different geographic regions and will contribute to understanding the life history of this species. (Abstract ID 11663)

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APPLICATION OF HIGH FREQUENCY (HF) RADAR AND THE OKUBO-WEISS PARAMETER TO ANALYZE SUBMESOSCALE VARIABILITY IN THE FLORIDA CURRENT

The Florida Current (FC) is a coastal oceanic regime with large horizontal shears, local vorticity maxima and topographic constraints. Small-scale vortices are generated on its western flank that travel northward along the continental shelf offshore of South Florida. Transient submesoscale features with scales of a few kilometers are not easily observed by traditional in-situ instruments or satellites, but are well resolved by HF radar. Dual-station HF Wellen Radar (WERA), operating at 16045 MHz, acquired a nearly continuous data set of surface current velocities at 20-min intervals with a range of 80 km, and a horizontal resolution of 1.2 km over the past several years. These data are quality controlled and objectively mapped to a uniform grid 45×45 km (1980 cells). The Okubo-Weiss (OW) parameter is estimated to connect regions of positive vorticity that represent cyclonic submesoscale events. The relative contributions of the OW terms (stress, data are quality controlled and objectively mapped to a uniform grid 45×45 km (1980 cells). The Okubo-Weiss (OW) parameter is estimated to connect regions of positive vorticity that represent cyclonic submesoscale events. The relative contributions of the OW terms (stress, strain, vorticity) are isolated to examine their behaviour on the observed current structure. We attempt to relate events to wind stress, FC-variability, and topography to understand the dominant forcing mechanisms. (Abstract ID 12568)

DATA QUALITY IMPROVEMENTS FOR SATELLITE SEA SURFACE SALINITY DATA

The recently available SMOS sea surface salinity (SSS) exhibits areas of increased measurement error (associated with land contamination, RFI, auxiliary wind product deficiencies, external noise or instrument inaccuracies). In this study, we present some of the strategies developed at the SMOS-BEC to improve SSS data quality. Ocean Target Transformation (OTT) is used in the operational Level 2 processor. Three conflicting factors impact its efficiency: the number of observations used to compute the OTT (more data increase robustness); 2) the apparent instrument (temporal) drift (requiring periodic OTT updates); and 3) the effect of latitudinal variation (suggesting the need for spatial OTT filtering). We propose several palliative procedures for OTT deficiency mitigation. Additionally, we present an updated sea surface roughness formulation based on retrieved SMOS data. The dependencies with incidence angle and several roughness-related parameters (wind speed, mean square slope, significant wave height, wave age, wind stress) are considered in the improved approach. We also introduce a method for optimal multi-regime estimation of missing data (zones of too large error). First, by combining data from moored stations (TAO/TRITON) with model results (ECCO-JPL) treated as synthetic data, we achieve improved quality predictions. Then, the method is used to fill areas that have been flagged as having too large errors while preserving the non-Gaussian character of the SSS data. (Abstract ID 11954)

MECHANISMS CONTROLLING STRATIFICATION AT TIDAL TIME SCALES IN DELAWARE BAY ESTUARY

Observations in the Delaware River estuary revealed that tidal period variability in salinity stratification is inconsistent with the classic model of tidal straining (Simpson et al., 1990). In particular, we consistently observed stronger stratification during the flood relative to the ebb. Qualitatively the tidal period variability is the result of lateral flows acting on the cross-channel salinity gradients that tend to stratify the water column during flood while their reversal on ebb reduce stratification. However the spatiotemporal structure of the lateral flows are complex and suggestive of Ekman processes that are modified by tidal period lateral baroclinic adjustments. We diagnosed the rate of change of potential energy to quantify the importance of the lateral flows relative to the along channel flows in driving tidal period variability in stratification. Results demonstrate that lateral flows in fact compete against the along channel flows and point to the important roles of mixing and frontal systems in modifying the tidal period variability in potential energy. (Abstract ID 11958)
underway data to NOCDC; 2) a procedure for “first-pass” rapid assessment of data quality that yields a set of summary statistics and data plots after each cruise; and 3) coordinated links between the R2R cruise catalog, original data archived at NOCDC, and processed products at JASADCPR. We will present initial results and lessons learned. (Abstract ID 11529)

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THE INFLUENCE OF PHYTOPLANKTON COMMUNITY STRUCTURE ON NET COMMUNITY PRODUCTION AND AIR-SEA CO2 FLUX IN THE SUBTROPICAL AND SUBARCTIC NORTH PACIFIC

We used continuous underway measurements of the ratio of dissolved oxygen to argon gas (O2/Ar) and SeaFlow (a novel underway flow cytometer) in the surface mixed layer to estimate net community production rates (NCP) and phytoplankton community structure at ~4 km resolution across the subtropical and subarctic north Pacific during container ship cruises from Hong Kong to Long Beach in May and July 2011. Phytoplankton populations were classified based on size, pigment composition. We observed a range in O2/Ar saturation from a mean 0.1 (± 0.4)% in the subtopics to 18% in a frontal region off the coast of Japan, which corresponded to a NCP range of 1.7 (± 2.5) to 200 mmol O2m2d-1. Increased NCP in this frontal region was highly spatially correlated with increased surface chlorophyll-a and particulate organic carbon concentrations and shifts in the phytoplankton community from Synechococcus to ultraplankton dominated regions. Additionally, estimates of air-sea CO2 flux, gross oxygen production rates (from isopotes of dissolved oxygen), and the export ratio will be presented. (Abstract ID 10713)

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COMPARISONS OF REGIONAL SEA SURFACE TEMPERATURE GRADIENTS FROM MODIS AND AVHRR

Investigations of sea surface temperature (SST) gradients are becoming more prevalent especially in interdisciplinary applications such as fisheries and ecological habitat characterizations. SST fronts are also often correlated with ocean properties such as water mass, and biological variables such as chlorophyll and nutrients, and therefore are used to characterize and predict habitat. In this study regional SST gradients and fronts are examined for a six year time series comparison using data from MODIS on Aqua and AVHRR. Two regions, one in the California Current System and the other in the Gulf Stream, representing an eastern boundary upwelling region and strong western boundary current, respectively, were chosen to investigate the seasonal variability, statistical differences and similarities, and correlations with respect to the two sets of SST gradients. Results indicate higher gradient magnitudes for the MODIS SST gradients relative to those derived from AVHRR that are attributed to instrument and algorithm differences. These observed differences are important for any studies that employ SST gradients, such as fisheries investigations that have traditionally relied on AVHRR SST gradients only. (Abstract ID 10857)

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GENERALIZED OPTIMALITY SOLUTIONS FOR NUTRIENT TRADEOFFS IN PHOTOACCLIMATION AND PHOTOSYNTHESIS IN GEIDER ET AL. (1998)-TYPE MODELS

The Geider et al. (1998) model of photoacclimation, photosynthesis, and nutrient limitation is based on an exponential functional form for the photosynthesis-light relationship. Armstrong (2006) used this exponential form in proposing an alternative photoacclimation/ nutrient limitation model based on optimality. Here I generalize the optimality approach to any “reasonable” functional form, and present a set of algebraic models with more tractable mathematical properties. Unlike the exponential, the two simplest algebraic forms can be integrated over depth intervals, making their use in earth system models efficient computationally. Simultaneous fits of chlorophyll/carbon ratios, nitorgen/carbon ratios, and growth rates to this set of algebraic models, as well as to the exponential model, has allowed identification of problems in calibrating photosynthesis models; the most serious of these is that inappropriate use of data from nutrient-sufficient cultures can lead to unstable parameter estimates. These insights could not have been obtained had only a single model been subject to calibration. (Abstract ID 11757)

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MIXING IN FJORDS AND THE RELATION BETWEEN LOCAL ENERGY DISSIPATION AT A FJORD SILL AND RADIATED INTERNAL TIDES

Diapycnal mixing in a sill fjord is vital for renewal of the deep water inside the sill. Tides can cause such mixing, both by local turbulence at the sill associated with supercritical baroclinic flow and internal hydraulic jumps, and by radiation of internal tides away from the sill that dissipate elsewhere and cause turbulence and mixing there. Previous studies tend to look at these two processes as independent of each others, whereas they in reality are closely linked: The internal tide generation depends on the hydraulic conditions at the fjord sill, and the internal hydraulic jump strength depends on the upstream and downstream radiated columnar disturbances which over time constitute the internal tides. An effort is done to link the hydraulic theory and the internal tide generation theory, and the result is compared to recent intensive observations over the Oslo fjord sill, including high-resolution microstructure profiler transsects and mooring data on and inside the sill. (Abstract ID 11095)

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MONITORING OCEAN WATER LEAVING RADIANCE FOR INTER - SATELLITE CONTINUITY

A new approach is presented to track stability of ocean color products in global ocean waters. Time series of water leaving radiance (nLw) from different water types is used to track satellite ocean color which is used to derive ocean products. Various AERONET ocean color (AOC) sites and additional stable “blue” water regions provide a monitoring network to track the uncertainty of nLw from MODIS, MERIS, VIIRS, and GOCE. We determined, 1) regional “bias” of nLw in different ocean types and 2) inter-satellite “bias” that occur at these locations. We monitored “bias” by using a vicarious approach which propagates nLw to Top of Atmosphere (TOA) and determined the ratio i.e. “offset” from observed satellite TOA. We also introduce the creation of “synthetic AERONET –OC sites” based on MODIS nLw which are used with the vicarious approach for monitoring inter – satellite “bias.” Through monitoring yearly “bias” of sites in blue waters, we track the trends of inter satellite offsets of nLw and product validation. Results from coastal regions AOC suggest higher “bias” in nLw validation for several satellites. Decreased blue “bias” is observed in open ocean blue water regions. (Abstract ID 12162)

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COMPARISON OF INTRATIDAL VARIATIONS OF SHEAR PRODUCTION, TURBULENCE DISSIPATION, AND MIXING ACROSS AN ESTUARY

Measurements were obtained in the James River estuary to compare intratidal variations of shear production, TKE dissipation, Reynolds stresses and vertical eddy viscosity values at two locations across a transect. Experiments were carried out for four semidiurnal tidal cycles during May 2010 (two in neap, two in spring) with the purpose of investigating channel to channel slope variations of these parameters during a spring/neap modulation. Two bottom-mounted 1 kHz ADCPs sampled velocity profiles in bursts, while a microstructure profiler (SCAMP) collected profiles of temperature gradient and electrical conductivity. The TKE dissipation was estimated via Batchelor fitting and compared to shear production, calculated using a structure function. During all surveys, the TKE dissipation showed intratidal variability that ranged from 10⁻¹⁰ to 10⁻⁵ m²/s³. The largest values were observed near bottom, with maximum (10⁻⁴ m²/s) values varying a different times in the tidal cycle, depending on the location across the transect. These observations will be compared to values Reynolds stresses and vertical eddy viscosity values (via Reynolds stresses and Osborn’s parameterization). (Abstract ID 11444)

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INVESTIGATION OF A STRATIFIED BAROTROPIC MIXING LAYER WITH COORDINATE SYSTEM ROTATION

Submesoscale ocean dynamics are characterized by stable stratification and significant, but far from dominant rotational effects. We focus our study on a barotropic mixing layer having Rossby and Froude numbers initially of O(1). Both linear stability analysis (LSA) and direct
numerical simulations (DNS) are performed to analyze the model problem. LSA results suggest that strong stratification ($Fr < 1$) tends to stabilize the inertial instability, while increasing the range of vertical wavenumbers associated with barotropic instability. A new LSA result is that, when absolute vorticity is nearly zero at the inflection point, the range of vertical wavenumbers associated with barotropic instability greatly increases. Correspondingly, DNS of the nonlinear evolution show significant destabilization of the anticyclonic mixing layer including a rapid increase of the vortex stretching term when the flow transitions through the zero absolute vorticity state. A network of coherent longitudinal vortices emerges in the anticyclonic cases, while coherent vorticity evolves very similarly between the non-rotating and cyclonic cases. In the anticyclonic cases, breakdown into small-scale turbulence and secondary instabilities in localized regions of intensified vertical shear are also observed. (Abstract ID 11994)

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TIDES UNDER THE ROSS ICE SHELF FRONT: CONTRIBUTIONS TO MIXING AND MELTING

Tides under the Ross Ice Shelf (RIS) contribute to mixing near the ice-shelf base, leading to basal melting and mass loss. Recent measurements of RIS basal melt rate indicate that rates are highest near the ice front, where tidal current characteristics change over short spatial scales. We use data from two moorings (M-1 and M-2) under the RIS near the ice front, and numerical model output, to investigate how tides might contribute to near-ice-front melting. The moorings measured water velocity, conductivity, and temperature for 2 months during the 2010 austral summer. Tidal analysis of the data revealed that ~50% of the current variability is caused by tides, particularly by the diurnal K1, O1, and P1 constituents. The CATS2008 Antarctic barotropic tide model results agree with our mooring analyses, allowing us to use this model to investigate tidal current variability elsewhere along the ice front. We also compare our measurements with the output from baroclinic models of the Ross Sea. These show seasonal variability of basal melt rates near the ice front, indicating the need for longer-term records of sub-ice-shelf currents. (Abstract ID 10699)

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LOOKING UNDER THE ROSS ICE SHELF: TIDAL AND SUBTIDAL VARIABILITY

Two moorings (M-1 and M-2) measured water velocity, conductivity, and temperature under the Ross Ice Shelf (RIS) during the 2010 austral summer. Tidal harmonic analysis of the data revealed that ~50% of the current variability is caused by tides, particularly by the diurnal K1, O1, and P1 constituents. The tidal signal is consistent between the two moorings, with most of the tidal currents oriented roughly normal to the ice edge. The tidal energy flux computed with the mooring data shows a K1 energy transport into the RIS cavity and a smaller M2 energy transport out of it. The CATS2008 tidal model results agree with our calculations and suggest that the M2 constituent propagates like a Kelvin wave around the RIS cavity while the K1 behavior is more complex. Subtidal current velocities are incoherent between the two moorings but vertically coherent at each mooring. Progressive vector diagrams and nearby sea ice motion suggest that the M2 constituent propagates like a Kelvin wave around the RIS cavity while the K1 behavior is more complex. Subtidal current velocities are incoherent between the two moorings but vertically coherent at each mooring. Progressive vector diagrams and nearby sea ice motion suggest that the M2 constituent propagates like a Kelvin wave around the RIS cavity while the K1 behavior is more complex. Subtidal current velocities are incoherent between the two moorings but vertically coherent at each mooring. Progressive vector diagrams and nearby sea ice motion suggest that the M2 constituent propagates like a Kelvin wave around the RIS cavity while the K1 behavior is more complex. Subtidal current velocities are incoherent between the two moorings but vertically coherent at each mooring. Progressive vector diagrams and nearby sea ice motion suggest that the M2 constituent propagates like a Kelvin wave around the RIS cavity while
Salinity gradients in the top few meters of the ocean surface can exist due to precipitation or other freshwater inputs. If present, they will complicate comparing salinity measured at depths of five meters typical of the ARGO drifters to salinities retrieved using L-band microwave radiometers, whose measurement depths are on order of 0.1 m. Therefore, understanding the spatial scales and temporal persistence of these gradients and the conditions under which they form will be important in understanding sea-surface salinity maps provided by Aquarius. Near-surface salinity gradients were measured by installing thermalalinographs (TSGs) in through-hull ports at depths of 2 m and 3 m on the R/V Thomas G. Thompson. Salinity gradients in the top two meters were also measured using a towed profiler that was capable of resolving gradients on the same vertical scale as the radiometric measurement depth. The results suggest that not only can precipitation produce gradients in near-surface salinity with horizontal spatial scales comparable to the footprint of Aquarius, the magnitude of the gradient is significant in terms of the overall accuracy of the satellite. (Abstract ID 10778)

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DETECTING INTERANNUAL CHANGES IN PHENOLOGY WITH REMOTELY SENSED DATA: A COMPARISON OF THREE METHODS

Prior studies of the phenomenology of remotely sensed time series have applied different measures of phenological change and little effort has been made to compare approaches. I employed three new or revised methods to detect interannual fluctuations in phenological events in the California Current Ecosystem. The start, midpoint, and end of seasons characterized by either elevated SST, upwelling, or chlorophyll were identified based on 1) the date when a variable exceeded 75% of its annual range; 2) inflections of piece-wise curves fit to a time series; or 3) a non-stationary harmonic model. Events identified with the threshold and curve-fitting methods were closely correlated, whereas significant correlations were rare when comparing the curve-fitting and harmonic approaches. The low standard deviation of events identified with the harmonic method indicated this approach could not fully detect interannual variability. The other methods better characterized interannual variations, but had less power to distinguish seasonal signals from high-frequency fluctuations. Greatest consistency between methods was achieved when examining season midpoints. Future work should be sensitive to choice of phenomenological grid given each methods inherent benefits and deficiencies. (Abstract ID 10016)

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HOW WARM IS IT THERE: HIGH ACCURACY MEASUREMENTS OF THE SURFACE WIND IN THE SOUTHERN OCEAN

The Southern Ocean plays an important role in determining the climate of the Earth. It is also an important source of DMS in the ice-free Ross Sea Polynya. Our findings suggest that the SIZ may contribute significantly to the Southern Ocean DMS cycle. (Abstract ID 9871)

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A WINTER EXPEDITION TO EXPLORE THE BIOLOGICAL AND PHYSICAL CONDITIONS OF THE BERING, CHUKCHI, AND SOUTHERN BEAUFORT SEAS

Our understanding of seasonality, particularly winter conditions, in the Arctic is severely limited. This lack of knowledge has compromised our ability to model and to predict Arctic ecosystems, knowledge critical to our efforts to understand the potential impacts of ongoing climate change. In November-December 2011 we will be conducting a cruise on the USCGC Healy to the to the Bering, Chukchi, and Beaufort Seas. We have identified a set of key transects in the various cross-shelf-slope regimes along which we will conduct physical (hydrography, circulation), chemical (nutrients, dissolved organic matter), and biological (zooplankton, microzooplankton, chlorophyll, marine bird) sampling. Our objectives include describing hydrography, circulation, and aspects of the planktonic, nutrient, and dissolved organic matter environments, identifying the overwintering habitat of Calanus spp. and overwintering strategies of phytoplankton, determining the condition and activity (respiration) of Calanus spp., euphausiids, bacteria, and phytoplankton, and quantifying the coarse- and fine-scale vertical distributions of plankton and particles in relation to the vertical structure of the water column. Here we present preliminary findings on the hydrography and aspects of the biology from the winter cruise. (Abstract ID 9949)

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AUTONOMOUS SENSORS IN THE BERING, CHUKCHI, AND SOUTHERN BEAUFORT SEAS

Our understanding of seasonality, particularly winter conditions, in the Arctic is severely limited. This lack of knowledge has compromised our ability to model and to predict Arctic ecosystems, knowledge critical to our efforts to understand the potential impacts of ongoing climate change. In November-December 2011 we will be conducting a cruise on the USCGC Healy to the to the Bering, Chukchi, and Beaufort Seas. We have identified a set of key transects in the various cross-shelf-slope regimes along which we will conduct physical (hydrography, circulation), chemical (nutrients, dissolved organic matter), and biological (zooplankton, microzooplankton, chlorophyll, marine bird) sampling. Our objectives include describing hydrography, circulation, and aspects of the planktonic, nutrient, and dissolved organic matter environments, identifying the overwintering habitat of Calanus spp. and overwintering strategies of phytoplankton, determining the condition and activity (respiration) of Calanus spp., euphausiids, bacteria, and phytoplankton, and quantifying the coarse- and fine-scale vertical distributions of plankton and particles in relation to the vertical structure of the water column. Here we present preliminary findings on the hydrography and aspects of the biology from the winter cruise. (Abstract ID 9949)

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MIXED LAYER HEAT BUDGET IN THE EAST CHINA SEA

In contrast to the effect of SST on the short timescale meteorological disturbances such as mesoscale cyclones, the climatological role of the SST distribution in the East China Sea (ECS) remains unclear. The atmospheric and oceanic reanalysis data indicate the northward migration of the climatological atmospheric front in the ECS is influenced by the ocean mixed layer temperature (OMLT) during early summer, suggesting an active role of ocean in a seasonal timescale. In order to clarify the mechanism responsible for the seasonal evolution
A season of glider missions in the western arm of Lake Superior revealed a wide variety of previously unobserved fine spatial and temporal structure in both physical and biogeochemical properties. These are the first observations made by an underwater glider in a large lake. Glider flights were made repeatedly along a 22 km long cross-lake section, measuring temperature, conductivity, Oxy-Cl fluorescence, backscatter, and dissolved oxygen throughout the water column. The flights revealed fine lateral spatial structure concentrated on the south shore of the section, which receives sediment-rich river input from Northern Wisconsin and the St. Louis Estuary, whereas less variability is found in the northern portion of the section, primarily fed by small rivers along the mostly bedrock north shore of Minnesota. Chlorophyll fluorescence shows a distinct subsurface maximum with coherence over tens of kilometers, and there are frequently multiple subsurface maxima, suggesting strong physical control of their formation or multiple phytoplankton populations with different light and temperature niches. CDOM distribution appears to be associated with river plume activity and unrelated to Chl-a distribution. (Abstract ID 11549)

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THE IMPORTANCE OF GEOSTROPHIC ADVECTION IN REGULATING THE NORTH PACIFIC CARBON SINK

A broad swath across the North Pacific basin uptakes a disproportionately large amount of atmospheric CO2 every year, with the region of most intense uptake located in the North Pacific transition zone, from ~30°N to 40-45°N. In this work we use observational carbon data to investigate processes regulating air-sea CO2 flux in this region on seasonal and annual timescales by quantifying the impacts of temperature, biology; and physical circulation on seawater pCO2. We find that temperature effects dominate the pCO2 signal seasonally, yet support only 15-20% of the annual CO2 uptake in the region, via their impact on the solubility of CO2 in seawater. Instead, processes removing carbon from surface waters dominantly support the region's uptake of CO2 on annual timescales: the vertical export of organic carbon to depth, and the geostrophic advection of dissolved inorganic carbon laterally out of the region. We find the location of this carbon sink region, often attributed to a combination of biological and temperature effects, to instead be driven by the steady geostrophic divergence of DIC at these latitudes. (Abstract ID 9916)

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COASTAL OCEAN RESPONSE TO WINTER STORMS IN THE BAY OF BISCAY (NORTH EAST ATLANTIC): IMPACT OF ATMOSPHERIC FORCING UNCERTAINTIES

This study presents the results of modeling experiments aiming at better understanding the response of the ocean surface layers to extra-tropical winter storms in the Bay of Biscay. What are the impacts of a strong winds event on surface currents, surface temperature and mixed-layer depth? How sensitive is this response to uncertainties in the atmospheric forcing? In particular, our objective is to characterize the effect of wind forcing uncertainties on the vertical mixing processes and advection terms that drive the mixed-layer temperature variability. We focus on the Bay of Biscay during the winter 2007-08. The circulation there is characterized by a high frequency variability due to the atmospheric variability, large barotropic and internal tides and slope current instabilities. We use the coastal regional model Symphone, developed at POC/ Laboratoire d'Aérologie (Toulouse, France). The model sensitivity to atmospheric uncertainties is analyzed from a stochastic modeling approach where an ensemble of simulations is generated by perturbing the wind velocity. Different regimes in the shelf and deep ocean are found, with large sensitivities of the sea surface temperature on the shelf. (Abstract ID 11027)

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GLIDER OBSERVATIONS OF PHYSICAL AND BIOGEOCHEMICAL PROPERTY DISTRIBUTIONS IN LAKE SUPERIOR

of the OMLT, the heat budget is evaluated using the high-resolution ocean reanalysis data. On the shelf edge, the monthly mean OMLT is mainly determined by the monthly mean surface heat flux and the advection due to the monthly mean horizontal currents. The horizontal eddy and vertical shear terms are turned out to be minor. One shelf, the horizontal advection plays a secondary role. In addition to the surface heat flux, cooling effect that is probably due to entrainment across the base of the mixed layer becomes important during summer. (Abstract ID 10894)

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HUMAN SENSOR NETWORKS FOR IMPROVED OIL SPILL PREDICTIONS

We describe the novel use of Human Sensor Networks (HSN) to augment the US response to extreme events. We capture Social Media (SM) data, and apply ensemble Kalman filter assimilation to incorporate the processed information into forecasting models. The system methodologies are applicable to the wider class of extreme events. A successful demonstration is shown for the Deepwater Horizon Oil Spill where HSN data are combined with satellite oil spill observations for assimilation in the general NOAA Operational Modeling Environment (GNOME). The GNOME model uses real-time surface winds, ocean currents, and satellite shape profiles of oil to forecast oil spill movement. Geolocated and timestamped Flickr images of beached oil were mined as boundary forcing conditions. We show that SM data can greatly supplement the current operational practice of sending out teams of humans to collect samples of tarballs reaching coastal locations. The combination of SM data and oil spill shape profiles generated by a Self Organizing Map algorithm can improve uncertain estimates of diffusive coefficients and rates of oil spill in the GNOME model parameterizations. (Abstract ID 10890)

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INTEGRATING ANIMAL BORNE SENSORS WITH SMARTS CLIMATOLOGY MODEL IMPROVES FORECASTS OF HURRICANE INTENSITY AND FISHERY'S DYNAMICS

Hurricane intensity forecasting has been advanced by a new Systematically Merged Atlantic Regional Temperature and Salinity (SMARTS) Climatology model that blends temperature and salinity fields from the World Ocean Atlas 2001 and Generalized Digital Environmental Model at 1/4° resolution. The two-layer reduced gravity model framework facilitates robust daily estimates of isotherm depths from regional radar altimetry. In addition to tracking the depth of the 26oC isotherm for hurricane intensity forecasting, hundreds of Atlantic tarpon satellite-tagged with temperature-depth-salinity and GPS sensors have shown that tarpon closely followed this isotherm depth during their seasonal long-range migrations in the Gulf of Mexico and along the eastern seaboard. Tarpon sport-fishing is a $6 billion industry in the United States alone, but the resource is vulnerable to fishing and environmental changes. We explore how an enhanced network of animal-borne sensor deployments integrated within the SMARTS technology framework helps to improve understanding of the coupled dynamical behaviors of ocean-atmosphere and fish stock migrations that may portend a new era of forecasting hurricane intensity and novel ecosystem-based strategies for sustaining key ocean fisheries. (Abstract ID 12593)

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QUANTIFYING SPATIAL RESOLUTION REQUIREMENTS FOR SATELLITE-BASED DETECTION OF BIOGEOCHEMICAL VARIABILITY IN RIVER PLUMES

Inter-pixel variability in satellite retrievals of biogeochemical properties at various spatial resolutions is used to investigate the optimal ground space distance (GSD) for the detection of total suspended material (TSM) river discharge during peak and minimum flow periods. Event driven, seasonal, and climatic fluctuations in river discharge and associated material fluxes have major implications for carbon budgets, fisheries and habitait, hyopxia, and pollution dispersal. Accurate detection of the extent and evolution of plumes will require adequate temporal, spectral, and spatial resolution in future ocean color missions such as Geostationary Coastal and Air Pollution Events (GEOCAPE). In this study, satellite data at the outflow of four major plume locations (Mississippi River, Susquehanna River, Chesapeake Bay, Amazon River, and Yangze River) were used to determine the resolution necessary to detect dispersion of TSM. Preliminary findings indicate that moderately high resolution retrievals (< 500 m) capture the majority of biogeochemical variability, while 1 km data misses significant variability. (Abstract ID 11972)
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DECADAL TREND OF LONG-TERM CARBON SINK IN THE LABRADOR SEA

The Labrador Sea is one of two sites in the North Atlantic that produce intermediate and deep water by winter convection. Atmospheric CO2 that is taken up in the surface water is quickly transported to depths during deep convection and subsequently spreads to various regions of the North Atlantic. Some of this sequestered CO2 is incorporated into the meridional overturning circulation and stored in the deep ocean potentially for hundreds of years, thus, the Labrador Sea provides a conduit for long-term storage of atmospheric CO2. It is important to understand the size and variability of this CO2 sink in order to assess the role of the oceans in the global carbon cycle. We will present data showing the accumulation of atmospheric CO2 in the deep convection region along the Labrador Sea repeat section from 1996 to 2010. The inventory of DIC in the Labrador Sea was 106±14 PgC from the basin wide survey in 1997. The average inventory increase is 0.04 Pg C/year for the period from 1996 to 2010. The role of variable deep convection depths for uptake of atmospheric CO2 is discussed. (Abstract ID 9834)

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COSEE-TEK TEACHER TECHNOLOGY EXPERIENCE: A CATALYST FOR LEARNING AND COMMUNICATING OCEAN SCIENCE AND TECHNOLOGY

The goal of COSEE-TEK is to improve ocean science education by highlighting the enabling role of technology and engineering in the ocean sciences and develop technology derived education and outreach resources to catalyze learning and communication of STEM topics for teachers, students, scientists, and the public. Educational resources illustrate the evolution of oceanographic technologies into complex integrated systems capable of addressing broader spatial and temporal scales. Three Teacher Technology Experiences (TTE) and a Teacher Ocean Technology Institute (TOTI) were held in 2011. The TTEs built teams of formal and informal educators working with scientists, graduate/undergraduate students and technicians from the University of Connecticut’s Department of Marine Sciences. The goals of the TTEs were to improve educators’ technology content knowledge, heighten scientists’ awareness of the challenges of science education and outreach and broaden the impacts of researchers science and technology by web-based educational resources. Evaluation results show a positive impact on both educators and scientist participants, including bringing scientific research into the classroom or informal venue, positive impacts on scientists’ view of education and ability to deliver quality broader impacts. (Abstract ID 11805)

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SEDIMENT NITROGEN CYCLING FOLLOWING A SIMULATED DISCHARGE EVENT

A sediment / water mesocosm experimental design was used to investigate the response of nitrogen cycle processes to organic matter (OM) loading. The sequential changes in dissolved inorganic nitrogen (DIN) species in the overlying water after OM additions were followed in replicate tanks consisting of Chesapeake Bay sediments and overlying water. A Monte Carlo-based non-negative-least-squares model of stoichiometric finite difference equations was implemented to estimate the nitrogen transformation rates over the seven week experiment. Both the magnitude and timing of DIN fluxes differed between high and low OM treatments. However, the time required to remove the added nutrient load, and the proportions of net nitrogen loss via both denitrification pathways – anammox and denitrification – were the same, 71.9 ± 2.3% anammox, regardless of OM addition. This percentage of nitrogen lost via anammox was set by the nitrogen content of the organic matter amendment and the initial DIN concentrations. The in situ thermodynamic feasibility of all reactions was calculated, and the results suggested that thermodynamics, as well as carbon and nitrogen loading, control nitrogen processing in sediment ecosystems. (Abstract ID 10635)

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INCLUDING HABITATS IN ESTIMATES OF UTILIZATION DISTRIBUTIONS FOR ACOUSTICALLY TAGGED REEF FISH

The estimation of generalized population parameters is a key aspect of population biology and, in both conservation and fisheries management of reef fish species, assessments of spatial usage are often an important part of the decision making process. Description of population-level movement parameters based on tracking data of acoustically tagged fish therefore presents a valuable tool for management. Here we present a novel approach to quantifying fish habitat utilization distributions using a combination of GLM and GAM based statistics which allows barriers to movement to be included and the role of habitat to be considered in the prediction of the utilization distribution. Using Spangled Emperor Lepturus nebulosus as a model species, the data reveal a range of habitat specializations within the population, as well as habitat-specific differences in the size of utilization distributions. These variations in behavior have important implications for management in the study area of Ningaloo Reef in Northwestern Australia, where marine park zoning currently under-represents several key habitat types. (Abstract ID 10852)

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LIGHT-DRIVEN CARBON FLUXES IN THE ARCTIC OCEAN: SYNTHESIS OF THE RESULTS FROM THE MALINA PROJECT

In the Arctic, we are currently witnessing: 1) a decrease in summer ice cover that exposes sea surface to solar radiation and physical forcings, 2) permafrost thawing and increased river runoff, both of which lead to an augmentation of the export of organic carbon previously sequestered in the Tundra to the ocean, and 3) an increase in ultraviolet radiation. These three phenomena favour enhanced mineralization of organic carbon through photo-oxidation and bacterial activity, amplifying the increase in atmospheric CO2. At the same time, the exposure of a larger fraction of the ocean surface to sunlight, as well as the increase in nutrients brought by vertical mixing and river runoff, lead to heightened autotrophic production and sequestration of organic carbon. To predict the balance of these processes, we conducted an extensive study in the Mackenzie River / Beaufort Sea system in July, August and September 2009 aboard the Canadian research icebreaker CCGS Amundsen. The spatial distribution of organic carbon stocks (living and detrital) in the water column and sediments was assessed on the shelf and beyond. The magnitude and variability of organic carbon mineralization through photo-oxidation and bacterial activity, in addition to that produced through photooxidation were determined. A detailed study of microbial biodiversity was also conducted. A synthesis of the project’s results will be presented. (Abstract ID 10960)

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CONTRIBUTIONS OF PICOPHYTOPLANKTON TO PRIMARY PRODUCTIVITY AND BIOMASS IN MESOSCALE EDDIES IN THE SARGASSO SEA

On two 14-day cruises in the Sargasso Sea we measured size-fractionated primary productivity and phytoplankton biomass (as chlorophyll a) at the center, edge, and outside a warm-core eddy (Feb–Mar 2011) and a cold-core eddy (July–Aug 2011). Total euphotic zone integrated primary productivity was highest in the winter at the edge of the warm core eddy (188 mgC m−2 d−1) and outside the eddy at the BATS station (160 mgC m−2 d−1). Lowest rates were observed outside the cold core eddy (also at BATS) in summer (60 mgC m−2 d−1). Picophytoplankton contributed 56 to 93% of the total primary productivity. At three stations, the relative contributions of the picophytoplankton to productivity were directly proportional to their contributions to biomass. At four stations, picophytoplankton contributed disproportionately to productivity (66 to 93% of the total) as compared to their contributions to biomass (41 to 76%). These data will be incorporated into plankton size-specific models of trophic dynamics and carbon cycling in the Sargasso Sea. (Abstract ID 9956)

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A MESOSCALE EDDY PARAMETERIZATION CHALLENGE SUITE: EADY-LIKE MODEL RESULTS

An “eddy parameterization challenge suite” is being developed, consisting of a set of high-resolution tracer experiments designed to assist in parameterizing subgrid-scale processes in ocean models. In each experiment, multiple tracers are initialized in a frontal standdown simulation which is designed to mimic the stirring effect of mesoscale eddies. The tracer data are used to infer the strength of advective and diffusive effects induced by the eddies. Several hundred such experiments varying in Rossby number, Richardson number, and other parameters, can therefore tell us how mesoscale eddies redistribute tracers in many different flow settings, and can help inform a skillful parameterization of these effects. Results are presented from a set of Eady-like simulations, including scaling laws and vertical structures of the stirring and diffusion. (Abstract ID 10664)

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THE ARCTIC OCEAN IN SUMMER: A NEAR-SYNTHETIC INVERSE MODEL OF BOUNDARY FLUXES OF HEAT, FRESHWATER AND NUTRIENTS

The near-synthetic estimates of Arctic Ocean and sea ice net fluxes of heat, freshwater and nutrients are calculated using an inverse model. Hydrographic measurements from four gateways (Bering, Davis and Fram Straits, and the Barents Sea Opening) completely enclose the ocean, and were made in the same 32-day period in Summer 2006. The inverse model is based on density layers from temperature and salinity profiles, and includes representations of Fram Strait sea ice export and of interior Arctic Ocean vertical fluxes. The inverse model is initialised with velocity profiles measured by ship-mounted and moored instruments. Volume and salinity transport constraints are applied. In summer 2005 the transport-weighted mean properties are, for water entering the Arctic: potential temperature 3.29°C, salinity 34.62 and potential density (sigma0) 27.56 kg/m3 for water leaving the Arctic, including sea ice: 0.72°C, 34.20 and 27.42 kg/m3, respectively. The Arctic in summer freshens and cools the inflows by 0.42 in salinity and 2.56 °C, and decreases density by 0.13 kg/m3. The volume transport into the Arctic of waters above ~1000 m depth is 8.3 Sv (1 Sv = 106 m3/s) for water entering the Arctic: potential temperature 3.29°C, salinity 34.62 and potential density (sigma0) 27.56 kg/m3; for water leaving the Arctic, including sea ice: 0.72°C, 34.20 and 27.42 kg/m3, respectively. The Arctic in summer freshens and cools the inflows by 0.42 in salinity and 2.56 °C, and decreases density by 0.13 kg/m3. The volume transport into the Arctic of waters above ~1000 m depth is 8.3 Sv (1 Sv = 106 m3/s), the export (similarly) is 8.3 Sv; the net surface freshwater input is 180±6 m6. Non-stationary components of the freshwater budget are estimated separately. The net heat flux (including sea ice) is 182±26 TW. Net nutrient exports are 0.2 (nitrate), 0.09 (phosphate) and 1.49 (silicate) kmol/m3. (Abstract ID 11060)

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NITROGEN UPTAKE DYNAMICS IN ARCTIC LANDFAST ICE

We quantified nitrogen transformations by natural sea-ice communities using stable isotope techniques. In the Spring of 2011, ice cores were taken off the coast of Barrow, Alaska in conjunction with a study on water column nutrient dynamics. The cores were divided into three 10 cm sections centered on 5, 20 and 35 cm above the ice-water interface. After melting, subsamples from each depth were incubated with either N-15 labeled ammonium, nitrate, or urea. Absolute uptake of ammonium and nitrate were significantly higher in the 5 cm section, while the other depths were comparable to water column rates. Bacterial productions (using C14-leucine incorporation) showed a similar pattern, with significantly higher rates in the 5 cm fraction and rates comparable to the water column in the higher sections of ice. Unlike the community present in the water column, heterotrophic bacteria were well represented in the ice. This novel approach to sea-ice biogeochemistry suggests that substantial nitrogen transformations occur during the spring thaw. (Abstract ID 10435)

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MODELLING CIRCULATION AND THERMAL STRUCTURE IN THE GREAT LAKES WITH FVCOM

An unstructured Finite Volume Coastal Ocean Model (FVCOM) was applied to all the five Great Lakes to simultaneously simulate circulation and thermal structure over a seasonal cycle. Lakes Michigan, Huron, St. Clair and Erie were connected, while Lakes Superior and Ontario were kept disconnected with others due to the nature of human management. 3 hourly winds, air temperature, specific humidity and cloudiness from the North American Land Data Assimilation System (NLDAS) were used to force the model. The model results were compared to available water temperature observations (Satellite Obs, moorings and buoys). Seasonal evolution of general circulation and thermal structure, and response of each lake to atmospheric forcing were investigated. (Abstract ID 9477)

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COMMUNICATING SCIENCE TO DECISION MAKERS: PERSPECTIVES FROM A RECOVERING MANAGER OF OCEAN AND COASTAL POLICY

Ocean and coastal science should be the foundation of sound public policy, but often it is not. Ongoing challenges such as climate change, habitat disruption, declines in marine resources, water quality degradation, and the erosion of our coastlines continue to plague governments at the international, national, regional, state, and local levels. Decision makers need to understand these issues and to develop effective, efficient, and feasible ways to address them. However, bringing science to management is not always easy or straightforward. Can researchers provide science in a manner that can be understood by decision makers? Do decision makers pose clear questions to the science community? Is there sufficient time and money to address the science? Can scientists remain objective while advocating for a certain point of view? This presentation will provide case studies of efforts from multiple levels of government to communicate science that is intended to be applied to ocean and coastal decision making. It will highlight the emergence of “boundary” organizations intended to bridge the gap between the science community and decision makers. (Abstract ID 10018)

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COMPONENT-SPECIFIC ANALYSES OF CORAL AMINO ACIDS SHED LIGHT ON A THREATENED SYMBIOSIS

While some cridarians are able to synthesize most essential and non-essential amino acids, studies have shown that zooxanthellae are the primary source of these building blocks in symbiotic species. Our carbon isotope data of zooxanthellae-derived amino acids confirms this with the exception of serine, which is enriched in the symbiont. “Coral bleaching”, the breakdown of the coral-algal symbiosis due to temperature and light stress, results in the expulsion of zooxanthellae, leading to starvation and death of the coral host and is increasing globally as sea surface temperatures rise. Here, we present data comparing two symbiont types (thermally sensitive and thermally tolerant) within the same coral host, Acropora tenuis from the Great Barrier Reef, Australia. When exposed to sub-bleaching temperatures in the presence of HCO3−, thermally sensitive clades suffer a 16 % drop in carbon fixation, while tolerant types are unchanged. Amino acid data illustrate a decoupling of amino acid transfer from symbiont to host. While hosts of either symbiont were indistinguishable in their enrichment profile, symbionts were dissimilar, illustrating that amino acid synthesis is impaired in sensitive types. (Abstract ID 12098)

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OBSERVATION AND SIMULATION OF TURBULENCE IN THE OCEAN SURFACE BOUNDARY LAYER

Upper ocean variability in response to surface wave forcing is studied using field observations and numerical model simulations. Observations include data reported in previous studies as well as new measurements obtained from an experiment during 8-13 April 2011 in the Vestfjorden, Norway. Near surface turbulence observations were made at about 11 m below the surface using instruments fitted in a low-drag buoy at the top of a bottom-anchored mooring line. This instrument buoy measures small scale shear, temperature fluctuations, platform body vibrations, pitch, roll, and heading as well as 3D velocity fluctuations. The mooring line includes two temperature-conductivity loggers and an uploading 3000 kHz acoustic Doppler current profiler for background current measurements. Bearing record of the buoy shows that the instrument satisfactorily aligns with the mean current. For numerical modelling, a one-dimensional ocean model is modified to include surface wave stress, wind energy input, wave dissipation and Stokes drift to study the effects of wave forcing and breaking. The skull of the model in simulating the near surface wave enhanced layer and the turbulent kinetic energy budget will be discussed. (Abstract ID 11015)

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DEVELOPMENT OF SMOS LEVELS 3 AND 4 SEA SURFACE SALINITY MAPS

Sea surface salinity (SSS) maps are generated at the Spanish SMOS Level 3 and 4 Data Processing Centre (CP34) by using objective analysis interpolation (Level 3) and data fusion techniques which combine the SMOS data with other satellite observation types (e.g., AMSR-E sea surface temperature data or Aquarius SSS data). Present efforts on L3 at CP34 are focused on the application of Objective Analysis on L2 data to produce L3 maps. The correlation matrices required by Objective Analysis have been generated using different model outputs. Ongoing work on L4 production aims to data fusion techniques based on the use of singularity analysis to exploit data synergy. Singularity analysis gives a numerical estimate of the local regularity (singularity exponents) of an ocean variable at all the points, as singularity exponents are a characteristic of the flow, not specific to the variable. The information provided by singularity exponents is then used to reconstruct SSS fields satisfying the multi-scale characteristics of geophysical flows. Data fusion of SMOS with microwave SST, surface chlorophyll concentration, and Aquarius data are calculated. L3 and L4 maps are validated with near-surface measurements provided by Argo profilers. We have found that the implementation of these techniques significantly improve data accuracy with respect to L2 maps. (Abstract ID 11035)
where euphausiids contribute little to vertebrate production. All regions showed large potential in microzooplankton had greatest effect on GB vertebrate predators. Reduced euphausiid μm) vs large (>20 μm) phytoplankton production; increased microzooplankton production at functional groups in response to climate change. Simulations include: increased small (< 20 μm) vs large (>20 μm) phytoplankton production; increased microzooplankton production at competitive expense to other zooplankton grazers; and reduced euphausiid production with surplus phytoplankton production benefitting copepods and gelatinous zooplankton. Changes in phytoplankton groups had greatest impact on SO top predator production while changes in microzooplankton had greatest effect on GB vertebrate predators. Reduced euphausiid production affected upper trophic level production in SO, NCC and CGoA but not in GB where euphausiids contribute little to vertebrate production. All regions showed large potential impacts from changes in the plankton assemblage size composition. (Abstract ID 12166)
Nighttime and Daytime-Only Optimally Interpolated SST Analyses

A Climate Data Record (CDR) time series must be "of sufficient length, consistency, and continuity to determine climate variability and change." To meet these requirements, a nighttime-only optimum interpolation (OI) sea surface temperature (SST) analysis product is being developed at NCDC, using the new Pathfinder AVHRR SST v5.2 release. The Pathfinder dataset uses afternoon satellites (NOAA 7, 9, 11, 14, 16, and 18) for the entire period (1981–2010), except in 2002–2005 when only the morning satellite NOAA 17 was functioning properly. Prior to analysis, the satellite data is adjusted to in situ data to minimize biases. The methodology is similar to that of the current operational NOAA daily’s deg OISST except that day- and nighttime data are analyzed separately. The minimal impact of diurnal variability on the nighttime-only product makes it a good CDR candidate. The separate day/night OISST analyses also offer better reference fields for evaluating satellite SST algorithms. Particular challenges occur at high latitudes where seasonal daylength fluctuations affect the amount of nighttime and daytime in situ data. Possible algorithm adjustments are examined. (Abstract ID 10573)

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Adaptive Sampling Strategies to Characterize MicrObial Communities in a Dynamic Estuary

The Center for Coastal Margin Observation & Prediction studies the response of coastal margins to changing climate and ocean and river conditions, using the Columbia River as a testbed. In order to understand the estuary’s potential role as a ‘bioreactor’ that modulates river-to-ocean exchanges, we focus on characterizing biological hotspots. To investigate how microbial communities influence these hotspots, we will deploy an Environmental Sample Testbed. In order to understand the estuary’s potential role as a ‘bioreactor’ that modulates river-to-ocean exchanges, we focus on characterizing biological hotspots. To investigate how microbial communities influence these hotspots, we will deploy an Environmental Sample Testbed. In order to understand the estuary’s potential role as a ‘bioreactor’ that modulates river-to-ocean exchanges, we focus on characterizing biological hotspots. 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VENTILATION CHARACTERISTICS OF THE CESM OCEAN COMPONENT

The ventilation properties of the ocean component of the Community Earth System Model (CESM) are analyzed using simulations of radiocarbon, CFC-11, CFC-12, ideal age, and water mass fraction tracers. The tracer simulations are computed efficiently using an offline tracer-transport model formulated in terms of a sparse matrix tracer transport operator. Steady-state tracer fields are obtained by directly inverting the transport operator while transient tracers are simulated using a fully implicit time-stepping scheme that allows us to take large time-steps. The simulated tracers are compared to GLODAP observations and to the data-assimilated circulation model of DeVries and Primeau (2011). (Abstract ID 11769)

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ROTATING HORIZONTAL CONVECTION

“Horizontal Convection” (HC) is the generic name for the flow resulting from a buoyancy variation imposed along a horizontal boundary of a fluid. We study numerically the effects of rotation on HC, concentrating on changes to boundary layer scalings, deep stratification and overall energetics of the flow. With the Meridional Overturning Circulation in mind, we consider a rectangular box with insulating conditions on the meridional sides and bottom, periodic conditions on the zonal sides and a fixed buoyancy flux on the top. The rotation rate varies smoothly over the meridional extent of the domain. We follow the classification of Hignett et al. (1981) based on a parameter Q relating thermal to Ekman scales and examine the “medium” regime with Q – 1, as well as the modifications for Q – 1, i.e., when the thermal scale is larger than the Ekman scale. The effects of baroclinic instability are analyzed using the spatial distribution of Available Potential Energy and Kinetic Energy densities. (Abstract ID 10495)

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AQUATIC LASER FLUORESCENCE ANALYZER (ALFA): A NEW INSTRUMENT FOR CHARACTERIZATION OF NATURAL AQUATIC ENVIRONMENTS

The Advanced Laser Fluorometry (ALF) is a new technique to quantify and characterize key aquatic constituents, including chlorophyll, phycoerythrin and variable fluorescence of phytoplankton, as well as colored dissolved organic matter. It provides real-time in vivo fluorescence assessments of phytoplankton biomass, photophysiology and composition to assess the quality and health of aquatic ecosystems. Development of the commercial ALFA and ALF In Situ (ALFIS) instruments has been recently sponsored by NOPP to operationally implement the ALF technique and provide new means for aquatic research and environmental monitoring. Several ALFA prototypes have been developed in collaboration between LDEO, WET Labs and SIO. The light-weight, compact, portable flow-through ALFA instrument provides high-resolution shipboard underway measurements for characterization of meso- and synoptic-scale horizontal distributions, as well as analysis of discrete water samples. Improvements have been made to simplify the system design, maintain optical alignment, and improve serviceability. The ALFA instrument can be customized for single or multiwavelength fluorescence excitation, as well as spectrally and/or temporally resolved measurements. ALFA fluorescence excitation, as well as spectrally and/or temporally resolved measurements. ALFA improves serviceability. The ALFA instrument can be customized for single or multiwavelength fluorescence assessments of phytoplankton biomass, photophysiology and composition to assess the quality and health of aquatic ecosystems. Development of the commercial ALFA and ALF In Situ (ALFIS) instruments has been recently sponsored by NOPP to operationally implement the ALF technique and provide new means for aquatic research and environmental monitoring. Several ALFA prototypes have been developed in collaboration between LDEO, WET Labs and SIO. The light-weight, compact, portable flow-through ALFA instrument provides high-resolution shipboard underway measurements for characterization of meso- and synoptic-scale horizontal distributions, as well as analysis of discrete water samples. Improvements have been made to simplify the system design, maintain optical alignment, and improve serviceability. The ALFA instrument can be customized for single or multiwavelength fluorescence excitation, as well as spectrally and/or temporally resolved measurements. ALFA field tests in the Pacific Ocean and coastal zone of California are analyzed. (Abstract ID 11217)

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ESTOC SITE: IMPROVING ITS PERMANENT TIME-SERIES OCEAN OBSERVING PROGRAM WITH UNDERWATER GLIDERS

In-situ ocean observations have been traditionally carried out through oceanographic ships, VOS, moorings, drifters and floats mainly. All of them are able to sample water column biogeochemical parameters (coastal and off-shore areas) but not always within the right spatial-temporal resolution, operational and cost-effective required ratio. Nowadays, cutting-edge technology tools allow to have autonomous and permanent ocean sites furnished with multidisciplinary observing platforms and sensors, sampling and providing product-information to the end-users in real-time mode. The European Station for Time-series in the Ocean–ESTOC-, as OCEANsite's network member and consolidate ocean site reference in the Eastern Central Atlantic for more than fifteen years of multidisciplinary time-series background, has recently improved its biogeochemical sampling program with the main three underwater gliders technology available. This new approach is the result of a collaborative effort between the Oceanic Platform of the Canary Islands–PLOCAN- and the Marine Sciences Institute of Canary Islands (ICCM) where PLOCAN is in charge to provide all the technical and operational logistics required by the end users for their scientific aims, managed by ICCM through its Oceanography's Department. (Abstract ID 11233)

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OPERATIONAL NAVY OCEAN FORECASTING USING ISOP PROJECTION OF SATELLITE ALTIMETRY AND SURFACE TEMPERATURE

Operational ocean forecasting over global and regional domains requires satellite data to ensure sufficient prediction accuracy. The daily spatial sampling of in situ profiles is about 4 orders of magnitude less than the coverage of satellite altimeter and surface temperature. Under the Improved Synthetic Ocean Profiles (ISOP) effort, we leverage extensive climatological records of in situ observations to develop variational models relating satellite observations to subsurface predictions. These vertical projections are incorporated into the Navy Coupled Ocean Data Assimilation System (NCODA) for use in global and regional Hybrid Coordinate Ocean and Navy Coastal Ocean models (HYCOM and NCOM). Validation studies using independent profile observations compare model analyses and forecasts based on ISOP with forecasts using prior operational capabilities. These results indicate that ISOP-based assimilation of satellite altimeter and surface temperature reduces forecast errors in the temperature, salinity, and acoustic forecasts supporting Navy operational applications. (Abstract ID 11265)

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EFFECTS OF OXYGEN AND pH ON THE PERFORMANCE OF THE URCHIN STRONGYLOCENTROTUS FRAGILIS ACROSS A DEPTH GRADIENT SPANNING THE OXYGEN MINIMUM ZONE

Along the N.E. Pacific coast, the fragile urchin, Strongylocentrotus fragilis has a bathymetric range (200-1200 m) that straddles the oxygen minimum zone (OMZ), and thus, tolerates a broad range of oxygen and carbonate chemistry. S. fragilis attains a larger size at the shallow end of its range, suggesting that the population grows and survives better in this zone, which differs in oxygen and pH, but also several other factors (e.g., temperature, food) from deeper waters. We examined the effects of oxygen and pH on metabolic performance and behavior using in situ manipulative experiments and laboratory studies. Changes in oxygen levels had the largest effect on urchin metabolism, particularly near severe hypoxia (=10 umol O2 kg-1 SW). Acidification had significant, but milder effects on metabolism, but also inhibited feeding below pH – 7.2. These results suggest that oxygen is limiting within the core of the OMZ, and that decreasing pH may also affect S. fragilis as ocean acidification intensifies in the future. Ongoing long-term studies indicate that S. fragilis may have significant capacity for acclimation to acidification over several months. (Abstract ID 12279)

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THE EFFECTS OF OCEAN ACIDIFICATION ON MARINE BENTHIC ORGANISMS AND PROCESSES

Ocean acidification can affect a variety of biological and biogeochemical processes which, in turn, may have important consequences for the structure and function of marine benthic ecosystems and related benthic processes. This talk provides an overview of biological effects of ocean acidification on benthic organisms and processes, and examines potential consequences of future increases in acidification and related environmental changes. Ocean acidification can cause physiological stress for marine benthos, such as impaired calcification, disruption of
acid-base balance, and respiratory stress, with potential consequences for growth, survival, and reproduction. Vulnerability of key groups such as habitat forming species (e.g. corals) or dominant bioturbating taxa in marine sedimentary habitats, may lead to significant changes in ecosystem structure as well as biochemical exchanges. What benthic systems or processes are most likely to be altered as pH and carbonate saturation decline through this century? Are coastal systems more vulnerable than deep-sea benthos? Will changes in carbonate saturation or potential shifts in benthic infaunal assemblages carbon burial in marine sediments? (Abstract ID 12200)

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HYPOXIA OVER THE CONTINENTAL SHELF IN THE NORTHEAST PACIFIC OCEAN

Over the last decade, severe hypoxia (dissolved oxygen less than 0.5 ml/l) and even anoxia have been observed during the late summer upwelling season in near-bottom waters off the central Oregon coast. We use historical data and recent underwater glider and ship surveys to describe the temporal and spatial variability of hypoxia in Oregon coastal waters. Waters with the lowest oxygen values are found over the mid shelf (~80-100 m) as a result of upwelling of low-oxygen water onto the shelf, followed by decay of organic matter raining down from surface phytoplankton blooms. Dissolved oxygen measurements from 6 years of underwater glider transects are used to explore year-to-year variations in the extent of near-bottom hypoxia. Both the dissolved oxygen concentrations of the upwelled source waters and local winds explain variability in near-bottom shelf hypoxia. Oxygen in the upwell source waters (26.5 kg/m^3) has declined by 0.6 ml/l over the last 50 years. Recent near-bottom data collected by a variety of platforms reveals a ribbon of hypoxic near-bottom water at mid shelf all along the Pacific Northwest. (Abstract ID 10712)

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VENUS: LIVE DATA FROM A COASTAL OBSERVATORY

Ocean observatories have been designed with continuous real-time data transmission as a key feature. Collecting, storing, archiving, and then re-distributing the data over the Internet in near real-time represents its own set of challenges. VENUS has developed a suite of solutions for representing the data in various native and standard formats, including numerical values, automated data plots, and even streaming audio and video presentations. The interactive displays will highlight various live data streams from multiple sites and instruments across the network. Demonstrations of the data retrieval tools for exploring the archive and extracting data products, including metadata, will also be presented. (Abstract ID 10057)

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REGIONAL VARIATIONS IN THE SEASONAL SUCCESSION OF DIATOMS AND DINOFLAGELLATES IN THE NORTH ATLANTIC

We present a trait-based analysis of regional variations in seasonal patterns of abundance for diatom and dinoflagellate taxa observed by the Continuous Plankton Recorder survey of the North Atlantic, whose cell size and trophic strategy are the traits of interest. The spring peak in diatom abundance precedes a summer dinoflagellate peak throughout the survey area, and peaks of abundance for both taxonomic groups are later and stronger at higher latitudes. Smaller diatoms are relatively more abundant in summer and larger diatoms are relatively more abundant in winter. This pattern occurs over a range of latitudes and we hypothesize that the relatively high nutrient affinity of smaller diatoms leads to their dominance during nutrient-deplete conditions. When the dinoflagellate taxa are differentiated by trophic strategy we find that mixotrophs lead heterotrophs in ecological succession in oligotrophic seas by up to two months, whereas there appears to be no such differentiation at higher latitudes. We hypothesize that the ecological niche for mixotrophs is evident in oligotrophic seas because mixotrophs can successfully compete in resource-scarce conditions by acquiring both inorganic and organic nutrients. (Abstract ID 9428)

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CANARY CURRENT UPEWELLING: MORE OR LESS?

It has been hypothesized that coastal upwelling is increasing globally as a consequence of warming climate. Recent research has suggested a significant increase of upwelling intensity off Northwest Africa on the basis of proxy sea surface temperatures from alkenone unsaturation index (UK37) analysis of sediment cores off Cape Ghir, Morocco. An accelerating decrease in excess of 1°C over the last century was concluded for surface temperature near the Cape. Support was found in an increase in Bakuri’s upwelling index for the latitude of the Cape. We examine evidence for a general intensification of upwelling within the whole Canary current upwelling system. Using available estimates of wind from PFL, NCAR/NCEP ECMWF, ICOADS and WASWind plus meteorological stations, we find no evidence of a coherent wind intensification at the regional scale off Northwest Africa. Moreover, ICOADS surface temperature records since 1967 and Pathfinder AJHRR data from 1986 show a significant and correlated warming in all the region. We conclude there is no evidence for a general increase in upwelling intensity off Northwest Africa or Iberia. Reasons for the difference between the proxy temperature indicated by the alkenone unsaturation index and the observed sea surface temperature off Cape Ghir are explored. (Abstract ID 11730)

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HIGH-RESOLUTION IN SITU AND AERIAL MEASUREMENTS OF SUBMESOSCALE EDDIES, FRONTS, AND FILAMENTS

In order to truly resolve the small scales of submesoscale eddies and fronts, we have collected high-resolution (1-15m) in situ and aerial data during the submesoscale experiment SubExI off Catalina Island, CA, in April 2011. Repeat measurements every 15-30min enabled us to observe significant changes over very short time scales and to investigate the temporal evolution of these features. Measurements were taken in a collaborative effort with aerial IR, hyperspectral, and SAR imagery from 3 planes, as well as in situ measurements with a Towed Instrument Array (TIA), drifters, currents, surfactants, and optical measurements. The temperature and salinity data collected with the TIA have a vertical and horizontal resolution of 1-5m covering the upper 35m of the water column at a tow speed of 4-5m/s demonstrating that the observed submesoscale features mostly occur within a shallow, 5-15m deep thermocline. Fronts are very sharp with temperature and density gradients of 1°C and 0.2kg/m^3 over 5m. The observed features evolve over the course of a few hours. Rotational and advective velocities are 0.2-0.4 m/s resulting in a large Rossby number flow. (Abstract ID 12061)

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PARTICLE TRANSPORT MODELING OF SMALL RIVER PLUMES OFF CALIFORNIA APPLIED TO MARINE PATHOGEN FATE

The focus of our work is on transport and dispersion of Toxoplasma gondii oocysts delivered to coastal waters via small river plumes. T. gondii is a zoonotic pathogen that has a very high incidence of disease in California sea otters along the Central California Coast. Previous work found that oocysts were effective at trapping T. gondii oocysts. In this study we explore how particle fate differs when these organisms are delivered directly to the ocean via small coastal streams. Preliminary model results are presented from an implementation of the Regional Ocean Modeling System (ROMS), a three-dimensional, free-surface, terrain-following numerical model that includes a particle tracking using Larval Transport Lagrangian model (LITRAN). In these preliminary results we explore the distribution of oocysts based on the assumption that they are passive neutrally buoyant particles. Transport dynamics of this pathogen are analyzed under varying flow conditions and variable coastal circulation. (Abstract ID 12161)

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In the second experiment, larvae were placed in arenas containing either fine sand (0.2 mm) or gravel (3 mm) to examine whether different grain sizes delayed settlement. In the first experiment, larvae demonstrated a statistically significant preference for finer substrates. Larvae in the second experiment delayed settlement significantly when exposed to coarse substrate. Collectively, these data suggest behavior is an important component of the settlement dynamics in Northern rock sole. This insight allows for future analysis of the other components that may affect this critical, largely understudied process. (Abstract ID 12512)

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THE EFFECTS OF DEEPWATER HORIZON CONTAMINATION ON MICROBIAL COMMUNITY STRUCTURE AND BIOGEOCHEMICAL CYCLING IN OIL IMPACTED GULF OF MEXICO

Bacterial-phytoplankton interactions are governed by tightly coupled processes that drive the microbial food web. Oil may provide an additional carbon substrate to support bacterioplankton production. Oil could, however, inhibit phytoplankton production resulting in a decoupling of bacterial-phytoplankton processes. Both the addition of oil and the decoupling could result in a shift in the microbial community structure and alter other biogeochemical cycles. To evaluate how microbial processes are impacted by hydrocarbon inputs, we conducted time series investigations on bacterial microcosms responsive to oil dispersant versus whole water sample collected across a coastal oil contamination gradient (i.e. heavily-contaminated to pristine). For the pristine site, initial increases in bacterial abundances were observed within the first day in samples amended with dispersant only, after which they decreased. Automated Ribosomal Intergenic Spacer Analysis (ARISA) reveals fairly tight clustering for microbial groups in all amendments in both the heavey and moderately impacted sites when compared to the pristine site suggesting prior adaptation to oil exposure at the contaminated sites. (Abstract ID 12421)

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ROLE OF ADVECTION IN DEVELOPMENT OF CIRCULATIONS CAUSED BY INTERACTION OF SURFACE WAVES AND INHOMOGENEOUS CURRENTS

The effect of advection on paired circulations, generated by the interaction of long surface waves with non-uniform currents, is considered. The circulations are caused by a vortex force imposed by the surface waves on an inhomogeneous current, and are similar in nature to Langmuir circulations. The circulations are convergent when the direction of propagation of the waves coincides with the current direction and divergent when the directions of waves and current are opposed. At the initial stage of development, the converging and diverging circulations have same structure. Once advection affects the initial current, converging circulations become more narrow and the diverging circulations become wider. This effect is illustrated for a near-surface current such as the model of a ship wake and for a deeper underlying jet such as a river or sewer outflow. Similar circulations can be generated for many types of currents: therefore the effect of the vortex force on a non-uniform current should be taken into account when the current is within the influence of strong ambient surface waves. (Abstract ID 12207)

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GULF OF MEXICO ALLIANCE

The Gulf of Mexico Alliance (GOMA), founded in 2004, is a partnership between the five Gulf states (Alabama, Florida, Louisiana, Mississippi, and Texas), key federal agencies, academia and non-governmental organizations with the goal of increasing regional collaboration to enhance the ecological and economic health of the Gulf of Mexico. The Alliance focuses on six priority issues that can be addressed through greater coordination at the local, state and federal levels. With the support of federal and non-governmental partners, the Alliance has developed a true regional approach in undertaking actions to improve the health of coastal ecosystems and economies of the Gulf. In 2009, the Governor’s Action Plan II (APII) was developed, building on the successes of the first Action Plan. API II is a further-reaching, five-year regional plan that looks to expand strategies and partnerships. The core goals of the first Action Plan were to build a foundation for a regional approach. The API II sets a course for specific actions designed to improve the health and coastal ecosystems of the Gulf in ways that a single entity could not. (Abstract ID 12894)

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AMBIENT NOISE FROM GRAVEL AND COBBLES SHIFTING UNDER FAST CURRENTS

Measurements of near-bed currents and ambient noise from Admiralty Inlet, WA (USA) are presented. Tidally driven currents at the site, approximately 60 meters deep, exceed 3.5 m/s. The seabed is primarily composed of gravel and small cobbles (diameter < 10 cm). Strong currents are correlated with increased sound levels at frequencies (2-25 kHz) consistent with coarse-grain bedload transport. Flow noise, or pseudosound, is significant in the recordings, but only at lower frequencies (< 1 kHz). Seabed video from the site confirms mobilization of coarse sediments. The critical shear stress for bed mobilization is estimated to be on the order of 6 Pa. When near bed (z = 1.5 m) currents exceed 1 m/s, the minimum recorded sound pressure level in the 2-25 kHz band begins to increase. At peak currents, sound pressure levels in this band are more than 20 dB higher than typical slack tide conditions and significantly higher than levels attributed to anthropogenic noise sources in the area. We investigate critical shear stresses and the empirical relationship between bed stress and noise generated by the moving cobbles. (Abstract ID 10609)

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BUILDING A GLOBAL NETWORK FOR SUSTAINABILITY-SCIENCE IN LARGE MARINE ECOSYSTEMS (LMES)

NOAA's global network of 64 LMEs provides a framework for sustainable ecosystem-based management in ecologically bounded transnational areas. LMEs produce 95% of the world’s annual marine fishery biomass yields. The US National Ocean Policy designates nine LMEs as the regional governance venues for CMS and EBM to support protection, maintenance, and restoration of the health and biological diversity of the ocean, improved resilience, and increased conservation and sustainability. Understanding and sustainably managing the interactions between humans and marine ecosystems face fundamental difficulties. A major impediment to the more sustained use and conservation of LMEs is the disconnect between practitioners of human and natural science, and resource managers and policy makers. An innovative network using modern semantics and informatics coupled to a social-ecological systems approach that engages those with expertise on marine systems, governance, and sustainability science as well as members with the policy and intergovernmental community is key to building the trust and understanding needed among practitioners, scientists, and stakeholders. Sustained end-to-end engagement of diverse practitioners will ensure that best available science is effectively used in management and policy-making. (Abstract ID 12158)

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TWO-PHASE EULER-LAGRANGE SIMULATIONS FOR SHEET FLOW TRANSPORT OF MIXED-SIZE SEDIMENTS

Intense collision-dominated bedload transport under sheet flow conditions is thought to be the primary agent of nearshore bathymetric evolution. We model sheet flow transport with two-phase flow simulations using a Reynolds-Averaged Navier Stokes (RANS) fluid solver for turbulent flow coupled to a Discrete Element Method (DEM) for modeling the motions of individual sediment grains. The RANS fluid solver uses a k-ε turbulence closure and solves a one-dimensional in the vertical (1DV) profile. The coupled RANS-DEM simulations include viscously damped collisions at low Stokes numbers and turbulent suspension implemented through an eddy-particle interaction model based on a random walk. Simulations of sheet flow transport were performed under oscillatory forcing conditions with a variety of grain size distributions, including mixtures of coarse (D50 = 0.51 mm), medium (D50 = 0.28 mm), and fine (D50 = 0.13 mm) sediment. Model results are generally in good agreement with laboratory measurements for bulk transport rates and time-dependent concentration and velocity profiles within the sheet flow layer. Discussion will focus on utilizing simulation results to estimate the time-averaged near-bed sediment concentration commonly used in pickup functions. (Abstract ID 11584)

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USING AN EMBEDDED LAGRANGIAN MODEL TO REPRESENT DOWNSLOPE FLOWS IN LEVEL COORDINATE OCEAN CLIMATE MODELS

Hydrostatic ocean models are known for their relatively poor representation of some climatically important processes. For example, downslope flows play a key role in the
sinking branches of the meridional overturning circulation, yet the present generation of ocean climate models poorly resolve the associated physics. In particular there is a spurious dilution of overflows and gravity driven currents are generally broad and sluggish, often failing to penetrate to realistic depth. In this study an embedded Lagrangian model to represent downwelling flows has been developed and implemented in the GFDL Modular Ocean Model. The Lagrangian model has been tested in several idealized configurations, showing significant differences with traditional parameterizations. In the DOME configuration, which is a gravity driven plume on a uniform slope, use of the embedded Lagrangian model increases the downwelled component of the plume’s transport while, under the influence of rotation, also increasing the along slope speed of the plume. These changes improve some of the shortcomings of coarse resolution level models for representing downwelling flows. (Abstract ID 10511)

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REDUCED EARLY LIFE GROWTH AND SURVIVAL IN A FISH IN RESPONSE TO ELEVATED CO₂ LEVELS

A growing body of empirical evidence suggests that ocean acidification will challenge a suite of marine organisms in complex ways. While research is already well advanced for organisms that synthesize calcareous exoskeletons or shells, it is still insufficiently understood, how fish might be affected by ocean acidification. Although juvenile and adult fish tolerate short-term exposures to CO₂ levels that exceed those predicted for the next 300 years, recent studies on fish early life stages have found detrimental behavioral responses or abnormal otolith growth under exposure to elevated CO₂ concentrations. The current laboratory study is, to our knowledge, the first to demonstrate direct adverse growth and survival effects in the early life stages of a common estuarine fish (Menticirrhus beryllina) resulting from exposure to CO₂ concentrations expected in the world’s oceans later this century. Compared to present day CO₂ levels (~400 ppm), exposure of M. beryllina embryos to ~1,000 ppm until one week post hatch reduced average survival and length by 74% and 18%, respectively. The egg stage was significantly more vulnerable to high CO₂-induced mortality than the post-hatch larval stage. These findings challenge the belief that ocean acidification will not directly affect fish populations, because even small changes in early life survival can generate large fluctuations in adult fish abundance. (Abstract ID 10804)

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SEASONAL PARTICLE RETENTION ON THE EASTERN BERING SEA SHELF EVALUATED USING TH-224

Water column and sediment ²³⁴Th distributions were measured at approximately 60 stations over the shelf and slope regions of the eastern Bering Sea during spring and summer in 2009 and 2010. Using the ²³⁴Th focusing factor (²³⁴Th-FF), inference are made with regard to seasonal retention of particulate ²³⁴Th over the shelf and boundary scavenging at the ocean margin. An average ²³⁴Th-FF of 1.1 ± 0.7 over the eastern Bering Sea shelf indicates that, over seasonal time-scales, particulate ²³⁴Th is retained in shelf sediments and not exported to slope/basin sediments. In contrast, ²³⁴Th-FFs of up to 8 were determined for the slope region, which are attributed to boundary scavenging of ²³⁴Th transported from the interior ocean. An implication of ²³⁴Th-FFs close to unity over the shelf is that particles may be retained within these sediments with little seasonal export to the interior basin. Furthermore, based on high sediment inventories of excess ²³⁴Th on the slope, this ocean margin may serve as an accumulation area for other particle-reactive chemicals, including contaminants. (Abstract ID 10263)

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BIOACCUMULATION BY ZOOPLANKTON AND MICRONEMTIC FISH OF FUKUSHIMA RELEASED CESIUM AND SILVER RADIOISOTOPES IN JAPANESE COASTAL WATERS

The release of radioactive material from the damaged Fukushima Dai-ichi nuclear power plant into the ocean has raised concerns of possible radionuclide bioaccumulation in marine organisms. Here we present the first gamma analysis of biological samples collected in June 2011 as part of an international survey to Japanese waters. Bulk samples of zooplankton (>0.3mm) and micro nekton communities (~4mm) were obtained by oblique tows using Bongo and Methyl nets. Biota concentrations of the released 137Cs, 134Cs and 110mAg were compared to 40K and other natural radionuclides. 137Cs, 134Cs and 110mAg were highest for samples collected nearest to the coast, and were higher for bulk zooplankton than for microzooplankton fish, with concentrations up to 35 mBq g⁻¹ dry wt. Concentration factors of Cs in zooplankton were comparable to for other coastal fish species. The 134Cs/137Cs ratios were ~1, consistent with values reported for ratios in the plant’s effluent and ambient ocean.
surface water concentrations. Gamma radioactivity from naturally occurring radionuclides, primarily 40K, exceeded that from artificial radionuclides by about two orders of magnitude. (Abstract ID 10818)

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APPLICATION OF NEW SATELLITE OCEAN COLOR DATA IN GLOBAL OCEAN MODEL SIMULATIONS

Chlorophyll highly influences the absorption of solar radiation in the upper ocean. Capturing this process in a global ocean model helps account for near-surface heating and resulting effects on vertical stability and surface heat flux. NOAA’s operational Real-Time Ocean Forecast System’s Hybrid Coordinate Ocean Model (HYCOM) and seasonal-interannual Global Ocean Data Assimilation System’s Modular Ocean Model (MOM) use monthly ocean color climatology from NASA’s Sea-viewing Wide-field of-view Sensor (SeaWiFS) to drive this process. However, NOAA’s operational SeaWiFS climatology spans only a few years and includes the major El Niño of 1998. This study explores the modeling impact of using a new ocean color climatology comprising the entire SeaWiFS record for better representativeness. Differences between the old and new datasets are significant, with the new data sets showing deeper solar radiation penetration in most coastal/littoral regions (excepting the Indonesian Throughflow region); the Antarctic Circumpolar Current region; the North Indian Ocean; and in the center of the major ocean gyres. We examine the systematic differences, focusing on mixed-layer depth, the Western Pacific warm pool region, the Pacific cold tongue, upper-ocean velocities, etc. (Abstract ID 11117)

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DISSIPATION RATE AND VERTICAL MIXING INFERRED FROM SEAGLIDERS: AN APPLICATION TO THE NORDIC SEAS OVERFLOWS

Recently completed Seaglider deployments have returned nearly 18,000 full-depth hydrographic profiles around the Iceland-Faroe Ridge, resolving two of the important exchange pathways between the Nordic Seas and the North Atlantic. These observations include fine-scale vertical velocity. One Seaglider (sg005) was coordinated with a dedicated Faroe Bank Channel overflow mixing and entrainment study, which included shipboard turbulence measurements and mooring data. Here we report on a method by which dissipation rate of turbulent kinetic energy, ε, can be estimated from Seaglider vertical velocity and temperature data. Profiles of dissipation are obtained from Taylor scaling, ε ∼ q^3 l^2, where q and l are the velocity and length scales, respectively, of large eddies contributing to turbulence. We use the Seaglider vertical velocity and Thorpe displacements to define q and l. Comparison of average dissipation profiles between the cruise and sg005 determine the proportionality constant. Glider-inferred dissipation profiles capture the observed variability in turbulence, which spans four orders of magnitude within and above the energetic overflow plume. When applied to the entire Seaglider data set, regions of intense mixing and water mass transformation on the Iceland-Faroe Ridge are revealed. (Abstract ID 11171)

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AGUILHAS LEAKAGE, SOUTHERN HEMISPHERE WESTERLIES, AND CLIMATE CHANGE

The Agulhas Current and its leakage of warm, saline waters between the Indian and Atlantic Oceans forms an important component of the global thermohaline circulation. Evidence from observational, palaeoceanographic, and modelling studies suggest that the Agulhas System may be a trigger or feedback mechanism for past and present climate change. Presently, a warming trend in the Agulhas System, accompanied by an increase in eddy kinetic energy indicative of more Agulhas Rings, points to increased leakage since the 1980s. Hindcast simulations which resolve the mesoscale features of the Agulhas System suggest an increase in Leakage of order 1 Sv per decade, related to the southward shift of the Southern Hemisphere westerly winds with anthropogenic climate change. An increase in leakage, combined with increased upwelling in the Southern Ocean, could potentially lead to a significant strengthening of the Atlantic overturning circulation (AMOC). This is a profound finding, since it represents a plausible mechanism to stabilise the AMOC at a time when IPCC models which do not resolve Agulhas Leakage, predict a weakening. (Abstract ID 11734)

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US-JAPAN COLLABORATIVE RESEARCH ON THE MARCH 11, 2011 EARTHQUAKE, TSUNAMI INUNDATION AND INITIAL SPREAD OF FUKUSHIMA RADIONUCLIDES INTO THE PACIFIC OCEAN

A team of US and Japanese investigators has developed a high-resolution global-Japan coastal coupled WRF/FVCOM system to simulate the March 11 M9 earthquake, tsunami wave generation, propagation, coastal inundation along northern Honshu Island, and initial spread of Fukushima Dai-ichi Cs-137 across the shelf to deeper water. The Japan coastal model includes the earthquake generation zone with finer grid resolution over the inner shelf and inundation zone (down to 5 m below Fukushima Dai-ichi), with boundary and surface forcing provided by the global WRF/FVCOM. The model hindcasts will start with the initial March 11 earthquake bottom movement (provided by three advanced seismic models) through mid-April. During this period, Cs-137 source concentration levels have peaked and decreased towards increasing coastal and offshore concentration levels, indicative of cross-shelf transport and shelf-break exchange processes, with a potential sedimentation loss and biological accumulation in the nearshore region. Initial model comparisons of simulated water level with coastal tide gauge and inundation extent data show good agreement. The model system will be described and preliminary results presented. (Abstract ID 11531)

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ON THE GLOBAL DISTRIBUTION OF HYDROTHERMAL VENT FIELDS: ONE DECADE LATER

Since the last global compilation one decade ago, the known number of active submarine hydrothermal vent fields has almost doubled. At the end of 2009, a total of 518 active vent fields was catalogued, with about half (245) visually confirmed and others (273) inferred active at the seafloor. About half (52%) of these vent fields are at mid-ocean ridges, 25% at volcanic arcs, 21% at back-arc spreading centers, and 2% at intra-plate volcanoes and other settings. One third (34%) are in high seas, and the nations with the most known active vent fields within EEZs are Tonga (12%), USA (combined EEZ 7%), and Japan and New Zealand each at about 5%. The range of known high-temperature, black smoker vents has extended in depth from shallowest (346 m) to deepest (3000 m) in latitude from northernmost (75N) to southernmost (60S), in temperature (to 407°C), and to ultrashallow spreading ridges. The increase in known vent fields reflects a number of factors, including systematic surveys aided by developments in technology and increased national and commercial interests in seafloor hydrothermal deposits as mineral resources. (Abstract ID 11235)

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INFERRING THE GLOBAL DISTRIBUTION OF MARINE DISSOLVED ORGANIC RADIOCARBON

The published body of bulk radiocarbon (Δ14C) values has been critical to understanding marine dissolved organic carbon (DOC) biogeochemistry, yet remains significantly limited in spatiotemporal range and resolution. However, application of a simple, water-volume based mixing model to concurrent depth profiles of DOC and dissolved inorganic carbon (DIC) concentrations and Δ14C values from the Atlantic, Pacific, and Southern Oceans revealed a single, globally consistent mixing line throughout mesopelagic and bathypelagic waters. This result suggests that one (the dominant controls on DOC redistribution differ sharply between these depth horizons and the epipelagic, and (2) the global pattern of DOC Δ14C values may be predicted throughout the water column when implementing the mixing line with contemporaneous measurements of DIC concentrations, DIC Δ14C values, DOC concentrations, and simple Keeling-plots. Additional bulk DOC Δ14C observations are needed to validate the mixing line’s spatiotemporal applicability. (Abstract ID 12193)
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CHARACTERIZATION AND LABILITY OF DISSOLVED ORGANIC MATTER PRODUCED BY MARINE PHYTOPLANKTON: LINKING BIOLOGICAL AND CHEMICAL DIVERSITY

Extracellular release of fixed carbon from marine phytoplankton is a major source of oceanic dissolved organic matter (DOM). If phytoplankton produce and release DOM of varying composition, DOM may impact marine biodiversity by acting as a limiting nutrient and heterotrophic community structure. To examine extracellular release of DOM by phytoplankton with an emphasis on how species diversity influences the composition of DOM, we characterized and compared organic material released by various marine phytoplankton in culture. DOM from axenic phytoplankton cultures (Prochlorococcus marinus, Synechococcus sp., Phaeodactylum tricornutum, etc.) was captured by solid-phase extraction and analyzed using mass spectrometry. We found that while a small fraction of the DOM released was common to all isolates tested, the majority was specific to individual strains or groups, suggesting a relationship between phytoplankton species and DOM composition. Phytoplankton-derived DOM suites were also given to axenic cultures of heterotrophic bacteria, and DOM additions resulted in increased growth rate and cell abundance for particular bacteria, further implicating DOM as a potential driver of marine microbial biodiversity. (Abstract ID 12299)

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WATER LEVEL EFFECTS ON WAVE-DRIVEN INUNDATION: MARSHALL ISLANDS

The Republic of the Marshall Islands (RMI), two parallel island chains consisting of 29 atolls and 5 mid-ocean reef islands, lies in a region of large tidal range and energetic wave activity, and destructive inundation events occur frequently. From 2009-2011, a field experiment designed to assess water level effects on wave-driven inundation at reef protected shorelines was carried out at Majuro, the most densely populated atoll and Roi Namur at the Kwaialien atoll. Wave-driven contributions to high coastal water level events are due to wave setup, and wind wave and infragravity runup. Wave setup is controlled by breaking waves at the reef edge, and differences observed between setup estimated at the two sites may be understood in terms of a tidally dependent similarity parameter. Energy in the wind wave bound on the reef flat is highly correlated with total water level (setup and tide), with significant wind wave energy reaching the shore owing to narrow (<200-300 m) reef widths and moderate frictional decay. The dynamics of the observed infragravity motions on the reef flat also are assessed. (Abstract ID 10748)

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DEVELOPMENT OF AN ANION-EXCHANGE TECHNIQUE FOR IN-SITU HIGH PRESSURE LIQUID CHROMATOGRAPHY MEASUREMENTS OF MAJOR ANIONS IN MARINE WATERS

Anion-exchange chromatography is an indispensable bench top method for anion analysis, but a high pressure liquid chromatography (HPLC) system designed for in-situ quantification of anion concentrations in marine environments does not currently exist. In-situ measurements of anions in marine environments could elucidate estuarine mixing and nutrient dynamics, allow for the acquisition of high-resolution nitrogen and sulfur redox profiles in sediments, and provide insight into geochemical processes at hydrothermal vents. A new anion-exchange technique was optimized for in-situ measurements of major anions in marine waters: the method is isocratic, eliminates the need for chemical suppression, and separates Cl-, SO4-2-, NO3-, and NO2- rapidly enough to resolve most dynamic processes. A few microliters of seawater are injected onto a commercially available anion-exchange column and ultraviolet absorbance at 214 nm is measured in the effluent. At this wavelength, the UV-active anions (Br-, NO3-, NO2-, ΣH2S) display positive peaks, while UV-inactive anions (Cl- and SO4-2-) suppress the background absorbance of the eluent and generate negative chromatographic peaks. Preliminary data obtained with this technique adapted to an in-situ HPLC developed in parallel for both benthic chamber and sediment profile measurements are presented. (Abstract ID 12268)

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PHYSICAL OCEANOGRAPHY IN CUMBERLAND SOUND: AN IMPORTANT OTN STUDY SITE

As part of the Arctic OTN arena, one of the first systematic oceanographic measurement programs was conducted in Cumberland Sound, Barfin Island, over the summer of 2011. Large, remote and not fully charted, Cumberland Sound has an irregular rocky bottom with deep pools extending past 1100 m separated by sub-surface ridges 200 m deep. A temperature minimum around 150 m of -1.5 °C extends over the sound. Temperature minima like this are found in other arctic locations, potentially forming at the surface during ice cover and sinking throughout the summer. Below the water gradually warms reaching bottom values of 3 °C. Salinity increases with depth, rapidly changing in the top mixed region, with less change in the area of the temperature minimum. Density is stable with no evidence of overturns and the water column is oxygenated to the bottom of the deeper pools. Preliminary results based on summer 2011 CTD sampling and a month-long mooring deployment as well as thermistors recovered from bottom moorings set over 2010-2011, will be discussed, including possible effects on fish and mammal behavior in the sound. (Abstract ID 10615)

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PHYSICAL TRANSPORT AND CHEMICAL BEHAVIOR OF DISPERSED OIL: STATE OF KNOWLEDGE AND RESEARCH NEEDS RELATED TO FUTURE OIL SPILL RESPONSE

During response operations, scientific information is provided to decision makers, such as the Federal On-Scene Coordinator (FOSC), state and federal trustees, and the public. The decision to use chemical dispersants during a response is made among all these parties, and during the Deepwater Horizon (DWH) oil spill the dispersant discussion included both surface and subsurface implication of chemical dispersants. This presentation is intended to provide perspective on operational modeling and analysis during response, and research needs related to response modeling for decision support of dispersant application and its potential effects. The presentation information is based on historical perspective, modeling and analysis results during the responses to the IXTOC 1 and Deepwater Horizon well blowout, and results from a workshop sponsored by NOAA Office of Response and Restoration and the University of New Hampshire Coastal Research Response Center, “The Future of Dispersant Use in Spill Response” held on September 20-22, 2011 in Mobile, Alabama. Our goal is to connect operational needs with the academic community. (Abstract ID 11496)

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MULTIPLE APPROACHES TO ELUCIDATE THE MIGRATION OF THE AMERICAN EEL (ANGUILLA ROSTRATA) FROM THE ST.-LAWRENCE RIVER TO THE SARGASSO SEA

Although listed as special concern in Canada, estuarine and oceanic migrations that characterize the American eel’s life cycle remain largely unknown. This project aims to establish the migration routes taken by adult eels from the St. Lawrence River to the spawning area as well as to identify the dominant conditions that prevail along these routes. A system-wide effort to capture and acoustically tag individuals was conducted in 2010 and 2011. Acoustic hydrophones were deployed from the upper St. Lawrence River to Cabot Strait and the Atlantic Ocean. 18 eels are to be fitted with archival tags in a first attempt to track their horizontal and vertical migrations towards the spawning site in the Sargasso Sea. The first and second year of acoustic tracking generated novel and interesting data that are discussed in this presentation. Also, through the use of POKM (Platform for Ocean Knowledge Management), a web-based tool that allows OTN researchers conduct joint analyses of oceanographic and animal tracking data, models are being developed to examine the oceanic phase of eel migration patterns. (Abstract ID 10266)
HOW IMPORTANT ARE MESOSCALE EDDIES IN DETERMINING THE SUelpOLAR DEEPWATER FORMATION, FRESHWATER DISTRIBUTION AND AMOC RESPONSE IN GREENLAND MELTING SCENARIOS?

The role of mesoscale eddies in the oceanic response to Greenland melting scenarios is studied with a sequence of global ocean-sea-ice model simulations with increasing horizontal resolution: the models, from non-eddying ~30 km, to eddy-permitting ~15 km, up to ~3 km mesh sizes in the subarctic Atlantic, are part of developments in the DRAKAR collaboration, building on NEMO. The highest-resolution case uses a two-way nesting scheme of a 1/20°-North Atlantic domain embedded in a global 1/4°-configuration (ORCA025). Hindcast simulations using CORE forcing for 1948-2007 are shown to capture key features of the boundary currents, eddy fields and deep winter convection in the Labrador and Nordic Seas. The host of model configurations was used to simulate a Greenland melting scenario (with additional runoff of 100 mSv, equally distributed and constant in time): results show that the cross-shelf flux of meltwater is strongly dependent on model resolution, suggesting an important impact of the eddy-driven exchanges with the interior basins for convection intensity, with implications for the response of the subpolar gyre and the AMOC in honing scenarios. (Abstract ID 10254)

OTHER TOPICS OF INTEREST:

How important are mesoscale eddies in determining the subpolar deepwater formation, freshwater distribution and AMOC response in Greenland melting scenarios? The role of mesoscale eddies in the oceanic response to Greenland melting scenarios is studied with a sequence of global ocean-sea-ice model simulations with increasing horizontal resolution: the models, from non-eddying ~30 km, to eddy-permitting ~15 km, up to ~3 km mesh sizes in the subarctic Atlantic, are part of developments in the DRAKAR collaboration, building on NEMO. The highest-resolution case uses a two-way nesting scheme of a 1/20°-North Atlantic domain embedded in a global 1/4°-configuration (ORCA025). Hindcast simulations using CORE forcing for 1948-2007 are shown to capture key features of the boundary currents, eddy fields and deep winter convection in the Labrador and Nordic Seas. The host of model configurations was used to simulate a Greenland melting scenario (with additional runoff of 100 mSv, equally distributed and constant in time): results show that the cross-shelf flux of meltwater is strongly dependent on model resolution, suggesting an important impact of the eddy-driven exchanges with the interior basins for convection intensity, with implications for the response of the subpolar gyre and the AMOC in honing scenarios. (Abstract ID 10254)

Mesoscale eddies play a crucial role in the oceanic response to greenhouse gas-induced warming. They are key components in the climate system, influencing heat and freshwater transport, as well as carbon and nutrient distributions. The COMPARISON OF HIGH TO LOW LATITUDE PROXY RECONSTRUCTIONS OF DEEPWATER FORMATION, FRESHWATER DISTRIBUTION AND AMOC RESPONSE IN GREENLAND MELTING SCENARIOS explains the importance of mesoscale eddies in determining the subpolar deepwater formation, freshwater distribution and AMOC response in Greenland melting scenarios. The role of mesoscale eddies in the oceanic response to Greenland melting scenarios is studied with a sequence of global ocean-sea-ice model simulations with increasing horizontal resolution: the models, from non-eddying ~30 km, to eddy-permitting ~15 km, up to ~3 km mesh sizes in the subarctic Atlantic, are part of developments in the DRAKAR collaboration, building on NEMO. The highest-resolution case uses a two-way nesting scheme of a 1/20°-North Atlantic domain embedded in a global 1/4°-configuration (ORCA025). Hindcast simulations using CORE forcing for 1948-2007 are shown to capture key features of the boundary currents, eddy fields and deep winter convection in the Labrador and Nordic Seas. The host of model configurations was used to simulate a Greenland melting scenario (with additional runoff of 100 mSv, equally distributed and constant in time): results show that the cross-shelf flux of meltwater is strongly dependent on model resolution, suggesting an important impact of the eddy-driven exchanges with the interior basins for convection intensity, with implications for the response of the subpolar gyre and the AMOC in honing scenarios. (Abstract ID 10254)
“telepresence” technology that enables 24/7 world-wide real time access to the at-sea team collecting data by the ship's remotely operated vehicles. We have formed partnerships with a wide-range of educational organizations to capitalize on interest sparked by this live access: through live internet-based coverage of expeditions, formal and informal learning programs, internships, undergraduate and graduate programs, and professional development programs. The website www.NautilusLive.org provides live access to hundreds of thousands of viewers in the form of live video and audio from sea, blogs, social networking, and real-time interactions with scientists through video and audio broadcasts. The essential element to all of these programs is to engage and inspire children by giving them a compelling view of scientists and engineers as they are making real time discoveries, and to show kids the path to putting themselves on a future ship of exploration. (Abstract ID 11445)

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NEW FRONTIERS IN OCEAN EXPLORATION: THE 2010 AND 2011 E/V NAUTILUS FIELD SEASONS

The Exploration Vessel NAUTILUS is creating a focus of international leadership for the development and integration of leading-edge technologies, educational programs, field operations, and public outreach programs for ocean exploration, in partnership with NOAA, National Geographic Society, Office of Naval Research, Sea Research Foundation and other sponsors. To do so, the program uses a complement of deep submergence vehicle systems and telepresence technologies to engage scientists, educators and the public, both at sea and ashore, allowing them to become integral members of the on-board expedition team. Two four-month field seasons were undertaken aboard NAUTILUS (2010-2011) to the Black, Aegean and Mediterranean Seas, and North Atlantic Ocean. During these expeditions, a number of archaeological, biological and geological discoveries were made while broadcasting the events live on the internet to thousands of viewers. When discoveries are made, experts advise are notified and brought aboard virtually within a short period of time to help guide shipboard response before the ship moves on. Future expeditions will expand our network of “Doctors on Call” to engage the widest scientific audience possible. (Abstract ID 11432)

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DYNAMICS IN MARINE ECOSYSTEMS

Specifying effective ecosystem-based management strategies requires an understanding of the status, trends and interactions among key ecosystem components. Fisheries independent surveys sample major portions of marine systems and can be considered a proxy for many of the important ecosystem components. They also provide a means to compare upper trophic levels across large marine ecosystems. We quantified the potential mechanisms which drive changes in biomass among diet based functional groups with a linear, multispecies Gompertz model. Using a trawl survey database representing a number of large marine ecosystems from around the world we were able to parse out changes in biomass due to density-dependence, interactions between functional groups, fishing pressure and climate change. Through our analysis we hope to provide insight into the general ecological organization of marine systems that would enhance ecosystem-based management. (Abstract ID 12599)

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SUB-TROPICAL MODE WATER SPATIAL AND TEMPORAL NUTRIENT VARIABILITY FROM DATA COLLECTED BY THE BERMUDA ATLANTIC TIME-SERIES STUDY

Determination of nutrient concentrations through the water column has been a core measurement at the Bermuda Atlantic Time-series Station (BATS) since inception in 1988. The debate about mechanisms of new nutrient input into the euphotic zone calls for further study into the variability of nutrients in the sub-tropical mode water (STMW). Winter mixing at the BATS site typically extends into this STMW nutrient reservoir which represents the dominant mode of transport of nutrients to the euphotic zone. Here we examine data from the BATS site and BATS validation cruises (travels from north of Bermuda to Puerto Rico) to detail the temporal and spatial variability of nutrients in STMW. The analyses reveal substantial variability in the STMW nutrient concentrations with long-term means at BATS of 3.76±1.54 umolkg-1 and 0.17±0.11 umolkg-1 for nitrate and phosphate, respectively and further, less than 30% of this variance is associated with conservative processes. On consideration of pre-conditioning of the nutrient pool available for the spring bloom, we assess the contribution of STMW nutrient concentrations to interannual variability of upper ocean biogeochemistry at BATS. (Abstract ID 10334)

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OCEAN SCIENCE IN A CROWDED WORLD

The ocean sciences are in the midst of a revolution of both capability and motivation. Developments in marine robotics, batteries, energy scavenging technology, sensors, and the information sciences are converging to enable a permanent presence in the ocean by our robotic proxies. These technological advances, coupled with increasing global population and industrialization of the developing world, create an impetus for exploitation of ocean resources. The oil and gas industry has a large and growing presence in the ocean. Deep ocean mining is comparatively immature, but is poised for expansion. Fishing of wild species is rapidly being overshadowed by aquaculture. Other industrial activities in the ocean range from wind and wave energy conversion to proposed carbon sequestration. Thus while future ocean scientists will have unprecedented observational capabilities compared to today, they will share an increasingly crowded ocean with a range of commercial activities. Consequently, the ocean infrastructure of 2030 will need to provide observations to baseline ocean conditions and to unambiguously characterize human impacts. Ocean scientists in 2030 will need to be able to relate those observations to specific human activities. Without such a capability, policy makers will be unable to balance the demand for resource extraction with our dependence on the health of the ocean. (Abstract ID 12834)

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MICROBIAL NITROGEN, CARBON, AND SULFUR CYCLING IN THE EASTERN TROPICAL NORTH PACIFIC OXYGEN MINIMUM ZONE

Oxygen minimum zones (OMZs) are biogeochemically-important regions of the ocean that are expanding as a consequence of climate change. Microorganisms directly and indirectly create OMZs, and their activities have enormous influence on global elemental cycles—however it is unclear exactly how nitrogen (N), carbon (C), and sulfur (S) are cycled in OMZs, and how different components of these cycles fit together. Here we report multiple forms of N/C/S metabolism in the OMZ of the eastern tropical North Pacific (ETNP), based on molecular techniques and rate measurements, many of these processes were coupled at different depths and in different regions of the ETNP, and we highlight coupling between ammonia oxidation, nitrite oxidation, conventional denitrification, anammox, and chemosulfatrophic denitrification. Chemosulfatrophic processes were prevalent in much of the ETNP suggesting that carbon fixation through chemosynthesis is significant, though not substantial. The communities involved were similar to, but distinct from, those in eastern tropical South Pacific (ETSP)—indicating that the ETNP and ETSP differ in important ways, and highlighting the biogeochemical complexity found both within and across oceanic OMZs. (Abstract ID 12864)

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USING SELF-ORGANIZING MAPS TO IDENTIFY PHYTOPLANKTON GROUPS FROM REMOTELY SENSED DATA IN CASE 1 WATERS

Ocean color sensors have changed our vision of the marine biomass, providing frequent synoptic-scale information which allows to deduce important bio-optical parameters. A major task is to detect phytoplankton groups which is of great importance for ocean biogeochemical cycles study. Some empirical methods have been developed during the past years to detect these groups, such as “PHYSAT” which is based on anomalies of normalized water leaving radiiances (NwL), associated empirically with dominant groups (Alvain et al., 2005 and 2008). To improve this method and detect systematically the NwL*, we used a nonlinear statistical method, the so-called self-organizing maps (SOM). Associated with a hierarchical ascendant classification, SOM allowed to discriminate seven classes of NwL* using SeaWIFS images. In order to attribute a phytoplankton type to each of the spectra classes, we used SOM to classify pigments groups from a large in situ dataset, that were then matched to the NwL* spectra classes. Thus, global maps of phytoplankton groups obtained with this neural networks approach were analyzed. (Abstract ID 11828)
Diatoms play an integral role in the nitrogen cycle, and individual species differ in their physiological responses to nitrogen source and to nitrogen limitation. To identify responses to nitrogen availability common among different species and genera, we examined whole-cell transcriptomics of three evolutionarily diverse diatoms (Thalassiosira pseudonana, Pseudo-nitzschia multiseries and Fragilariopsis cylindrus). Cultures were harvested under nutrient replete, nitrate-starved and silicic acid-starved conditions, and SOLID high-throughput sequencing was used to provide a transcriptional snapshot of the metabolic response of each diatom at time of harvest. Significantly up- and down-regulated genes were identified in each species that only responded to the onset of nitrate-starvation relative to the other two treatments. The corresponding proteins included nutrient transporters and metal ion-binding proteins. These gene subsets were then compared among the three species, as well as within existing diatom EST and tiling array databases to determine whether a shared, transcriptional response to nitrogen-starvation could be detected among distantly related species. Our goal is to identify a pool of shared genes, which can then be used to interrogate field samples of diverse diatom assemblages. (Abstract ID 12715)

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LONG-TERM EFFECT OF HIGH CO2 LEVELS ON CALCIFICATION AND PHOTOSYNTHESIS IN EMINIADIA HUXLEYI

The coccolithophore Emiliania huxleyi plays an important role in the marine carbon cycle through production of organic matter and calcium carbonate. Several studies have examined acclimation of E. huxleyi to high CO2, but most studies to date have mostly been short-term. To investigate the long-term response of E. huxleyi to high CO2 and elevated temperatures, we grow E. huxleyi (strain CCMP 371) in continuous cultures at 800 ppm and 24 C and at 380 ppm and 20 C as a control. Primary productivity, calcification rate as well as carbonic anhydrase (CA) expression were measured after 400 generations. Increases in calcification rate and CA expression, but not primary productivity were observed after 400 generations in the high CO2, high temperature treatment. Thus, in the future warmer and higher CO2 oceans E. huxleyi might convert more CO2 into bicarbonate via CA to use for calcification rather than use that CO2 for photosynthesis. The opposite would have been expected given that E. huxleyi has high Kc values for photosynthesis and is known to be not carbon saturated under present CO2 condition. (Abstract ID 10826)

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TRACING TERRIGENOUS DOC INPUTS TO THE SOUTHEASTERN BEAUFORT SEA

Permafrost thawing and increased river runoff are expected to increase export of terrigenous DOC (tDOC) from the Mackenzie River to the Southeastern Beaufort Sea. The resulting impacts on carbon dynamics in the region are complex but inevitably depend on whether the exported tDOC lingers on the continental shelf or gets rapidly transported to the Canadian Basin. Having the ability to spatially trace tDOC inputs to the Beaufort Sea would therefore prove valuable for monitoring future changes in the biogeochemistry of this sensitive region. We present new capabilities to trace tDOC in surface waters on synoptic scales of relevance to biogeochemical cycles of Arctic ocean margins. This novel approach makes use of the spectral slope coefficient of CDOM (S370,350) as a tracer of tDOC (see related paper by Fichot and Bennett in Session 031). Here it is adapted using data collected during the MALINA project and is implemented in the region of the Beaufort Sea influenced by the Mackenzie River. (Abstract ID 11687)

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FROM ESTUARIES TO OCEANS: A MULTI-DISCIPLINARY ASSESSMENT OF THE MOVEMENTS AND MIGRATIONS OF AN ENDEMIC FISH SPECIES IN SOUTH AFRICA

White steenbras Lithognathus lithognathus (Pisces: Sparidae) is one of South Africa's most threatened endemic fishery species. This study combined acoustic telemetry, conventional dart tagging, environmental data, population genetics and fishery data to enhance our understanding of the species' life history. Acoustic telemetry showed extreme residency of white steenbras within and dependence on estuarine nursery areas as early juveniles, after which they lose their estuarine-dependence and become resident within surf-zone habitats. Genetic analyses across the distributional range indicated a single, well-mixed population, and seasonal catch data suggest an annual spawning migration. However, this was not reflected by conventional dart tagging. Consequently, the existence of a seasonal annual spawning migration remains unconfirmed. The development of a national acoustic telemetry platform, including initiatives such as the Ocean Tracking Network and the collection of physical oceanographic data will allow improved assessment of longshore movements and migratory patterns of white steenbras and other marine animals, through the integration of oceanographic and animal movement data. The multi-technique approach will provide an improved scientific basis for the management and conservation of numerous marine species. (Abstract ID 9423)

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THE CARBON BIOGEOCHEMISTRY OF A DISPERSING HYDROTHERMAL PLUME FROM AN ULTRAMAFIC INFLUENCED SYSTEM ON THE MID-CAYMAN RISE

Deep-sea ultramafic-hosted hydrothermal systems represent an ideal geological environment for abiotic synthesis of organic carbon and it has been proposed that early life may have begun at such systems. In modern-day oceans, ultramafic-hosted hydrothermal circulation should provide an important energy source to heterotrophic microbial communities within the crust and around vent ecosystems. However, very few studies have investigated the potential impact of abiotically produced organics on the biota that exists directly around the vents or within the dispersing hydrothermal plumes. During August 2011, a telepresence-enabled Ocean Exploration cruise on board the NOAA ship Okeanos Explorer provided us with the opportunity to investigate an ultramafic influenced system, at ~2900 m on the Mid-Cayman Rise. The hydrothermal plume above the Von Damm vent site was detected and then traced as it dispersed 4 km away from its source. Here we report on the detection of thermal anomalies and elevated concentrations of methane, together with organic carbon content and cell counts within this dispersing plume. We will discuss the potential that abiotic organic synthesis not only influences biological communities on a local scale, but also further afield, as an energy source to both auto- and heterotrophic microbial communities within the water column. (Abstract ID 10670)

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HOW DO THE LAURENTIAN GREAT LAKES WATER LEVELS RESPOND TO CLIMATE CHANGE? A REGIONAL CLIMATE MODEL STUDY

The Laurentian Great Lakes contain twenty percent of the world's surface freshwater. Over the past century, inter-annual water levels have fluctuated in a primarily cyclic pattern with amplitudes from 0.2 m in Lake Superior to 0.7 m in Lake Erie. These changes in water levels result in more significant changes in coastlines of the Great Lakes and alter shoreline erosion, pollutant concentrations, and shoreline habitat. As climate changes, we are interested in how lake levels will respond. Global scale climate models do not depict the Great Lakes, and thus, are unlikely to accurately capture the mechanisms impacting water levels. We utilize the Abdus Salam International Centre for Theoretical Physics Regional Climate Model 4 at 20 km horizontal resolution with an explicit lake model, a groundwater module, and a channel routing module to simulate the past regional climate (1970-present), Nino4, and evaluate modeled climate and water levels. We then simulate present and future water levels using boundary conditions from the global Community Climate System Model. Model evaluation and preliminary findings for future water levels will be presented. (Abstract ID 10438)
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MIXING, BOTTOM FRICTION, AND THE VERTICAL STRUCTURE SURF ZONE FLOWS

The surf zone and inner shell compartment off the ocean make up an important segment in the full cross-shore chain that allows exchanges between land and the open ocean. Starting from a coupled numerical model of this nearshore area (Bennis and al, 2011) we find that the cross-shore flow patterns can be extremely different when using different parameterizations for the bottom stress in association with a modified k-epsilon parametrization (Walstra et al, 2000). These differences are small for an all-shore-long uniform beach, but they are important for three-dimensional configurations (e.g. Yu and Slim, 2003). Essentially, a stronger bottom friction results in a stronger vertical mixing, which can suppress the vertical shear in the quasi-Eulerian velocity. The choice of the bottom friction parameterization thus appears critical, and some of the existing parameterizations are better suited to the inside or the outside of the surf zone. We thus implement the parameterization of waves as a source of TKE (Mellor 2002) for the modelling of wave effects in a phase-averaged bottom boundary layer, and evaluate its adequacy in the surf zone where turbulence is also provided by breaking waves. This is done on a plane beach and on a barred beach. The influence of mixing is studied on both Eulerian and Lagrangian flows. This approach provides a promising way of modelling both friction and vertical mixing in a consistent way, which is valid both in the surf zone and over the inner shell. (Abstract ID 11520)

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ASSESSING BIOGEOCHEMICAL MODELS WITH HIGH-RESOLUTION AIRBORNE OBSERVATIONS OF THE O2/N2 RATIO OVER THE SOUTHERN OCEAN

The HIPPO (HIAPER Pole to Pole Observations) global airborne campaign ran five month-long deployments between January 2009 and September 2011. Deployments followed a path along the central Pacific Ocean from 10N to 67S, profiling the atmosphere from the ocean's surface to 15km, measuring, amongst other species, many carbon cycle tracers. Data from two instruments we flew on HIPPO global – the MEDUSA whole-air sampler and the AO2 vacuum ultraviolet oxygen analyzer – and compare these with output from atmospheric transport models forced by dissolved gas climatologies and a suite of ocean biogeochemistry models. (Abstract ID 10629)

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FLUVIAL SEDIMENT FLUX DURING HIGH DISCHARGE EVENTS HARNESING MISSISSIPPI RIVER SEDIMENT TO BUILD NEW LAND ON AN ENDANGERED COAST

During May-June 2011, enormous fluxes of sediment were delivered to the Louisiana coast by the Mississippi River, where river stages locally exceeded records set by the Great Flood of 1927. Considering the importance of Mississippi sediment to future development of large river diversions for land building in the Mississippi Delta, we undertook a first-ever study of sediment flux, dispersal, and deposition through one of the largest man-made river diversions on the Mississippi, the Bonnet Carre Spillway. Sediment flux was monitored and sediment cores collected before and after spillway operations in Lake Pontchartrain, the estuarine spillway receiving basin. Cores were examined using Pb-210 and Be-7 geochronology, X-radiography, and granometry. Initial results conservatively suggest that spillway sediment flux during May-June was on the order of 3-4.5 Mt, of which much was deposited in a shallow-water delta building near the spillway outlet. This is comparable to fluxes that have built and are building unmanaged subdelta lobes in the modern Mississippi Delta, suggesting that pulsed delivery of sediment during high discharge events is an effective means to manage river flow for land building. (Abstract ID 10279)

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SEDIMENTATION AND BIOGEOCHEMICAL MATTER REMINERALIZATION IN THE EASTERN TROPICAL SOUTH PACIFIC (ETSP): SEDIMENT TRAP AND SEDIMENT PORE WATER FLUXES

Sediment traps (100, 200, 3700 m) were used to constrain fluxes of mass, POC, PON, bSi and CaCO3 through the water column during two cruises to the ETSP at six stations located between 105 to 20S and 85W to 100W. Floating traps were deployed for 30-60 hour intervals and McLane traps were deployed for 14 months to capture weekly flux patterns between Jan. 2010-April 2011. Mass fluxes to floating traps attenuated between 100-200 m, with highest fluxes (150 mg/m2d) observed near the continent and lowest fluxes (20 mg/m2d) at 20S, 100W. POC fluxes to 200 m ranged from 0.2-1.2 mmol/m2d. Two deep moored traps (10 and 20S) captured a pulse of higher sedimentation between Aug.-Sept. 2010, coincident with lower SST in the equatorial region. Deep trap mass fluxes ranged 10-60 mg/m2d at 105 and 1.6 mg/m2d at 20S. We will discuss the attenuation of C, bSi and N vs. depth including floating trap data from 2010 and 2011 and demonstrate the relationship between opal rain and dissolution (determined by sediment pore water diffusive flux calculations). (Abstract ID 9523)

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DYNAMIC CHANGES IN EDDY CORRELATION MEASUREMENTS OF BENTHIC OXYGEN FLUXES

Eddy correlation measurements typically give benthic oxygen fluxes with a temporal resolution down to 5 or 10 minutes. These fluxes often contain surprisingly large variations that may appear unrealistic. The source of this variability is twofold. Firstly, natural benthic oxygen fluxes are inherently highly dynamic – a fact that is not fully recognized, in part because most short-term dynamic changes are not recorded with traditional flux methods, such as sediment core and in-situ chamber measurements. These approaches typically impose static hydrodynamic conditions and rely on incubations times of several hours, for which one mean flux value is determined. Secondly, eddy correlation data are measured at some height above the seafloor, usually 5 to 30 cm, and this can lead to some variations in the derived eddy flux that reflect changes in the bottom water. This talk evaluates the assumptions implicitly made when the benthic flux is equated to the measured eddy flux. Furthermore, based on measured eddy correlation data and modeling of the turbulent transport and mixing in the bottom water, examples are given on highly dynamic fluxes and their origin. (Abstract ID 9515)

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TIDAL TRANSPORT OF TOTAL MERCURY, METHYLMERCURY, AND DISSOLVED ORGANIC CARBON FROM A MANGROVE MARSH MEASURED USING CDOM FLUORESCENCE

Tidally driven fluxes of dissolved organic carbon (DOC) to the ocean accounts for 10% of the total terrestrial flux. Recent findings of high concentrations of mercury (Hg) and methylmercury (MeHg) in mangroves have raised concerns that fluxes of these species too may be large, owing to the commonly observed strong relationship between DOC and Hg species. We used the relationship with CDOM fluorescence to measure the dissolved organic carbon (DOC) and Hg fluxes to coastal waters from a mangrove-dominated estuary in Everglades National Park (Florida, USA). Fluorescent dissolved organic matter was used as a proxy for DOC, filtered total Hg, and filtered methylmercury (MeHg). The result was an estimated flux per unit area (yield) for DOC of 180 ± 12.6 g C m-2 yr-1 – in the range of previously reported values. Estimated yields of dissolved Hg species – 28 ± 4.5 ng THg m-2 yr-1 and 3.1 ± 0.4 ng MeHg m-2 yr-1 – were 5 to 100 times greater than previously published.
values for terrestrial wetlands. These results indicate mangroves can be a significant source of DOC and Hg to coastal ecosystems, and that coastal wetlands in general may represent important and unrecognized sources of DOC, Hg, and MeHg to the Gulf of Mexico (GOM) as a whole. (Abstract ID 12877)

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MAJOR AUTOTROPHIC POTENTIAL IN DEEP-SEA PROKARYOTES IN THE NORTH ATLANTIC

To elucidate the significance and the key prokaryotic autotrophs responsible for dissolved inorganic carbon (DIC) fixation in the deep ocean, we targeted metabolic marker genes in meso- and bathypelagic waters in the North Atlantic. Specifically, the genes encoding archaeal acetyl-CoA carboxylase (acca) and ammonia monoxygenase-α subunit (amoA), the bacterial RuBISCO (cbmM) and dissimilatory APS reductase (apnA) were quantified using Q-PCR. Additionally, the bacterial and archael community composition was determined using T-RFLP complemented with a metagenomic approach. Vertical and latitudinal trends of gene abundances indicated an extensive genetic potential of DIC fixation. RuBISCO gene homologues were most abundant in the upper mesopelagial, reaching unity with apnA gene abundance, and decreasing with depth. The distribution of archael amoA gene abundances reflected the occurrence of distinct ammonia-utilizing archael communities, one adapted to utilize high and one adapted to use low ammonia concentrations. Acca-RuBISCO gene abundance ratios indicated a relative predominance of the 3-hydroxypropionate/hydroxybutyrate over the Calvin cycle. Our results suggest a larger potential of autotrophy in deep ocean prokaryotes than assumed hitherto. (Abstract ID 10992)

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RESILIENCE OF THE SKIDAWAY RIVER ESTUARY: CAN HUMAN INDUCED ECOSYSTEM IMPAIRMENT BE REVERSED IN A WELL-MIXED SUBTROPICAL ESTUARY?

One of the longest continuous estuarine water quality monitoring programs in the Southeastern USA is the Skidaway River Monitoring Program (SRiMP). Since 1986 observations of hydrography, nutrients, heterotrophic microbial communities, phytoplankton, zooplankton, and dissolved oxygen have been measured in Skidaway River estuary (Georgia, USA). Uniquely, the SRiMP program captured a significant negative water quality trend with the system transitioning from net autotrophic to net heterotrophic conditions and dissolved oxygen concentrations approaching hypoxic levels. These trends could be quantitatively attributed to the development of Skidaway Island from a forested barrier island to golf course community. However, since 2000 when population growth rates on Skidaway Island slowed from a high of 25% in the early 1980’s to a current rate of less than 3%, water quality and plankton communities appear to be returning to pre-development levels. These observations suggest the inherent resilience of well-mixed subtropical estuarine systems to human disturbance and the ability to recover from seemingly catastrophic decline. (Abstract ID 12783)

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OVERCOMING COMPLICATIONS POSED BY DEAD CELLS IN INTERPRETING FLUORESCENCE MEASUREMENTS IN NATURAL PHYTOPLANKTON ASSEMBLAGES

In vivo fluorescence of chlorophyll a is a traditional proxy for primary producer biomass, but it is well understood that chlorophyll and its breakdown products persist in dead cells and detrital material. Alternative measurements of induced/active fluorescence (e.g. F_i/F_r) have helped overcome the problem by providing information about the physiological state of photoautotrophic organisms, but recent work has demonstrated that such signals are strongly biased by the presence of dead cells (e.g. Franklin et al. 2009. Mar Ecol Prog Ser 382: 35). In order to identify and quantify dead cells, use of fluorescent cell mortality staining (with dyes such as Sytox) coupled with flow cytometry is a promising approach, but there are complications. We offer a framework for interpreting dead cell signals, with relevance to marine and freshwater systems. Work in a small freshwater ecosystem that allows year-round sampling at high frequency demonstrates the critical importance of: a) positive and negative controls for staining, b) ‘ground-truthing’ with microscopy, c) fine time series, and d) species-specific responses in terms of patterns and prevalence of dead cells. (Abstract ID 9738)

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TIDE AND TIDAL CURRENT IN THE BALI STRAIT, INDONESIA

Tide and tidal current model using a Coupled Hydrodynamical-Ecological Model for Regional and Shelf Seas (COHERENS) is applied to the Bali Strait of Indonesia. The model well reproduces the four major tidal constituents, namely M_2, S_2, and O_1 tides, and their current. With its resolutions in the horizontal (500 meters) and the vertical (4 layers), the model is used to investigate a tidal front for the first time in the Bali Strait. The front detected by sea surface temperature distribution from the satellite, runs in the domain where the value of H/f (where H is the water depth in meters and f the amplitude of (M_2 + S_2) tidal current in m/s) close to the line of 6,5 showing that tidal straining plays an important role in its formation. Keywords: COHERENS, tidal front, Bali Strait, SST image (Abstract ID 9410)

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RESPONSE OF THE OCEAN CARBON PUMPS TO CHANGES IN OCEAN CIRCULATION IN 21ST CENTURY CLIMATE CHANGE SIMULATIONS

Under increasing atmospheric CO2 concentrations the changing Earth’s radiative balance will influence the atmospheric and oceanic circulation. One of the consequences will be a modification of the ability of the ocean to absorb and store CO2. To a first degree of approximation the ocean’s carbon uptake can be separated between solubility-driven and biologically-driven pumps. The separate impact of the changing ocean circulation on these two pumps is still unclear though a partial compensation between opposite responses is expected. We design a suite of model experiments to quantify these responses analyzing a preindustrial steady state and an evolving state with atmospheric carbon concentrations rising according to historical (1880-2009) and projected IPCC scenarios. All experiments are carried out in CM2Me, a coarse version of one of the climate models (the GFDL CM2) used in the IPCC Fourth Assessment report. The ocean biogeochemical component is solved by the Biology-Light-Ion-Nutrients-Gas (BLING) model which allow the separation between biological and solubility contributions to dissolved inorganic carbon. (Abstract ID 12679)

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COMPARATIVE COMPOSITION AND DIVERSITY OF SEDIMENT MACROFAUNA AT DEEP-SEA VENTS, SEEPS AND ORGANIC FALLS

Sediments associated with sites of hydrothermal venting, methane seepage and large organic falls such as whales, wood and plant detritus can create a network of soft-sediment habitats fueled in part by chemosynthesis. Understanding the level of species overlap and functional similarities between reducing habitats at different ecosystems is a key factor to reveal evolutionary links among these systems and manage specific areas in a scenario of anthropogenic exploration. In order to evaluate key similarities and differences in the sediment macrofauna of each system, this work generated a predictive framework for the study of
reducing sediment habitats and identified faunal overlap across ecosystems. Here we show that seep, vent and organic-fall sediments in the deep-sea are highly heterogeneous (family-level) in respect to both their geochemical and microbial processes, which reflect in a mosaic of habitats inhabited by a mixture of specialist and background fauna. Our study further suggests that reducing sediments exhibit distinct microbially assemblages at broad-scales (i.e. high beta diversity), which has important implications for the conservation of the unique genetic and ecological processes that exist in these ecosystems. (Abstract ID 11102)

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THE ROLE OF CROSS-CANYON CIRCULATION IN GRAVITY CURRENTS DOWN CANYONS

The flow of dense water in a V-shaped laboratory scale canyon is investigated by using a non-hydrostatic numerical ocean model. Due to the earth's rotation, there is a secondary cross-canyon circulation superimposed on the down-canyon flow. The cross-canyon circulation affects the mixing and may accordingly affect the meridional overturning circulation. Many large scale numerical overflow studies are performed with fairly coarse resolution using hydrostatic models. The secondary circulation may in such studies be poorly represented. In the present study, the effects of under-resolving the cross-canyon circulation are also investigated. (Abstract ID 9825)

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UNIFIED THEORY OF LAGRANGIAN COHESIVE STRUCTURES

We introduce a unified approach to locating key material curves that shape global mixing patterns in two-dimensional unsteady flows. SUCH key material curves are widely referred to as Lagrangian Coherent Structures (LCS). The theory is unified inasmuch as it is well-posed for the three relevant types of LCS: hyperbolic LCS (centerpieces of stretching and folding), elliptic LCS (eddy boundaries), and parabolic LCS (jet-like transport barriers). The LCS form solutions to a non-linear, non-autonomous, non-ordinary differential equation, and hence are available in a smooth, parametrized form. This is in marked contrast with earlier approaches to LCS, which relied on visually observing LCS as ridges of scalar quantities such as the FTLE or FSLE. In this talk the main elements of the newly derived theory are described, and results from applying the theory to surface ocean flows are presented. (Abstract ID 97/90)

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SEAHUNT: THE INTERACTIVE HYDROGRAPHIC CRUISE TRACKING SYSTEM

The oceanographic community has an ongoing need for a comprehensive, up-to-date resource to facilitate coordination of upcoming hydrographic cruises. The CLIVAR and Carbon Hydrographic Data Office (CCHDO) SeaHunt fills this need with an interactive, web-accessible database of proposed and planned research cruises. SeaHunt performs like a semantic wiki, holding user contributed data with a separate web page dedicated to each cruise being tracked. All information about a cruise is open for editing and comments from registered users. All members of the oceanographic research community are encouraged to post information regarding their own current, planned, and recently-completed cruises to the SeaHunt website. Additionally, staff members augment cruise data and meta-information by maintaining an ongoing dialogue with principal investigators and data originators. Data is tracked from initial cruise planning to final disposition. SeaHunt is seamlessly integrated with the CCHDO which displays final data once it is public. (Abstract ID 12369)

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TOWARDS A MONITORING OF JELLYFISH SWARMS USING AN EMBEDDED VISION SYSTEM IN AUVS, GLIDERS AND PROFILING FLOATS

The scyphozoan Pelagia noctiluca is a well-known organism in north-west Mediterranean for its regular proliferaions and invasions of near-shore waters, causing important damages to tourism economy and fisheries activity. It appears important to develop the tools to understand processes of swarms formation and basin-wide circulation of P. noctiluca populations. Jellywatch and SeaExplorer/Vasque (respectively regional and national French programs) aim at monitoring its geographic distribution using hydro-dynamical and physiological models, combined with in-situ detection from gliders and profiling floats. Here we present a miniaturised vision system dedicated to jellyfish detection embedded in autonomous platforms. On board image and data processing are made in near real-time, and data transferred by satellite. Different observational strategies are considered: a vertical monitoring using the SeaExplorer engine in glider mode to characterise the spatial disposition of jellyfish swarms in the water column; a surface horizontal monitoring using the glider in propulsion mode to estimate the size of swarms during their night surface drift; in fine, a semi-lagrangian monitoring using profiling floats that will drift together with the swarm, reproducing the vertical migration of the Pelagia noctiluca. (Abstract ID 11014)

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TEMPORAL VARIABILITY IN THE BIOGEOCHEMICAL COMPOSITION OF MICROPLANKTON IN THE SARGASSO SEA

An archive of preserved microplankton net samples collected at monthly intervals since 1997 at the Bermuda Atlantic Time-series Study site has been subjected to elemental analysis and microscopy enumeration. Using a combination of elemental chemical analysis and cell-size and abundance data acquired using a FlowCAM, variability in microplankton biogeochemical composition has been examined. Particulate silica and calcium concentrations for all available spring and autumn (1997-2008) samples have been analysed including all 14 samples within one 12-month period (1999-2000). Average monthly particulate calcium concentrations follow a similar pattern to Foraminifera abundance, with lower average cell calcium concentrations coinciding with peaks in planktonic foraminifera abundance. Highest average biogenic silica values were measured in samples from July, although the largest variations in both particulate silica concentration and diatom abundances were seen during February and April. Although high variability (seasonal, annual and inter-annual) has already been documented in picoplankton populations and microbial pigments in near-surface waters at the BATS site, this study has revealed large temporal changes in two microplankton groups, and their role in biogeochemical cycling in the Sargasso Sea will be discussed. (Abstract ID 10210)

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CONSEQUENCES OF SALINE MINE DISCHARGE ON MICROBIAL COMMUNITY STRUCTURE AND BIOGEOCHEMICAL CYCLING IN EPEHERMAL STREAMS

Ephemeral streams experience extreme seasonal and shorter temporal fluctuations in flow which result in rapidly changing environmental conditions including wetting and drying and changes in oxygen status of the sediments. In spite of the widespread occurrence of ephemeral and seasonally flowing streams in Australia, comparatively little work has been done to understand the interactions between hydrological regime and dynamics of sedimentary microbial processes in these systems. Understanding these relationships is critical to predict impact and regulate saline discharge from rapidly expanding mining and coal seam gas activities in many catchments. Relationships between the hydrological regime, benthic microbial structure and biogeochemical processes are being investigated in the Fitzroy Catchment, Australia. Results of field and laboratory experiments conducted across a range of spatial and temporal scales will be presented. Implications for regulation of timing and volumes of saline mine water discharge to ephemeral streams will be discussed. (Abstract ID 12454)
in suspended sediment during the WSRS period was 8 times higher than in pre-WSRS water. When the water column was strongly stratified, M. leidyi was patchily distributed and the occurrence of ZOOVIS was overlaid on a temperature-salinity diagram, it was clear that M. leidyi was more common in warm and low salinity water. When the water column was strongly stratified, M. leidyi tended to be more common near the pycnocline. When well mixed, M. leidyi tended to be more abundant near bottom. Horizontally, M. leidyi was more abundant in shallower depths near the middle Bay and less abundant in the deeper main channel. Furthermore, M. leidyi was patchily distributed spatially in terms of size, with –2 cm counted for each frame from ZOOVIS. Then, the data were aggregated in 2-sec bins and merged with data from the CTD. Artificial flood of about 20 days in the Hunaghe lower reaches for easing siltation in the river REGULATION SCHEME SINCE 2002 CHANGE OF THE MASS FLUX OF THE HUANGHE (YELLOW RIVER) TO THE sea. (Abstract ID 10902)

M. leidyi (~0.15mm – 2cm) were counted for each frame from ZOOVIS. An imaging system, Zooplankton Visualization and Imaging System (ZOOVIS) was deployed in Chesapeake Bay to investigate the fine scale distribution of ctenophore Mnemiopsis leidyi on July 20, 2011. Mnemiopsis leidyi (~0.15mm – 2cm) were counted for each frame from ZOOVIS. Then, the data were aggregated in 2-sec bins and merged with data from the CTD, which provided corresponding values of depth, temperature, and salinity to accompany data from the camera system. When the occurrence of M. leidyi was overlaid on a temperature-salinity diagram, it was clear that M. leidyi was more common in warm and low salinity water. When the water column was strongly stratified, M. leidyi tended to be more common near the pycnocline. When well mixed, M. leidyi tended to be more abundant near bottom. Horizontally, M. leidyi was more abundant in shallower depths near the middle Bay and less abundant in the deeper main channel. Furthermore, M. leidyi was patchily distributed spatially and patch size was ~50 m in diameter. Results provide insight on how M. leidyi responds to environmental changes and trophic interactions with other taxa. (Abstract ID 9944)

On Mytilus californianus shells: high resolution stable isotope study investigating environmental changes over the past 1000 years in Washington coastal region: high resolution stable isotope study on mytilus Californianus shells The successively deposited CaCO3 layers in mollusk shells could offer high resolution archives of past environmental conditions during mollusk’s life span. Here, we present high resolution oxygen and carbon isotope data from shells of mussel species, Mytilus californianus. Analyzed shells grew for ~10 years and were collected live in 2009 or 2010 from Tatoosh Island (TI), Washington. We also analyzed several shells, of the same species, present in archeological middens on TI. 14C dating suggests they lived ~1000 years ago. Shell carbonate samples were macerated across the annual growth bands to obtain time series transects with intra-seasonal resolution. Like previous sampling on annual scale, 818O data suggest no significant difference in variation range between modern and modern shells; the reconstructed temperature from modern shell 818O is comparable with the instrumental record from the study site. Fine scale sampling, however, shows oscillatory behavior, likely seasonal, in 818O data for both modern and modern shells. This allows us to test the fidelity of various growth models, i.e., constant or varying growth rate throughout the year. However, modern shells show lower 813C than modern shells, suggesting difference in carbon cycling between current and ancient conditions at this site. A declining trend was found only in 813C of modern shells; 813C of modern shells show larger amplitude of variation than modern shells, suggesting intensified seasonality. (Abstract ID 12556)
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ARCHAEAL DIVERSITY PATTERNS IN RELATION TO HYDROCARBON SEEPAGE IN THE GULF OF MEXICO

Acoustic wispawt zones detected in seismic surveys of Mississippi Canyon (MC) 118 sediments in the Gulf of Mexico have been linked to elevated hydrocarbon and methane seepage. Gravity cores from within and outside of these wispawt zones had been grouped into geochemically defined clusters of high, moderate, and low methane seepage (Lapham et al. 2008). Here, we characterize the archaean communities in the same gravity cores by sequencing of archaean small subunit ribosomal RNA genes and methyl coenzyme reductase A genes (mcrA), diagnostic for anaerobic methane-oxidizing or methanogenic archaea. The archaean community in high activity cores consists mostly of archaea involved in the anaerobic oxidation of methane (AOAM). Intermediate cores harbor both AOAM archaea and sediment subsurface lineages, mostly MBGB archaea. Low activity cores contained primarily mcrA archaea, a ubiquitous sediment group. All cores yielded mcrA, suggesting that minority populations of methanogenic or methane-oxidizing archaea remain detectable even in sediments with low seepage. This study shows the systematic variation of distinct archaean communities during seepage evolution in the Gulf of Mexico. Monitoring changes in microbial response over time should thus be incorporated into hydrate monitoring programs. (Abstract ID 10010)

ONE YEAR IN THE GULF STREAM: HIGH-RESOLUTION MEASUREMENTS OF AIR-SEA INTERACTION FROM A SURFACE MOORING

We present a 14-month time series of surface meteorological and subsurface oceanic measurements from one mooring deployed in the Gulf Stream, off New England, during the CLIMODE experiment. The 1-minute sampling allows the detailed surface characterization of synoptic weather systems. Using the COARE bulk algorithm, estimates of air-sea fluxes of heat and momentum are given, with winter hourly values sometimes higher than 1200 W/m² and 1 N/m², respectively. Direct estimates of these fluxes from an eddy-covariance sensor on the same platform are also available for validation. Similar meteorological data from NDBC buoys are also used to compare air mass properties near and away from the SST front. Concomitant satellite data (AVHRR) indicate that SST spatial gradients are between 0.5 and 1 degree Celsius per km. Other remote sensing SST products, with lower resolution, underestimate these gradients. However, very rapid temporal changes in in-situ SST data suggest that SST gradients may be even higher than estimates from AVHRR. Subsurface temperature measurements below the surface mooring are also presented to describe the upper oceanic thermal structure near this intense SST front. (Abstract ID 11391)

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This study has also identified and characterized the microbiology associated with wispawt zones and the adjacent non-wispawt sediments. We have applied both metagenetic and metatranscriptomic approaches to characterize the diversity and abundance of different microbial communities within the Cariaco Trench. Using metagenetic methods, we have identified a high diversity of bacterial and archaeal communities that are enriched in wispawt sediments. These communities are enriched in genes involved in hydrocarbon degradation, suggesting that these communities are adapted to thrive in the nutrient-rich environment associated with deep-sea methane seepage. We have also used metatranscriptomic methods to investigate the activity of these communities and have identified a high abundance of genes involved in hydrocarbon degradation in wispawt sediments. These results suggest that these communities are actively metabolizing hydrocarbons in the Gulf of Mexico. The comparison of baseline and post-spill sediment communities has provided the first insight into the environmental impacts of the BP spill on ecologically important processes in the Gulf of Mexico. Our results not only corroborate the critical role of hydrocarbon degradation in driving ecological processes in the Gulf of Mexico but also suggest that the wispawt zones are ecosystems that are highly sensitive to anthropogenic disturbance.

RESISTANCE TO OCEAN ACIDIFICATION IN LARVAE OF A SUBTROPICAL FISH

Many previous studies of the impact of ocean acidification (OA) on larval fishes are focused on benthic-spawning tropical species. Many of these studies have reported negative effects on larval development and growth, with reduced survival and decreased size-at-age. These studies have primarily focused on high CO2 treatments (~800ppm), which are well above the predicted increase in atmospheric CO2 concentration by the end of the century. However, the effects of OA on larval development and growth in subtropical species, which are likely to be more sensitive to changes in ocean chemistry, remain largely unknown. We have investigated the effects of OA on larval development and growth in the cobia, Rachycentron canadum, a subtropical reef-associated species that is widely harvested for food and sport fishing. We have performed experiments in which larvae were reared under high and low CO2 treatments, with the latter representing ambient conditions. We have measured a wide range of physiological and ecological endpoints, including survival, growth, and developmental rates. Our results have shown that OA has a significant impact on larval development and growth, with reduced survival and decreased size-at-age at high CO2 treatments. These results highlight the need for continued research on the effects of OA on larval development and growth in subtropical species, as these species are likely to be more sensitive to changes in ocean chemistry.
to observe the cycle of the seasonal pycnocline, which isolates EDW from the surface mixed layer during spring, summer, and fall, and to quantify the degree of mixing which may be responsible for the erosion of the subducted EDW layer during this restratification season. Elevated mixing and EDW erosion rates are found near the top of the EDW layer and are substantially larger than those found at the bottom of the layer. Assuming that vertical mixing is the dominant mechanism of EDW destruction, dependent upper bound estimates of diapycnal diffusivity ranging from $10^{4}$ to $10^{5}$ m$^2$ s$^{-1}$ are inferred using potential vorticity (PV) as a tracer. Diapycnal mixing is also inferred using CLIMODE and Line W hydrography. These mixing rates are used to estimate upper bound EDW volume destruction rates that are compared to formation and destruction rates inferred from climatological air-sea fluxes. (Abstract ID 10580)

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ANALYZING THE EFFECTS OF CLIMATE CHANGE ON SEA SURFACE TEMPERATURE IN MONITORING CORAL REEF HEALTH IN THE FLORIDA KEYS USING SEA SURFACE TEMPERATURE DATA

This presentation discusses use of 4-kilometer satellite-based sea surface temperature (SST) data to monitor and assess coral reef areas of the Florida Keys. There are growing concerns about the impacts of climate change on coral reef systems throughout the world. Satellite remote sensing technology is being used for monitoring coral reef areas with the goal of understanding the climatic and oceanic changes that can lead to coral bleaching events. Elevated SST is a well-documented cause of coral bleaching events. Some coral monitoring studies have used 50 km data from the Advanced Very High Resolution Radiometer (AVHRR) to study the relationships of sea surface temperature anomalies to bleaching events. In partnership with NOAA's Office of National Marine Sanctuaries and the University of South Florida's Institute for Marine Remote Sensing, this project utilized higher resolution SST data from the Terra's Moderate Resolution Imaging Spectroradiometer (MODIS) and AVHRR. SST data for 2000-2010 was employed to compute sea surface temperature anomalies within the study area. The 4 km SST anomaly products enabled visualization of SST levels for known coral bleaching events from 2000-2010. (Abstract ID 10656)

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ON THE BRAZIL CURRENT SYSTEM OFF SOUTHEAST BRAZIL (22S): TOP - BOTTOM DIRECT VELOCITY MEASUREMENTS

In this work we present recent top-bottom direct velocity measurements in the Brazil Current (BC) System off southeastern Brazil (22S). The dataset was collected during the CERES Experiment using L-ADCP CTD and Vessel Mounted (VM) ADCP profiles were obtained simultaneously. The observed profiles are in good agreement with the baroclinic numerical modeled velocities constrained by T-S observations and VM ADCP measurements. The results show the BC in the upper 500 m flowing southward, with maximum velocities of about 0.4 m/s and transport of 4 Sv. Below the BC, the Intermediate Western Boundary Current (IWBC) flows northward having a vertical extent of 700 m, maximum velocities around 0.15 ms$^{-1}$, and transport of about 3.5 Sv. The IWBC presents a skewed vertical structure that differ greatly from the typical parabolic-shaped cross-section of the surface-intensified BC. Our results corroborate the fact that the flow pattern of the BC System is mainly baroclinic: (up to 75-80%) off Southeast Brazil. (Abstract ID 11337)

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TRACKING MICROBIAL CHANGES IN THE DEEP OCEAN; LESSONS LEARNED FROM THE D-ESP

The ESP is a field deployable system that combines autonomous sample collection with molecular analytical-detection functionality. Detection capabilities include nucleic acid and protein hybridization arrays, quantitative PCR, and sample preservation. This talk will focus on the accumulated experience gained by deploying the ESP in deep (>900m) water to study microbial populations in Earth’s oceanic seep and hydrothermal vent environments. Known as the Deep-ESP (D-ESP), the instrument and its attendant geochemical assay is deployed to a free-fall benthic lander, which can be repositioned using a remotely operated vehicle (ROV). The D-ESP is capable of operating as a stand-alone system or integrated within a deep-sea cable observatory network. This talk will present deployment results from multiple sites off the west coast of the U.S., including Monterey Bay, methane vents off Southern California, and Axial Seamount. Results show temporal and spatial changes in microbial populations and functional gene prevalence in relation to fluid source and water column chemistry. We will discuss some challenges in engineering design and microbiology procedure that result from placing a microbiology laboratory into the deep ocean. (Abstract ID 10914)

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A ONE-DIMENSIONAL SEDIMENT-WATER COLUMN MODEL INCORPORATING RADIOISOTOPE 7BE

The Community Sediment Transport Modeling System (CSTMS), implemented within the Regional Ocean Modeling System (ROMS), couples hydrodynamics and sediment transport, and has been applied to many coastal locations. CSTMS has been used primarily to track particulate, non-reactive sediment, but has recently been modified to account for reactive particulate and dissolved matter, providing a new tool for evaluating preservation of event layers. Models that represent flood sedimentation estimate grain size patterns and deposit thicknesses and are therefore disconnected from field observations based on geochronology, notably 7Be (t1/2 = 53.3 days) which is delivered to the marine environment primarily by thalassic sediment. We address this issue by using a reactive sediment bed model to produce prototypical 7Be profiles for a seabed subjected to a range of flood inputs, resuspension events, and bioturbation rates. A one-dimensional (vertical) test case includes a non-cohesive sediment bed and multiple classes of sediment, some of which are initially labeled with 7Be. We examine changes to 7Be and grain size profiles through cycles of flood and resuspension events, and produce 7Be profiles that look reasonable. (Abstract ID 10567)

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SHELF WATER SALINITY VARIABILITY: EASTERN NEWFOUNDLAND TO CAPE HATTERAS, AND POSSIBLE FRESHWATER SOURCES

Shelf water salinity, temperature, volume, and position of the shelf front along the eastern seaboard of the U.S. and Canada show large inter-annual fluctuations over the last three decades. Fresh water sources responsible for large-scale, shelf-wide spatial and temporal patterns of salinity variability have not been clearly identified. We seek to understand the role of Labrador Current (LC) transport fluctuations and pathways over and around the Tail of the Grand Banks, and through the Strait of Belle Isle (SBI), along with freshwater inputs from the Gulf of St. Lawrence onto the Canadian and U.S. continental shelves through examination of upstream LC transport variance and changes in St. Lawrence River freshwater discharge using a proxy quantity (RIVSUM). Minimum mean surface salinity and large annual sea surface salinity fluctuations on the eastern Scotian shelf strongly suggest a Gulf of St. Lawrence fresh water source. However, on inter-annual time scales, lagged correlations between RIVSUM and eastern Scotian shelf sea surface salinity, account for only 12% of salinity variance, implying a greater importance for input of low salinity Labrador shelf water through SBI. (Abstract ID 9746)

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AUTONOMOUS EXPLORATION OF CARBON FLUX SEDIMENTATION IN THE TWILIGHT ZONE

The export of organic carbon below 100 m is 10 Pg C per year. Despite the need to understand the biological drivers for export and the depth dependence of carbon remineralization for carbon cycle prediction, there are scant observations of sedimentation dynamics in the upper 1000 m. The Carbon Flux Explorer (CFE) is designed to sustain high-frequency observations of particulate organic and inorganic carbon sedimentation to kilometer depths, absent of ships. A refined technique, reprogrammable and adaptive once deployed, and rely data to shore in near real time via Irudian satellite links for seasonal to years. Between Aug. 5 and Sept 14, 2011, two Carbon Flux Explorers, each gained 41 day records of the hourly variation of sedimentation at 250 m as they tracked the aging waters. We present first synthesis of results in contemporaneous hydrographic and remote sensing frameworks. (Abstract ID 10915)
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A QUESTION OF SCALE: CONNECTIVITY OF PLANKTONIC COPEPOD POPULATIONS WITHIN AND BETWEEN OCEAN BASINS

Linkages among marine populations, communities, and ecosystems are defined by barriers to dispersal of various types, including ocean circulation patterns, biogeographical boundaries, and continents. Genetic markers of connectivity retain the signature of historical events and conditions, like climatic variation, geology of the ocean basins, and genetic bottlenecks, among others. For cosmopolitan open-ocean pelagic species (i.e., those found in all ocean basins between 40°N to 40°S), genetic distance may be significantly correlated with oceanographic distance (i.e., as the current flows) between collection sites. In this study, we use DNA sequence variation of the barcode region of mitochondrial cytochrome c oxidase I as a standard measure to examine and compare the relationship between ocean circulation and connectivity within and between ocean basins among diverse species of planktonic copepods. The results are evaluated in terms of morphological, ecological, biogeographical, and evolutionary characters of the species. Comparative phylogeographic analysis will be useful to understand, quantify, and predict coupled responses of communities in response to ocean circulation changes that may be driven by climate change and variability in the future. (Abstract ID 9570)

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DEVELOPMENT AND EVALUATION OF OCEAN-CLIMATE MODELS: AN IMPLEMENTATION OF GM FOR UNSTRUCTURED VERTICAL GRIDS

An implementation of the Gent-McWilliams (GM) parameterization of eddy fluxes suitable for ocean models using unstructured vertical grids is presented. Owing to the intended use of this scheme in quasi-isopycnic coordinate models like HYCOM, the scheme makes use of the concept underlying GM that baroclinic instability flattens isopycnals. Laplacian interface smoothing in HYCOM, originally introduced to suppress grid-scale noise and later equipped to diagnose the resulting bolus fluxes, already captures the essence of GM in that model's isopycnic subdomain but has no effect in its level coordinate subdomain. The proposed scheme removes this incongruity by (a) transforming the model state into purely isopycnic space; (b) smoothing the resulting interfaces; (c) deducing the bolus fluxes spawned by the smoothing; (d) projecting the bolus fluxes back onto the native grid where they are then used for transport. Baroclinic channel flow experiments using different combinations of fixed-depth and isopycnic coordinates depict the expected transition from a thermally indirect Deacon cell, typically seen in level coordinates, to a thermally direct overturning pattern when the proposed GM parameterization is applied. The scheme is numerically resilient even in weakly stratified regions but is not meant to address questions regarding the proper use of GM in the surface mixed layer. (Abstract ID 12305)

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OS/AGU/ASLOAbstract Book
Time series data archived from pressure, accelerometer, or thermal sensors permits analyses of diving behaviour and thermal physiology providing remarkable insights about reproductive biology. We show these migratory species exhibit incredible patterns of site fidelity and navigate specific corridors within vast seas to reach regions critical to their life history. By integrating biologging technology with oceanography, isotope studies, and molecular genetic analysis, we now have a better understanding of the lives of apex marine predators and the perils they face in the future. (Abstract ID 12289)

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FOOD WEB STRUCTURE AND EPIBENTHIC MACROFAUNA IN THE CHUKCHI SEA: A COMPARISON BETWEEN 2004 AND 2009

The Russian-Americans-Long-term-Census-of-the-Arctic builds a time series of environmental and biotic conditions in the Chukchi Sea, an area experiencing substantial climate change. Here we present a first comparison of food web structure and epi-benthic communities between 2004 and 2009. In 2004, food web structure, based on 13C ratios, differed regionally with benthic organisms in the eastern Chukchi Sea experiencing more terrestrial material than those in the western part. Similar patterns were found in 2009, but the 13C depleted food source indicated freshwater influence in the western region in 2009. Based on 15N ratios, no differences in trophic position of benthic consumers were found between the two years. Epi-benthic macrofauna from 60 trawl samples, including 8 resampled stations, was dominated in abundance and biomass by echinoderms and crustaceans in both years. Species richness was highest for mollusks and crustaceans in both years. Repeat stations and comparison with earlier studies suggest an increase in overall epibenthic biomass (since 1976), including an increase of the now often dominant snow crab. Geographically, the sampling coverage was expanded to the eastern East Siberian Sea in 2009. (Abstract ID 9363)

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ASSIMILATION OF HF RADAR-DERIVED SURFACE CURRENTS ON TIDAL-TIMESCALES

A surface current observation system based on high-frequency (HF) radar has been developed for Barter Island, NE, and the coastal waters of New York and New Jersey. Data from this system is being assimilated via a Newtonian damping scheme into the New York Harbor Observing and Prediction System. The impact of the HF radar data assimilation (DA) is analyzed by computing the DA skill by comparing (non-assimilated/assimilated) model solutions with in-situ observations of three-dimensional currents, temperature, and salinity which have not been included in the assimilation. The HF radar data were assimilated into the NYHOPS model hindcast cycle on daily forecast basis for a period of 49 days beginning 24 February 2007. Model skill metrics for the near-surface layers in the inner-NH shelf region show improvements of hindcast DAskill of 24% and forecast DAskill of 18% for three-dimensional u (v) currents, and a hindcast improvement DAskill of 33% and forecast DAskill of 25% for three-dimensional temperature (salinity). The nudging scheme is robust and efficient for the HF radar DA into the operational NYHOPS forecast model and is capable of importing in the observations with minimum computational expense. (Abstract ID 11468)

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DIVERSE DATA SYSTEMS FOR BIODIVERSITY DATA, A CASE STUDY OF MARINE MAMMAL OBSERVER DATA

Cooperative efforts across academic, government, and industry partners can help support expansive data requirements of CMSP's integrative management framework. Professionals coordinate at the community level, for example a geophysical or an ecological society, to develop data systems for exchanging and managing common data. Data systems tend to be built around standards, like the Climate and Forecast metadata conventions for NetCDF, because this can help reduce costs and duplicative effort across the community. However, a challenge to producing nationally consistent digital data and metadata occurs when partners from the associated scientific community use specific applications that produce data heterogeneity. A case study is examined for when a specific application, marine mammal observer data, are synthesized with other data from a broader community using the US Ocean Biogeographic Information System (OBIS). OBIS functionality complements the US National Oceanographic Data Center's efforts to preserve these data for re-use by marine mammal biologists. We discuss the meaning of data standards in the context of this diverse data system and how standards help national repositories to better support CMSP. (Abstract ID 11962)

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VISUAL BASIN-SCALE SURVEY OF DEEP-SEA PARTICLES (200 – 6000 M) IN THE TROPICAL AND SUBTROPICAL ATLANTIC OCEAN USING A DIGITAL IN-LINE HOLOGRAPHIC MICROSCOPE

Particles in the size range of 100 µm to 5 mm dominate the mass flux from the surface to the deep sea with smaller particles being too small to sink, and larger ones not sufficiently abundant to contribute appreciably to the flux. However, many live zooplankton organisms and neutrally buoyant particles also fall within this size range. Thus, accurate quantification of sinking flux based on particle numbers and sizes alone is difficult unless particles can be better characterized. One step towards this goal is to visually examine these particles and group them into categories of potentially sinking (e.g., dense fecal pellets, ballasted debris), free-swimming (zooplankton) and potentially neutrally buoyant (e.g., amorphous, low-density marine snow particles). Here we demonstrate the application of digital inline holographic microscopy (DIHM) for particle characterization and sizing for specific water masses such as the oxygen minimum zone, the North Atlantic Deep Water and the Antarctic Bottom Water. An important advantage of DIHM over conventional microscopy is its inherently large survey volume at high resolution. (Abstract ID 12228)

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DEVELOPING REGIONAL TOOLS FOR DATA INTEGRATION

The Alaska Ocean Observing System functions as a regional oceanographic data assembly center and operates several user interface tools and backend data management systems. Developing sustainable and scalable information systems requires the integration of several disciplines including informatics, software engineering, and cyber-infrastructure design. Utilizing interoperability systems for data transport and High Performance Computing (HPC) techniques for visualization/analysis ensure that data is openly available to the broader user base in addition to other machines and data assembly centers. AOOS is developing several tools which leverage a common underlying application framework called the AOOS Ocean Portal. The AOOS Ocean Portal provides a platform to rapidly deploy tools which are specific to regions, themes, management issues and emergency response and planning applications. As a result, the AOOS data management team can actively support several independent user interface tools, each with their own subset of data and functionality, supported by a single collective code base. A specific portal is scheduled for release in January 2012 which integrates atmospheric/oceanographic models and remote sensing data sets, real time and historic sensor streams and GIS data layers for the Cook Inlet region. Several additional tools are in development including a circumpolar Arctic portal. (Abstract ID 12082)

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AN EXPERIMENTAL AQUARIUM SYSTEM WITH CAREFULLY CONTROLLED CARBONATE CHEMISTRY, OXYGEN LEVELS, AND TEMPERATURE, FOR INVESTIGATING THE IMPACTS OF CLIMATE CHANGE

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ensures that the tanks are maintained at the desired treatment levels. (Abstract ID 10891)

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of El Nino. (Abstract ID 10765)

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THE IMPACTS OF CENTRAL- AND EASTERN-PACIFIC EL NINO EVENTS ON THE SOUTHERN OCEAN
El Nino is known to have significant influence on the global ocean and weather patterns. Classical El Nino events are characterized by a maximum SST anomaly in the eastern-equatorial Pacific. Since the 1990s, there have been frequent occurrences of the so-called central-Pacific El Nino, where the maximum SST anomaly is located in the central equatorial Pacific. Classical El Nino events are known to influence Southern Ocean dynamics, sea ice and heat flux through atmospheric teleconnections. In this study, we investigate the impacts of the ongoing change in El Nino characteristics on the Southern Ocean using multi-sensor satellite observations along with ECCO ocean state estimation products. We analyze Southern Ocean sea surface temperature, sea level, ocean bottom pressure anomalies, and changes in the circulation of the Southern Ocean (including the Antarctic Circumpolar Current) in general to characterize the differences of the state of the Southern Ocean during central- and eastern-Pacific El Nino events. The study also contrasts the influence of the Southern Annular Mode (SAM), the dominant mode of atmospheric variability over the Southern Ocean, to the effects of El Nino. (Abstract ID 10765)

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ON THE DISPERAL OF LEATHERBACK TURTLE HATCHLINGS FROM MESO-AMERICAN NESTING BEACHES
So little is known about the early life history of leatherback turtles (Dermochelys coriacea) from hatching to adulthood that this period has been termed the “Lost Years.” For critically endangered eastern Pacific leatherback populations, continued and rapid declines underscore the urgent need to develop conservation strategies across all life stages. We investigate leatherback hatching dispersal from four Meso-American nesting beaches using passive tracer experiments within a Regional Ocean Modeling System (ROMS). The evolution of tracer distribution from each nesting beach showed the strong influence of eddy transport and coastal currents. Modeled hatching from Playa Grande, Costa Rica, were most likely to be entrained and transported offshore by large-scale eddies coincident with the peak leatherback nesting and hatching emergence period. These eddies potentially serve as “hatchling highways” providing a means of rapid offshore transport away from predation, and a productive refuge within which newly-hatched turtles can develop. We hypothesize that the most important leatherback nesting beach remaining in the eastern Pacific (Playa Grande) has been evolutionarily selected as an optimal nesting site due to favorable ocean currents that enhance hatchling survival. (Abstract ID 9950)

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CHARACTERIZATION OF ORGANIC LIGANDS IN CULTURES AND SEAWATER BY HPLC-ICP-MS
Organic ligands dominate the speciation of many oceanic trace metals and have important effects on metal solubility and bioavailability. Information on the chemical composition and distribution of marine metal complexes is therefore helpful to our understanding of biogeochemical metal cycling. One approach is to extract organic ligands from seawater and identify the compounds that are associated with trace metals. We have developed a method to separate organic compounds by high-performance liquid chromatography and measure their metal content via multi-collector inductively coupled plasma mass spectrometry. The detector response increases linearly with metal concentration and varies with solvent composition (water - methanol). After concentrating organic compounds from seawater and cultures on a polystyrene resin and analyzing the extract with our method, we characterize peaks that correspond to organic-metal complexes. The fraction containing these compounds can be collected and further purified for detailed characterization by nuclear magnetic resonance spectroscopy and mass spectrometry. The method can detect less than 1 pmol of a metal complex and allows us to study ligands of multiple trace metals simultaneously, such as Mn, Fe, Co, and Ni. (Abstract ID 9464)

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RAPID GLACIAL-MARINE SEDIMENTATION AND EFFECTS ON GLACIER MELTING AND FJORD HYDROGRAPHY: COLUMBIA GLACIER FJORD, AK
Marine-ending glaciers are retreating rapidly worldwide, and many recent studies point to ice-ocean interactions as some of the most important and least understood processes controlling glacier mass balance and sea-level rise. Since 1982, the rapid retreat of Columbia Glacier has exposed a 16-km-long fjord, of which very little about the marine environment is known. New bathymetric, seismic and sedimentologic measurements collected in September 2011 suggest rapid (tens of meters per year) accumulation of sediments near the glacier front. The rate of sediment accumulation is on the same order of magnitude as rates of ice surface lowering and thinning, and hence the glacial sedimentation is likely to be important to glacier stability. These deposits shield the ice front from circulating warm ocean water, and thereby slow the ice loss due to submarine melting. Seismic records, bathymetry and preserved sedimentary structures within the fjord deposits suggest gravity flows are likely to be the dominant sediment transport mechanism, which may be linked to seasonal and other changes in the subjacent hydrologic system. The sedimentary record preserved within the newly-opened fjord contains a record of glacier behavior, associated climatic changes, erosion, and sediment transfer events. (Abstract ID 10689)

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ZOOPLAGNKTON COMPOSITION AND ABUNDANCE IN LAMONI BAY, NORTHEAST LUZON, PHILIPPINES
There has been a lot of interest in understanding the oceanographic and ecological dynamics occurring in the waters off northeastern Luzon, Philippines. This area is highly influenced by the western boundary current system of the western Pacific as brought about by the bifurcation of the north equatorial current into the Kuroshio and Mindanao Current. Previous studies have identified high primary productivity in several areas that are said to be driven by upwelling
dynamics near the shelf. These processes are usually linked to productive fisheries. The focus of this study then is on the link between primary productivity and fisheries, which is zooplankton and ichthyoplankton. Plankton collection was conducted along spatial zones identified a priori based on chlorophyll a profiles determined from previous studies. Quantitative and qualitative analysis was done using conventional microscopes and a FlowCAM. Data among spatial zones were then compared. (Abstract ID 12667)

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SEASONAL BENTHIC NUTRITION CYCLING IN A BALTIC SEA ESTUARY

Decades of urban, industrial, and agricultural discharge of nitrogen and phosphorus to the Baltic Sea have contributed to the spreading of water column hypoxia and annual widespread cyanobacteria blooms. Central to mitigating Baltic Sea eutrophication is to resolve how much reduction strategies of external N and P loading are offset by internal loading of the Baltic through nutrient recycling from the sediment. We investigated the seasonal variation of benthic nitrogen and phosphorus cycling in an estuary of the Baltic impacted by decades of sewage discharge. Sediment nutrient fluxes, denitrification, Anamox, DNRA, potential nitritation, and total and diffusive oxygen uptake (TOU/DOU) were quantified with 15N-tracer methods and microsensor profiles. Data indicate benthic net effux of ammonium and phosphorus during the summer months, decreasing N loss with increasing organic matter content, and benthic N/P regeneration with a ratio of 3 to 7 compared to the sewage discharge N/P of 25, and a significant contribution (6 to 25%) of Anamox to N loss. On average benthic denitrification and Anamox may reduce the N load to the estuary by up to 54%. (Abstract ID 12091)

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THE WIND FORCING OF NEAR-INERTIAL WAVES AT THE KUROSHIO EXTENSION OBSERVATORY (KEO) AND JAMSTEC KUROSHIO EXTENSION OBSERVATORY (JKEO)

The western North Pacific experiences a variety of storms during the cool season. These storms influence the ocean through their modulation of radiative and turbulent (sensible and latent) heat fluxes at the air-sea interface, and through wind forcing. The present study focuses on the latter mechanism, in particular the generation of near-inertial waves (NIWs) due to their influence on oceanic mixing. Storms that feature local winds rotating anti-cyclonically with time can lead to wind forcing in quasi-resonance with NIWs, hence generating large amplitude NIWs. The present study considers hourly data from the Kuroshio Extension Observatory (KEO) and JAMSTEC Kuroshio Extension Observatory (JKEO) moorings. The analysis involves computation of rotary wind spectra during the cool seasons (October-March) of 2004-2010 for KEO and 2007-2010 for JKEO. The upper ocean responses observed at KEO and JKEO to storms with strong forcing of NIW are compared with the responses to cold-air outbreaks accompanied by enhanced surface heat fluxes. The relative frequencies of these two kinds of storms on monthly to seasonal time scales are related to large-scale atmospheric circulation patterns. (Abstract ID 9594)

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OPTICS AND ACOUSTICS OF SEDIMENT SUSPENSIONS

In this tutorial I will summarize our knowledge regarding the relationships between the concentration of suspended particles and their optical and acoustical properties. I will then address the reasons for variability in these relationships, focusing particularly on the extent of particulate composition, size and packaging (aggregation). (Abstract ID 12180)

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NEARSHORE RESOURCE CHARACTERIZATION MAPS: MARINE SPATIAL PLANNING, CAPACITY BUILDING AND COASTAL SCIENCE IN MASSACHUSETTS

An ongoing 3-year study to develop methods to produce shallow water (1-10 m), nearshore resource characterization maps for the Massachusetts Office of Coastal Zone Management is nearing completion. The project description also noted ‘the need to build capacity’ to collect these types of data at the host institution. The Provincetown Center for Coastal Studies. Toward that end, a state-of-the-art interferometric sonar system was acquired. This instrument collects coincident swath bathymetry and acoustic backscatter imagery and is designed specifically to work in nearshore environments. The impetus for this project was the need to develop high resolution, high accuracy resource maps to better manage the state’s marine resources. Scientists and managers working with these data are actively formulating unexpected directions of inquiry and investigation. As innovative technologies increase the quality of data, new ideas and fresh questions are asked, and a better understanding of the natural system is reached. Some examples include documenting seafloor features <5 cm in relief, a potential new method for remotely sensing elgrass biomass, and tide-coincident, seamless, onshore-offshore resource maps. (Abstract ID 12682)

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Our understanding of the carbonate parameters from hydrographic data in the Southern Ocean has been considerably advanced by the collection of large global datasets over the last 50 years (GOSECS 1960-1970s, GLODAP 1990s, CARINA and PACIFICA 2000s). However, there are still many areas of the globe that have had little sampling for carbonate parameters. We have used the global datasets from the Southern Ocean (south of 26°S)greenS), with measured dissolved inorganic carbon (DIC) and alkalinity to develop multiple linear regressions (MLR) to estimate alkalinity and DIC from the common hydrographic parameters: temperature, salinity, depth, pressure and oxygen. We find distinct regimes based on water masses, where the alkalinity and DIC differ from the different atmospheric and oceanic processes. The aim of this work is to use all the hydrographic data for the region to produce detailed maps of the carbonate parameters: pCO2, pH (CO32-), aragonite saturation, calcite saturation, that take into account local currents, especially around complex topography e.g. around New Zealand. Oxygen sensors on Argo floats would further improve the coverage and allow for estimates of seasonal and interannual variability in carbonate parameters. (Abstract ID 10632)

**SUGGESTIONS TO HELP TEACHERS ACHIEVE MORE WHILE DOING OUTREACH**

Teachers have helped scientists disseminate marine sciences information through a number of research experience programs that place teachers in research projects. Teachers can be effective translators of a discipline’s content and research methods because they understand students’ potential and limitations. The partnership with educators is taking new meanings as teachers interact with larger communities through new technologies that allow them to write blogs and broadcast their experiences from the field. Yet, content quality still depends on the teacher’s knowledge of the field. In this presentation, we will suggest activities that will help researchers prepare teachers so that content quality can be maximized. We will also share the challenges and successes of these activities from the field. Our suggestions are based on the experience of one high school teacher with a Masters in Oceanography who spent 64 days on a cruise in the Southern Ocean (CLIVAR SfP) through PolarTREC (Teachers and Researchers Exploring and Collaborating) (Abstract ID 9462)

**INLAND SEAS**

A 10,000 km² hypoxic ‘dead zone’ forms, during most years, in the central basin of Lake Erie. To investigate the processes driving hypoxia, we conducted a two-year field campaign. Mixing in the lake interior, during the stratification period, was examined using current meter and temperature logger data as well as ~600 temperature microstructure profiles; from which turbulent mixing parameters were computed. Our results demonstrate that near-inertial Poincaré waves drive shear instability, generating ~1 m amplitude and 10 m wavelength high-frequency internal waves with ~1 m density overturns. These lead to greater than one order of turbulent mixing parameters from spectral backscattering dependence. (Abstract ID 10265)

**SECLUSIONS**

To this aim measurements were focused on one of the most energetic sections for internal waves in the Indonesian seas are one region of the strongest internal tide generation these waves significantly modify the energy flux paths relative to small and medium sized lakes where $>0.25$. (Abstract ID 11713)

**TURBULENT MIXING AND INTERNAL TIDES IN THE INDOMIX CRUISE**

The Indonesian Throughflow is the only passage at low latitude between the Pacific and the Indian oceans. As such it constitutes a key region of the thermohaline circulation where water mass properties are strongly modified as a result of a strong turbulent mixing. As the Indonesian seas are one region of the strongest internal tide generation these waves are expected to play a major role in driving this mixing. The INDOMIX cruise aimed to characterize small-scale turbulence and its relationship with the larger scale internal tidal signal. To this aim measurements were focused on one of the most energetic sections for internal tides located within the Alenghara sea area. Classical time-scale measurements have been performed together with microstructure measurements with repeated profiles over 24 hours. A strong internal tidal signal was evidenced with currents up to 50 cm/s and solitary waves leading to isopycnal displacements of the order of 50m. Consistently high values of energy fluxes up to 80kW/m were obtained with various propagation directions. The latter reveals the complex pattern of internal tide generation occurring both along the shelf edge and within passages. Spots of high energy dissipation were characterized below the pycnocline where the strongest internal tidal signal is observed as well as above the bottom topography. Eventually a set of
fine-scale parameterizations was tested against our turbulence measurements and a refined parameterization proposed. (Abstract ID 11310)

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IMPACT OF NON-LINEARITIES ON AN INCREMENTAL 4D-VAR DATA ASSIMILATION METHOD IN A HIGH RESOLUTION NUMERICAL OCEAN MODEL.

A current state for numerical ocean models is to adequately represent meso- and small-scale activity, in order to simulate its crucial role in the general ocean circulation and energy budget. It is therefore also a challenge for data assimilation (DA) methods to control these scales. However this small-scale activity is strongly linked to the nonlinear character of the flow, whereas DA methods are generally much less efficient in such contexts than in (almost) linear ones. The purpose of this poster is to address this problem specifically, by exploring the behaviour of an incremental 4D-VAR DA method in a nonlinear ocean model. A series of experiments assimilating simulated altimeter data in an idealized Gulfstream-like configuration of the NEMO ocean model at increasing resolutions (which is a proxy for increasing nonlinearity) are analyzed. We present in particular results characterizing scales and structures of the analysis error along the assimilation process, as well as tentative links with small scale activity. Moreover we investigate some strategies for DA in such nonlinear contexts, with the aim of reducing this analysis error. (Abstract ID 11031)

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LIGHTLY TETHERED UNMANNED UNDERWATER VEHICLE FOR UNDER-ICE EXPLORATION

The Woods Hole Oceanographic Institution has been awarded funds by the National Science Foundation to develop by 2014 a robotic underwater vehicle for under-ice exploration. By employing a long, light-weight tether, the vehicle will provide the U.S. Polar Research Community with the capability to tele-operate, under direct real-time human supervision, a remotely-controlled inspection and survey vehicle under fixed ice at ranges up to 20 km distance from a support ship. The vehicle will enable exploration and detailed examination of the biological and physical under-ice environment through the use of high-definition video, coupled to a suite of chemical and biological sensors. Conventionally-tethered ROV systems, limited to horizontal ranges of a few hundred meters from their support ships, cannot access environments under ice too thick to further. Under, long-range light-fiber tether technology provides the high bandwidth link necessary for real-time control under the direction of the shipboard science party that AUVs cannot meet. Thus, the PROV (Polar-ROV) will enable upward imaging of the ice underside, and downward imaging of the seafloor on the continental shelf to depths of 1000 m. (Abstract ID 11678)

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FUNCTIONAL GENE PYROSEQUENCING: CHARACTERIZING THE DISTRIBUTION AND DIVERSITY OF THE NIRS GENE AND ITS ROLE IN DENITRIFICATION OF COASTAL MARINE SEDIMENTS

Recent advances in DNA sequencing technology have expanded efforts to understand the role of microbes in ecosystem function. Two approaches are widely used: sequencing 16S rRNA to examine the extent of taxonomic diversity, and sequencing metatranscriptomes to examine the distribution of genes being expressed. The former provides information on microbial diversity, but little on ecosystem function. The latter is informative with regard to function, but is only capable of capturing a fraction of the total number of expressed genes. We developed a hybrid approach wherein we use pyrosequencing to examine genetic diversity, but to explore the relationship between genetic diversity and ecosystem function we focus, instead, on PCR-amplicons of a single functional gene. Our proof-of-concept focuses on nirS, a key gene in the denitrification pathway, that plays a critical role in coastal systems by removing fixed nitrogen. However this small-scale activity is strongly linked to the nonlinear character of the flow, whereas DA methods are generally much less efficient in such contexts than in (almost) linear ones. The purpose of this poster is to address this problem specifically, by exploring the behaviour of an incremental 4D-VAR DA method in a nonlinear ocean model. A series of experiments assimilating simulated altimeter data in an idealized Gulfstream-like configuration of the NEMO ocean model at increasing resolutions (which is a proxy for increasing nonlinearity) are analyzed. We present in particular results characterizing scales and structures of the analysis error along the assimilation process, as well as tentative links with small scale activity. Moreover we investigate some strategies for DA in such nonlinear contexts, with the aim of reducing this analysis error. (Abstract ID 11031)

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BACKSCATTERING OF LIGHT BY SUSPENDED PARTICLES

Ocean colour measurements rely on the backscattering of light. As with other optical properties, backscattering by particles is expected to be a function of particle cross sectional area, although there are few data sets that explore the relationship explicitly. Here, we report measurements of backscattering coefficients and particle cross sectional area in UK coastal water. The results show that the backscattering coefficient increases with particle area per unit volume but that the slope (the backscattering efficiency) depends on the percentage of organic material. The efficiency is about 0.01 for high organic content rising to 0.06 as organic content falls to 10%. A tentative explanation is that this is due to the higher refractive index of mineral material. The implication for remote sensing is that reflectance coefficients depend upon the mineral content as well as the area of particles in suspension. Hill et al., report in this session that the area of particles per unit mass increases with the organic content. Together, these findings may explain why ocean colour is so good for deriving the mass concentration of suspended sediment. (Abstract ID 10884)

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TRENDING OF THE COASTAL "GAIN" AT DIFFERENT TIME SCALES USING TOA RADIANCE (LT/VT/L) FOR OCEAN COLOR SENSORS.

We examine time scales of variability of "gain" or bias in spectral radiance between satellite and in situ measurements from the AERONET-OC. Using a long time series of match-ups of ocean color radiance, we determined how the gain changes on weekly, monthly, and annually cycles for different global regions. This enables us to establish practicable spectral "offsets" that can be used for regional adjustment of satellite derived water leaving radiance. This is done as a preliminary step in a larger effort to expedite calibration of the VIIRS and GOCI sensors. The current procedure requires years of coincident data collection before sufficient match-ups can be obtained to produce a valid vicarious calibration. By using the match-up procedure of NASA ORBG and exploiting radiometrically calibrated data from the AERONET-OC sites, short term monitoring of the relationship between satellite derived top of the atmosphere (TOA) radiance, Lt, and in situ nLw propagated to TOA, vLt, can provide basic information to support ocean color products during the early stages of sensor deployment. (Abstract ID 12006)

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DIRECT OBSERVATIONS OF FORMATION AND PROPAGATION OF SUBPOLAR EDDIES INTO THE SUBTROPICAL NORTH ATLANTIC

Subsurface float and moored observations are presented to show for the first time the formation and propagation of anticyclonic submesoscale coherent vortices that transport relatively cold, fresh subpolar water to the interior subtropical North Atlantic. Acoustically tracked RAPOS floats released in the southwest-flowing Western Boundary Current at the exit of the Labrador Sea reveal the formation of three of these eddies at the southern tip of the Grand Banks (42°N, 50°W). It was found that the eddies had average rotation periods of 5–7 days at radii of 10–25 km, with mean rotation speeds of up to 0.3 m s⁻¹. One especially long-lived (5.1 months) eddy crossed under the Gulf Stream path and translated southwestward in the subtropical recirculation to at least 35°N. Velocity, temperature and salinity measurements from a nine-month deployment of two moorings south of the Gulf Stream at 38N, 50W reveal the passage of at least two eddies with similar hydrographic and kinematic properties. The core temperature and salinity properties of the eddies imply their formation at intermediate levels of the Labrador Current south of the ‘Tail of the Grand Banks. These observations confirm earlier speculation that eddies form in this region and transport anomalously cold, low-salinity water directly into the subtropical interior. (Abstract ID 9321)

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MICRONUTRIENT TRACE ELEMENTS IN THE AUSTRALIAN SECTOR OF THE SOUTHERN OCEAN: MERIDIONAL DISTRIBUTIONS AND SEASONALITY

Southern Ocean phytoplankton growth and community composition is unquestionably limited by micronutrient trace elements, with iron playing a central role. Change in the supply and availability of iron may be the single largest forcing of Southern Ocean ecosystem productivity and health in the next century, and thus is intrinsically linked with changes in carbon cycling and global climate. The Southern Ocean sector south of Australia has seen extended efforts of sampling since 1994, most notably along the SR3 section from Antarctica to Tasmania (~140°E), with nearly 300 seasonal iron observations in surface waters. Here we present the full water column distributions of a series of trace elements along SR3 conducted as part of the GEOTRACES program, including micronutrients (Fe, Cd, Co, Cu, Ni, Zn) and tracers (Al) of sources. We examine the importance of biological activity; trace element supply (upwelling, boundary currents, dust), hydrothermalism, glacial melt, and water mass characteristics in governing the meridional and seasonal distributions, with a focus on decoupling of trace element and nutrient cycles, and the characteristics of surface water replenishment processes for springtime production. (Abstract ID 9413)

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RETRIEVAL OF IOPS, BATHYMETRY, AND BOTTOM TYPE INFORMATION FROM HICO DATA

A Lookup Table approach to retrieving IOPS, bathymetry and bottom type information has been applied to HICO imagery. The LUT spectra are generated using EcoLight and uses known bottom type information. As many as one million calculated spectra span the expected range of parameters are used. The comparison metric used is the unweighted Euclidean distance. In clear water examples, such as the Bahamas, it is shown that mixed bottoms are important to consider. In particular, adding mixtures at the 10/90 or 75/25 ratios, shows improved matches between the measured and calculated spectra. The level of mixed bottoms that must be represented in the LUT is important because adding many mixtures slows the processing to unacceptable levels. As an alternative to adding spectra to the LUT, an optimal estimation step may be helpful. (Abstract ID 11404)

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EVIDENCE FOR STRONG SELECTIVE ENRICHMENT OF BACTERIA WITHIN FROST FLOWERS ON THE SURFACE OF ARCTIC SEA ICE

Frost flowers, saline ice structures on the surface of newly formed sea ice, have received recent attention for their potential role in atmospheric halogen chemistry and aerosol production and their newfound habitability. We analyzed bacterial community composition and structure (16S rRNA amplicons) from Arctic frost flowers and underlying sea ice with the long-term goal of informing how biology may influence frost flower chemical and physical processes. Strong agreement between phylochip, T-RFLP, and clone library results, analyzed by MDS, suggests that, in the northwestern Arctic, Hg has bound to different bottom type distributions. Elemental Hg, in contrast, has strong nutrient-like profiles along the west coast of Africa with deep water concentrations as much as 50% of total Hg. Monomethylmercury has pronounced mid-water maxima associated with the oxygen minimum zone, where it is likely to result from either in situ methylation or isopycnal transport from the margin. Vertical profiles suggest that deep-sea sediments are not an important source of monomethylmercury. (Abstract ID 11501)

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INTEGRATING GLOBAL PHYTOPLANKTON DATA FROM 1890 TO 2010

Understanding large-scale phytoplankton dynamics requires accurate, multi-decadal measurements of abundance and distribution. Since 1890, marine phytoplankton abundance has been assessed using a diverse range of sensors and observational platforms; inter-calibrating these datasets has been challenging. Consequently, synthesis of historical phytoplankton data have been rare and the need for accurate, long-term assessments of phytoplankton is commonly acknowledged. We derive quantitative indices of phytoplankton abundance from measurements of upper ocean transparency and colour calibrated with direct measurements of surface chlorophyll. The strong correlation and linear scaling of predicted data enabled construction of a comprehensive, globally inter-calibrated phytoplankton time series from 1890 to 2010. The calibrated phytoplankton data reproduced the well-established spatial features of phytoplankton biomass and were strongly correlated with phytoplankton concentration derived from two independent remote sensing platforms discontinuously available since 1978. These results suggest that with careful statistical treatment, it is possible to generate a globally integrated phytoplankton time series extending 120 years into the past. This database may enable new insights in the areas of climate science, biogeochemical cycling, and marine ecosystem structure and functioning on centennial timescales. (Abstract ID 11764)

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COMPARISON OF NATURAL AND IMPOUNDED MARSH ACCRETION RATES IN COASTAL DELAWARE

In the face of rising sea level and increasing human pressures, the accretionary status of estuarine marshes is a growing concern among scientists and environmental managers. In coastal Delaware there is a need to determine sediment accumulation and marsh accretion rates for impounded wetlands fringeing Delaware Bay, because these areas particularly vulnerable to flooding and loss during coastal storms. To address this need, we are comparing accretion rates for several impounded marsh systems with baseline rates determined by identical methods for undisturbed marshes in the region. Using Cs-137 and Pb-210 chronologies along with density and loss-on-ignition measurements, we are determining the specific contributions of organic and inorganic sediment accumulation to overall rates of marsh accretion. Results show a high level of spatial variation in rates due to localized factors that moderate mineral sedimentation and vegetation growth. Whereas some of the impounded marsh is accreting at rates below the baseline rates of 3-5 mm/yr, others are accreting within and even above this range. Through ongoing work we are beginning to identify biotic and abiotic conditions that influence the accretionary deficits. (Abstract ID 11318)

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BUILDING ON THE SUCCESS OF OCEAN ACIDIFICATION RESEARCH IN THE BROADER CONTEXT OF GLOBAL ENVIRONMENTAL CHANGE

Research into the biological threat of reduced pH, termed Ocean Acidification ( OA), has yielded many insights over the past decade. Moreover, the findings from OA research have been successfully disseminated to a wide audience, extending well beyond the boundaries of the traditional scientific community. There is much to be learnt from the OA community by the fledging research field which is investigating the effects of global environmental change on oceanic biota. In turn, much of the preliminary research into global environmental change reveals that the interplay of multiple environmental stressors on ocean biota results in either significant amplification or diminution of the effects of a sole stressor such as OA. Our growing appreciation of how global environmental change will manifest itself in turn lays down the challenge of understanding the complex interplay of a matrix of changing ocean properties and their biological
implications. We will present examples of how we can better identify and catalogue biological responses, and subsequently predict the sign and magnitude of their feedbacks, by taking a holistic view of the effects of global environmental change. (Abstract ID 9773)

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A CLIMATE CHANGE ATLAS FOR THE OCEAN

The increasing likelihood that we will encounter a changing climate in the coming years has major ramifications for both coastal and offshore waters in many biogeographical provinces. Each of these regions is characterized by a range of water bodies with a diverse marine biota. However, their environmental properties will be altered, by varying degrees, in the near future, and there will also be differing impacts on resident marine biota. Within the Exclusive Economic Zone (EEZ) of each nation, particular regions, and some plant and animal species will be more susceptible to change than others. This will raise major issues for policymakers and managers regarding the alteration of the ecosystem services within and the economic value of each national EEZ. Using the format of an Atlas of Ocean Climate Change (Oceanography 24 doi:10.5670/oceanog.2011.42) is the first step in developing a comprehensive assessment what may happen to our seas in the coming decades. We will provide illustrative examples from the New Zealand Atlas that will reveal how such a tool can readily be applied to other oceanic regions. (Abstract ID 9775)

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THE EVOLVING ATLANTIC Pb AND Pb ISOTOPE DISTRIBUTION

On numerous cruises during the past 27 years, including the first leg of the US GEOTRACES North Atlantic Transect (US-GT-NAT), we have obtained unimportuned decontaminated deep-sea profile samples for ~1000 Pb concentration analyses and ~500 Pb isotope analyses. Where stations have been reoccupied on decadal time scales (western and eastern North Atlantic), we see Pb decreasing strongly in the upper ventilated ocean (due to the phasing out of Pb gas) and remaining relatively constant in the more slowly ventilated deeper waters. Pb isotope ratios change in the ventilated waters as the proportion of U.S. and European sources varies (the U.S. phased out Pb gas faster than Europe). 208Pb/206Pb, 206Pb/207Pb, and 206Pb/204Pb ratios form near-linear arrays (set up by global U-Th-Pb reservoir evolution) with a scatter exceeding analytical error by a factor of 3-10. Triple isotope plots therefore allow for more subtle determination of Pb sources; e.g. Pb isotope data from the modern Mediterranean outflow is distinctive from the waters that sank from the North Atlantic 80 years ago. (Abstract ID 12306)

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MODELING BAROCLINIC TIDES IN THE GULF OF MEXICO

The goal of the study is to document and understand baroclinic tide generation in the Gulf of Mexico. We first validate the barotropic tidal implementation in a Hybrid Coordinate Ocean Model (HYCOM) Gulf of Mexico configuration by comparing simulated tidal amplitudes and phases to available observations. The four main tidal constituents (M2, O1, S2, K1) present in the Gulf of Mexico are well represented when using surface astronomical forcing together with the barotropic tidal transports and elevations prescribed at open boundary locations. The barotropic tides are then investigated by quantifying the location and magnitude of the tidal energy conversion in the Gulf of Mexico as a function of the vertical stratification. We show that the baroclinic components of the tidal velocities are negligible within most of the basin, except in areas with strong topography (e.g. West Florida Shelf, Yucatan Peninsula) where intense internal waves can be generated and can lead to important internal tidal conversion processes. The impact of the model horizontal grid resolution (1/12° and 1/25°) on the representation of the internal wave field is also addressed. (Abstract ID 10520)

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SUBMESOSCALE PROCESSES IN THE GULF OF MEXICO

We present a suite of numerical experiments focusing on the impact of submesoscales processes in the Gulf of Mexico throughout the water column. Our focus is on the role of ageostrophic velocities in setting a) the horizontal and vertical mixing of Mississippi river waters, b) the interaction between the river waters and the Loop current and c) the mixing associated with the Loop eddies. Our simulations cover the period 2000-2011 and we consider two nested domains with lateral resolution varying from 1 to 1.6 km covering most of the Gulf. We use Lagrangian tracers, passive tracers and a NPF2 model to quantify transport, both at the surface and at depth. (Abstract ID 10658)

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E-CO2 SCHOOL LAB: A SCIENTIFIC VIRTUAL EXPERIENCE FOR STUDENTS.

Experimental approach is widely recognized to be the most effective method in science teaching, but lack of time and funds sometimes prevent its application. E-CO2 School Lab is a virtual interactive laboratory for students from K7 to K12 dealing with Ocean Acidification Problem. E-CO2 School Lab offers three perturbation experiments based on reaction of calcareous red alga (Corallinaceae – Rhodophyta) in a high CO2-world. Students handle two virtual aquariums, the first representing actual condition, the second IPCC forecasted conditions for year 2100, taking several measurement of the algal growth and development. The Lab is supported by a large and multi medial miniWiki, where students can reach easily all information that they may need. E-CO2 School Lab is a team-work: even though it can be played individually like a video-game, the real aim is to stimulate discussion about Ocean Acidification and its impact on marine ecosystem. The teacher, whose leading role remains fundamental, can tailor the experience on his/her class level and on demand (teacher’s guide disposable on line). E-CO2 School Lab, available free on line, is proposed to meet the need of experimental teaching of science, with low time and fund investments. (Abstract ID 9615)

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COMPARING THE TROPHIC ECOLOGY OF MESOPHTIC AND EUPHTHIC FISHES USING COMPOUND SPECIFIC ISOTOPE ANALYSIS OF AMINO ACIDS

The trophic ecologies of eleven fish genera in six families from mesophotic (50-120m) and euphotic (~40m) reef ecosystems were assessed using bulk tissue and individual amino acid stable isotope compositions. Reef fishes were collected using subsamplers and closed circuit rebreathers from the waters near the Hawaiian Islands of Maui and Lanai. Using the difference between nitrogen isotope values of glutamic acid and phenylalanine we calculated the trophic position of multiple reef fishes to address ontogenetic and depth related differences. Slight differences in trophic position are seen between the two depth ranges, however opposing trends between fishes with planktonic and benthic driven feeding strategies were found. Bulk tissue carbon isotopic composition revealed distinction between these two feeding styles across depth groupings. The remaining trophic and source amino acids were compared among groupings to investigate the potential drivers of the trends. Depth related disparities in trophic ecology have the potential to impact the use of ecosystem based management models in Hawaiian reefs as well as the refugial potential of mesophotic reef ecosystems. (Abstract ID 12469)

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BACTERIAL COMMUNITY STRUCTURE OF A FRESHWATER SPRING IMPACTED BY HYDRILLA

Hydrilla verticillata is one of the most invasive aquatic plant species and causes ecological and economical problems in freshwater systems. We will test the hypothesis that Hydrilla alters the normal bacterial community by investigating bacterial populations of Wakulla Spring which is impacted by Hydrilla. Water samples were collected from Wakulla Spring and two conduits (not impacted by Hydrilla) over an annual period. Two liters of the samples from each site were filtered through 0.2µm filters and stored at -20°C for further processing. Culturable bacteria were enumerated by the spread plate method using R2A medium and colony forming units (CFU) enumerated after one week. Bacterial DNA was extracted from 0.2µm filters, amplified with universal rRNA gene primers. Amplified products were separated by DGGE and prominent bands excised, reamplified and sequenced. Results revealed some differences between the two springs in both total CFU and the DGGE profiles. The next step will be cloning of environmental DNA from Wakulla Spring. (Abstract ID 9779)
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SPATIAL AND TEMPORAL BIO-OPTICAL VARIABILITY AT LUCINDA JETTY COASTAL OBSERVATORY: IMPLICATIONS FOR CALIBRATION AND VALIDATION OF OCEAN COLOUR SENSORS

The Lucinda Jetty Coastal Observatory (LJCO) was established as part of Australia's Integrated Marine Observing System (IMOS) to provide continuous above and below water optical measurements in complex coastal waters. This data stream is a critical input towards improving and validating coastal and continental shelf satellite ocean colour products. Field programs were carried out in April and November 2010 to characterize the spatial and temporal scales of bio-optical variability at and around LJCO, and to determine whether the parameters measured continuously at the site were representative of the surrounding local waters. Continuous instrumental data, as well as in situ water samples to be analysed by laboratory methods, were collected regularly at LJCO and from sites close to LJCO over a 4-day period. Preliminary results show low scales of spatial and temporal variations in the measured bio-optical parameters indicating that the continuous instrumental data collected at LJCO is representative of a larger footprint around the site. Implications of these findings for matchup analysis of above and below water optical parameters for current ocean colour missions will be discussed. (Abstract ID 12790)

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VENTILATION OF THE TROPICAL ATLANTIC BY EQUATORIAL DEEP JETS

Vertically alternating deep zonal jets of short vertical wavelength were discovered in the equatorial oceans more than 30 years ago. In the Atlantic, these jets have periods of about 4.5 years and are observed to be coherent across the equatorial basin. They are known to transport deep water mass characteristics from the western boundary towards the eastern equatorial basin. Here we present long-term velocity and water mass observations at intermediate depths showing that the equatorial deep jet causes a pulsating oxygen flux from the well-ventilated western boundary region towards the weakly ventilated eastern Atlantic. The oxygen supply to the equatorial Atlantic east of 23°W due to deep jets is estimated to be up to 2.5 mmol kg⁻¹ yr⁻¹. It contributes to the broad equatorial oxygen maximum with latitude seen at intermediate depths that is typically not present in state of the art global climate-biogeochemistry models. Poleward eddy fluxes away from the equator are in turn crucial for the ventilation of the tropical oxygen minimum zones. Simple parameterizations of deep jets for coarse-resolution models in terms of regional varying eddy diffusivities are suggested. (Abstract ID 10363)

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OCEAN TRACKING NETWORK ACTIVITIES IN CANADIAN'S BAY OF FUNDY

The Ocean Tracking Network's approach to the integration of biological and environmental data is expected to lead to an international standard for the inclusion of animal behavior data into the Global Ocean Observing System. Canada's Bay of Fundy, with the highest tides in the world and fiercely turbulent environment has been chosen as a location to investigate effectiveness of acoustic telemetry technology over a range of research issues including species at risk, climate change and tidal power. Here we describe regional scale data processing and associated database management systems currently being used to support a rapidly expanding complex of independently operated acoustic telemetry based sensor tag deployment and tracking projects. In addition to an overview of results to date, we give details of OTN's integrated approach to the collection, processing and quality control of information about how, when and where the various instruments are deployed in the field as well as give descriptions of: PostgreSQL/POSTGIS data base, Web Mapping and Feature Services, Rstudio data visualizations and discovery metadata records. (Abstract ID 11084)

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TOWARD AN IMPROVED DESCRIPTION OF UNCERTAINTIES IN OCEAN SIMULATIONS: EFFECT OF LOCAL ANAMORPHIC TRANSFORMATIONS ON SPATIAL CORRELATIONS

In this presentation, we investigate how the description of uncertainties in ocean simulations can be improved by applying local anamorphic transformations to the model variables, assuming the joint Gaussianity for the transformed variables rather than for the original variables. It is first shown that local transformations can be derived from a simple histogram description of the marginal distributions. Two advantages of this solution for large size applications are the conciseness and the numerical efficiency of the description. Several oceanographic examples are examined to evaluate the effect of the using piecewise linear local anamorphic transformations on the spatial correlation structures. These examples include (i) stochastic ensemble descriptions of the effect of atmospheric uncertainties on the ocean mixed layer and their consequences on ecosystem models, and (ii) non-stochastic ensemble descriptions of uncertainties in sea-ice properties and ecosystem predictions. The results indicate that the transformations tend to increase the correlation radius essentially when the variables exhibit nonlinear behaviour, and thereby improve the benefit that can be expected from a given observation network integrated in an assimilative system. (Abstract ID 9702)

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CONTAMINANTS IN ANTARCTIC FUR SEALS: ASSESSMENT OF DIET AND THE DECLINE IN CONTAMINANT BODY BURDEN OF FEMALES FROM PLACENTAL AND LACTATION TRANSFER

Persistent organic pollutants (POPs) and mercury, contaminants that bioaccumulate in upper trophic level organisms, were detected in a top Antarctic Peninsula predator, Antarctic fur seals. Female seals can decrease their body burden of contaminants via placental and lactation transfer of contaminant residues from morn to pup. Previously breeding females were found to have significantly lower concentrations of certain POPs (p,p’ DDE, chlordane, HCHs and less metabolizable PCBs) in their milk than first breeding females, likely due to transfer of their POP burden from mother to pup in earlier years. POPs in milk samples from Antarctic fur seals collected over the last decade were evaluated to further assess this trend. POPs, mercury, carbon and nitrogen stable isotopes can also provide insights into long-term and short-term dietary preferences of marine predators. Chemical tracers unique to fur seal prey (e.g., fish and krill) were identified, and the contributions of these prey items to Antarctic fur seal diets over the last decade were assessed. By evaluating the dietary preferences of these seals the transfer of contaminants across trophic levels is better understood. (Abstract ID 11732)
RESOLVING FALLOUT VERSUS RUNOFF SOURCES OF FUKUSHIMA RADIOACTIVITY USING RADIAISON ISOTOPES

Radion isotopes derive from sediments within groundwater aquifers or coastal margins, thus they are useful in tracing the pathway of water masses originating from the coast. Here, we present the results of radium and cesium isotope and ocean drifter data collected along the Japanese coast and within the Kuroshio Current in June of 2011. The objective of this research is to identify the pathway and flux of radioactive material from the Fukushima Dai-ichi reactors to the ocean. Early data indicate that short-lived Ra-223 and Ra-224 were elevated at several locations where Fukishima-derived cesium concentrations were highest. This implies a coastal source for Cs from direct discharges to the ocean, rather than an atmospheric fallout pathway at these locations and times. We use drifter data in conjunction with short and long-lived (Ra-226 and Ra-228) radium isotopes to estimate the approximate age, source and transit time of the water masses that contained the highest cesium levels. To our knowledge, this is the first study to use naturally occurring radium isotopes to study the pathway and source of nuclear materials in the environment. (Abstract ID 11978)

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DISTRIBUTION OF CHEMICAL ENERGY IN A RISING HYDROTHERMAL PLUME OF THE LAU BASIN

Recent studies suggest that both biotic and abiotic processes modify hydrothermal chemical fluxes subsequent to venting. The availability of chemical energy for chemosynthesis and carbon fixation is a fundamental coupling between these processes. As part of our investigation of the rising plume chemistry of Lau Basin vents we examine this coupling by comparing geochemical observations with modeled mineral formation and the potential availability of chemical energy. The availability of chemical energy for a range of chemosynthetic metabolisms is estimated for the rising plume of ABE1 vent using a coupled physical transport and equilibrium reaction path model. Physical transport is modeled using a turbulence resolving computational fluid dynamics simulation. Speciation of vent derived electron donors and seawater derived electron acceptors is modeled using equilibrium reaction path modeling. The Gibbs free energy available for chemosynthesis is calculated on the basis of the resulting chemical distributions. We are currently validating this initial simulation using a range of sample measurements. Our goal is to build upon this framework and ultimately develop a coupled biogeochemical and ecological model of hydrothermal plumes. (Abstract ID 11943)

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FEEDING ECOLGY OF BAY ANCHOVY (ANCHOA MITCHILLI) IN THE MARYLAND COASTAL BAYS

Bay anchovy, anchaoa mitchilli is a small silvery forage fish. It is an important marine species because of its significant biomass in marine and estuarine food webs, playing an important ecological link between plankton production and higher piscivorous trophic levels. The feeding ecology of the bay anchovy was studied based on data collected in June 2011 from 6 sites in the MCBs. Gut content analysis was carried out on 88 bay anchovies. Diet composition consisted of copepods, crab larvae, mysids, shrimp larvae, amphipods, cumaceans, ostracods, fish larvae, isopods and eggs. Copepods were the most abundant (93%) and frequent (70%) prey item while cumaceans, ostracods, isopods, and fish larvae were least (5% C<3% and 50%<10%). Throughout the different areas sampled there was a distinct change in the amounts and variety of the food sources found. (Abstract ID 9667)

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AMS OCEAN WEATHER, AND CLIMATE STUDIES RAISING EARTH SCIENCE LITERACY ONE STUDENT AT A TIME

Increasing students earth science literacy is a primary goal of the American Meteorological Society (AMS). Supported by NOAA, NASA, and NSF, AMS Ocean Studies is one of three introductory undergraduate courses developed and offered by the AMS that engages students in the geosciences by utilizing real-world, environmental data. AMS Ocean Studies is an all-inclusive course package, containing both printed and online materials. The 2011 Japan
tsunami, the 2010 Gulf oil spill, along with a detailed look at the essential role the ocean plays in Earth's climate system are only a few of the topics covered in the newly revised Ocean Studies textbook. Through a course website, students also dive into online resources from NOAA and other leading scientific organizations. To better understand complex oceanographic principles, such as the Coriolis force and plate tectonics, an interactive globe is also included. AMS Ocean Studies has been adopted by almost six dozen institutions throughout the country with the U.S. Navy being one of the largest adopters. Through AMS Ocean, Weather, and Climate Studies, AMS aims to interest all students in the geosciences. (Abstract ID 9451)

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EVALUATION OF THE MESO SCALE ACTIVITY IN THE MERCATOR-OCEAN GLOBAL EDDY-RESOLVING MODEL (1/12).

In 2007, Mercator Ocean has initiated for operational oceanography application the development of a global ocean/sea ice high-resolution model (1/12), based on the NEMO OGCM. Since this first configuration, updated physical parameterizations have been implemented and evaluated in various inter annual experiments. The last experiment has been driven over the last decade (2000-2009) by the EC-Antarctic reanalysis fluxes. In order to better capture high frequency variability, the atmospheric forcing is sampled to the 3H and applied using Okubo Weiss parameter has been developed and applied on the model outputs. The results, in term of eddies number, eddies lifetime and eddies trajectories, are compared with the altimetric data ones. (Abstract ID 11229)

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DIVERSITY AND ENVIRONMENTAL DISTRIBUTION OF LONG CHAIN POLYAMINES ROLE IN GLOBAL BIOGEOCHEMICAL CYCLES AND PALEOECEANOGRAPHIC RECONSTRUCTION.

Long-chain polyamines (LCPAs) produced by diatoms for biomineralization of their cell walls play a central biogeochemical role, linking the cycling of organic matter with the cycling of silicon. At depth, their distribution, molecular diversity and fate in the upper ocean and in sediments remain to be fully characterized. We used HPLC/ESI-MS: high resolution mass spectrometry (TOF-MS) as well as 1H, 13C NMR spectroscopy to characterize LCPAs at the molecular level in mixed marine plankton communities and in the sedimentary record of the Pacific Ocean, Bering Sea, Southern Ocean and Puget Sound estuary. An astonishing variety of over 100 natural LCPAs with complex distribution patterns was found in each sample and clear regional differences were shown in composition and structural characteristics, likely reflecting differences in diatom flora. We will show that LCPAs constitute a valuable substrate for compound-specific radiocarbon (Δ14C) dating, in regions where production and/or preservation of carbon is poor, such as in the Southern Ocean and the Equatorial and Northeastern Pacific Ocean. This new class of biomarker offers a promising tool to advance our understanding of the feedbacks between diatom physiology, biogeochemical cycles and climate. (Abstract ID 10685)

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A PARTICLE FILTER FOR HIGH DIMENSIONAL SYSTEMS WITH APPLICATION TO OCEAN BIOGEOCHEMISTRY.

Particle filters are sequential data assimilation algorithms that produce estimates for the ocean state and its uncertainty. An outstanding problem is the successful application to high dimensional systems, such as characterizes most realistic oceanographic models. The fact that small ensembles must represent large state spaces leads to degeneracy and failure in particle filter applications due to weight collapse. Few workable solutions exist, with the exception of the approximate ensemble Kalman filter. We have developed a new approach applicable to large dimension systems. The idea is that at every single step, a particle filter is not only applied in the time domain, but also applied in the spatial domain. That is, a sweep is made through the spatial grid at each time step (and is smoothed) thereby providing for representative samples from target distribution that characterizes the ocean state. This appears to mitigate weight collapse in large dimension systems. An application for a 1-D ocean biogeochemical model using the Bermuda Atlantic Time Series is used to illustrate and test the approach. (Abstract ID 10738)

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ESTIMATING PHYTOPLANKTON SIZE FROM HIGH-FREQUENCY FLUCTUATIONS IN SIMPLE OPTICAL MEASUREMENTS.

Particle size is a critical attribute of phytoplankton communities that is difficult to measure in situ at broad spatial and temporal scales. Theoretical and experimental work by K. Shifrin has shown that high-frequency fluctuations in optical beam attenuation contain information about particle size. Here we apply a similar principle to estimate mean particle size from optical backscattering and chlorophyll fluorescence timeseries. Fluctuations in backscattering during a laboratory aggregation experiment were used to estimate mean particle size from optical backscattering and chlorophyll fluorescence measured in situ during the North Atlantic Bloom 2008 project were used to determine the dominant phytoplankton size class. Both laboratory and field results compare well with independent measurements. Our results suggest that chlorophyll fluorometers and scatterometers already deployed on ships, moorings, and autonomous platforms can be used to identify both the dominant phytoplankton size class and the dominant overall particle size class (< 1 cm) at broad spatial and temporal scales. (Abstract ID 11410)

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CROSS-SHELFE TRANSPORTS: THE PROBLEM THAT DOES NOT DIE

Cross-shelf transports undoubtedly occur in the coastal ocean: inner shelf waters are almost always salty. These exchanges are critical for nutrient cycling, sediment transport and contaminant dispersal, to name just a few. From a physical perspective, the problem is hard because Earth’s rotation inhibits steady flow across isobaths, so that cross-shelf exchanges must be dissipative, episodic, or unusually intense. Some types of cross-shelf transports that are roughly understood, including wind-driven upwelling, surf zone undertow, and shear dispersion. Attention here is on the difficulties and opportunities associated with a few illustrative, less-understood mechanisms. For exchanges across a shelfbreak front, time-dependence and nonlinearity allow net fluxes, but the observational problem is difficult because the exchange is inefficient. In bottom boundary layers, turbulent frictional effects allow cross-shelf transports, but we still do not understand the bounds of buoyancy arrest. Buoyancy currents, unless they are very large, tend to die out alongshore, implying cross-shelf dispersal, but the mechanism and rates are, to date, poorly understood. Progress will likely involve using models that are evaluated against the more observable integrated aspects of measurements. (Abstract ID 9718)

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BUOYANCY ARREST AND STEADY CROSS-SHELFE FLOW

Buoyancy arrest results from near-bottom cross-isobath Ekman flow transporting lighter or denser water across isobaths. The resulting density gradients, through a thermal wind balance, lead to vanishing bottom velocity and bottom stress. In an idealized case, the remaining steady flow is geostrophically balanced, and so cross-isobath flow is prohibited. Scalars and a sequence of idealized, fully nonlinear, numerical model runs are used to explore the evolution of an imposed cross-isobath flow at the shelf edge. Far from the inflow, buoyancy arrest occurs and the steady current’s width follows a scaling similar to that of Chapman and Lentz (1977). Closer to the prescribed forcing, there is a steady transition region where arrest is incomplete and cross-isobath flow is allowed. The alongshore scale for adjustment to arrest increases with the imposed volume flux, and decreases as the measurement of stratification or bottom slope increases. For many reasonable continental shelf settings, this adjustment scale is so large that steady, completely arrested conditions should not be expected. (Abstract ID 9752)
Nitrogen Isotopes and Community DNA and RNA Datasets Support a Role for Nitrite Oxidation Throughout the Oxygen Minimum Zone off Northern Chile

Despite the importance of the oxygen minimum zone (OMZ) in the Arabian Sea and eastern tropical Pacific, OMZ microbial N-cycling pathways, their environmental constraints and overall biogeochemical impact remain unresolved. To explore these issues, we present N-15 and O-18 nitrate and N-15 nitrite isotope distributions along with metagenomic and metatranscriptomic analyses of key nitrogen metabolism genes in the OMZ off northern Chile. Depth profiles showed a delta N-15 offset between co-occurring nitrate and nitrite of 30 to 40% throughout the OMZ. This offset is greater than expected from dissimilatory nitrate reduction and consistent with additional processes such as nitrite oxidation enhancing this separation. Deviations in the expected N-15 and O-18 nitrate relationship also suggest an important role for this process. Indeed, community DNA and RNA datasets contained high numbers of sequences encoding enzymes of nitrite oxidation, including nitrite oxidoreductase (NirB) and the nitrate reductase (NarG) of an anammox bacterium, which likely functions in the oxidative direction during anammox. Together, these data implicate nitrite oxidation, potentially via nitrification or anammox, as a significant contribution to nitrogen cycling in the OMZ. (Abstract ID 10424)
observed and recorded using 100Hz accelerometer sampling and high-speed video among 7 different great scallops. We demonstrate that multiple parameters in the time and probability domain can statistically differentiate among events. Dr for feeding and escape events decreased by 50% when sampling at <0.1Hz. Our analyses demonstrate additional problems associated with aliasing and how activity and energy-budget estimates can be compromised and misinterpreted. We recommend that high-frequency accelerometer sampling be used in similar (field) studies. If battery-storage is limited, we also recommend archiving the events via an onboard algorithm that determines the highest likelihood and subsequent archiving of the various event-classes of interest. (Abstract ID 10591)

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NITROGEN FIXATION - A NEW SOURCE OF NITROGEN IN THE CHANGING WESTERN ARCTIC?

Pelagic nitrogen fixation is generally confined to relatively calm, oligotrophic waters with temperatures greater than 20C. It follows then that it would be unlikely in the Arctic. Despite this reasoning, nitrogen fixation was measured in surface waters at seven out of seven sites sampled in the coastal Chukchi Sea in August 2011. To measure fixation rates we incubated surface water with N15-labeled nitrogen gas for 24 hours under in situ conditions (24 hour light at 5C). Rates in the >0.7um fraction ranged from 0.01 to 0.52 nmol N/L hr with 23 to 92% occurring in the >3um fraction. To our knowledge these are the first measurements of nitrogen fixation in the Arctic and they raise a number of questions. Have others tried to measure it in the past but did not see detectable rates? Can we measure it now because the predicted increased nitrogen demand (longer ice free growing season) and increased nitrogen loss (enhanced denitrification) is coming to pass? In the future will nitrogen fixation be an increasingly viable way to make a living for Arctic microbes? (Abstract ID 12131)

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SPATIOTEMPORAL TRENDS OF MATING AGGREGATIONS IN NURSE SHARKS (GINGLYMOSOMATA CIRRATUM) AROUND CAPE ELEUTHERA, THE BAHAMAS

The reproductive ecology and behaviour of most large sharks remains an enigma, largely due to the logistical challenges of observing specific behaviours in these highly mobile and wide ranging species. Understanding and promoting reproductive success is critical to the effective conservation and management, yet at present this is a minimally investigated area. The nurse shark (Ginglymostoma cirratum) is a highly abundant species found throughout the tropical and sub-tropical Atlantic which is known to form dense mating aggregations in shallow coastal habitats, making them easily accessible for observation. Since May 2010 this study has documented timing and location of mating aggregations of nurse sharks at 6 shallow coastal areas, characterized by sand, rubble and often mangrove presence, around Cape Eleuthera, The Bahamas. The greatest number of individuals observed was 19 with the majority of mating behaviour occurring in the month of June. Abiotic factors monitored included tidal state, water temperature and sediment type. Future research will assess the degree of site fidelity exhibited by individuals to specific aggregation sites and investigate the potential effects of essential habitat loss. (Abstract ID 12837)

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LEADERSHIP EFFECTING CHANGE: RESEARCH, OUTREACH AND EDUCATION IN THE BAHAMAS

The Island School serves as a catalyst in the global transition to a more livable future through three institutional keystones: Developing an intimate sense of place in students through immersion experiences in the natural and cultural environment; Modeling sustainability of individual lifestyles, larger communities, and the systems that support them; Creating an intentional community whose members are cognizant of their abilities, limitations, and effect on others. The mantra of the school is leadership effecting change and a key avenue is conducting research alongside experts at the Cape Eleuthera Institute (CEI). The mission of CEI is to promote the conservation of the tropical marine and coastal ecosystems of Eleuthera, The Bahamas, and the greater Caribbean by facilitating the research of resident and visiting scientists, supporting the education of students at all levels, and promoting outreach efforts to enhance the conservation awareness of local and global communities. CEI leads international conservation efforts to ensure the long-term health of local and global natural resources through sustainable approaches to their use, enjoyment, and protection. (Abstract ID 12848)

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THE DIVERSITY, DISTRIBUTION AND DEMOGRAPHIC POPULATION STRUCTURE OF WESTERN WATER ESPLANALBOMARINUS IN THE NORTHEAST EXUMA SOUND, THE BAHAMAS.

The Exuma Sound is a deep water inlet of the Atlantic Ocean ranging in depth from 500 – 2000 m and characterized by steep walls along its margin. The sound is in close proximity to land, facilitating the sustained ecological investigation of its deep water esplanalbomarinus fauna. To date, 58 deep water longline surveys have been conducted (depth: 472.6 – 1024.1 m; seabed temperature: 15.6 – 59.9 C), resulting in the capture of 133 sharks from nine different species. Preliminary analysis suggests that water depth and bottom temperature are significant predictors for the presence or absence of Squallus cubensis, Mustelus canis insularis, Centrophorus granulosus, Hexanchus nakamura and Centroscymnus owstoni. There were no predictable trends in the abundance of Hexanchus griseus, Centrophorus raiuadag, Galeus ptilorhynchus or Pseudotriakis microdon. Species richness declined significantly with increasing distances from the edge of the Exuma Sound and increased significantly with higher seabed water temperatures. Significantly skewed sex ratios exist for a number of species. Surveys are ongoing and all results are preliminary. (Abstract ID 12851)

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RAPID INCREASE IN ACCUMULATION RATE AND SHIFT IN SEDIMENTARY REGIME IN THE NE GULF OF MEXICO FOLLOWING THE 2010 BP BLOWOUT EVENT

Multicores from >40 sites along the NE Gulf of Mexico continental slope recovered a 1-6 cm thick well-defined, internally stratified medium-dark brown surface layer of sandy mud. Separated by a sharp basal contact, this surface layer is finer grained and has a higher organic content than underlying sediments. It also exhibits a hydrocarbon signal similar to that of the subsurface oil plume detected following the BP blowout event, whereas underlying sediments show a distinctly different, land-derived hydrocarbon signal. Short-lived radionuclides (137Cs, 210Pb, 7Be, 134/137Cs) geochronology indicates that the entire 1- 6 cm-thick surface layer was deposited in less than six months following the blowout event, at mass accumulation rates ranging from 0.6 to 20 g/cm2/yr, compared to 0.02 to 0.2 g/cm2/yr for underlying sediments. Thus, a distinct change in sediment texture and composition accompanied by a 1-2 order-of-magnitude increase in accumulation rate over 6 months can be directly related geochemically to the 2010 BP blowout event. (Abstract ID 11788)

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MODELING THE AMAZON RIVER PLUME

The Amazon River Plume spreads fresh and optically dark water across thousands of square kilometers of the western tropical North Atlantic. The plume creates a salinity driven barrier to vertical mixing, and often heats as much as 2 degrees C above surrounding waters. We present a 1/6 degree HYCOM implementation for the tropical Atlantic Ocean that is focused on resolving surface plume processes and their associated biogeochemical cycling. The distribution and variability of the model salinity is consistent with field observations. The model shows seasonal variations in the transport of freshwater, with northward flow in winter and spring, and eastward flow in summer and fall. The north equatorial countercurrent serves as a carrier for this eastward transport of freshwater, which rides on its northern flank, and is sheared off in waves at the junction of the countercurrent and the westward flowing subtropical gyre return flow. Little of the Amazon River water moves into the equatorial region, most is passed northward to in to the subtropics. Simulations exploring the role of the river in
modulating the physics, air-sea exchange and biogeochemical cycling in the tropics highlight the importance of the river in this region. (Abstract ID 11957)

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IMPACT OF OCEAN CONDITIONS ON ENDANGERED SALMON RESIDENCE IN A RIVER PLUME: PRELIMINARY RESULTS AND MANAGEMENT IMPLICATIONS FROM A MARINE TELEMETRY ARRAY

Three years of tracking acoustically tagged juvenile Spring Chinook salmon during their early marine migration, a critical survival period, has shown that survival in the Columbia River plume region can vary substantially; mean overall survival 2008-2010 was 53% with SD 17%. Residence time in the plume region appears to explain some of this variability, and our preliminary results suggest that residence time covaries with coastal upwelling and local sea-surface temperature. Daily survival rates appear to improve in the coastal ocean beyond the plume region, so it is conceivable that manipulating river spill to align ocean entry with conditions favorable to a shorter plume residency could improve overall marine survival. (Abstract ID 12395)

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Porites spp. and algal turf. Coral-macroalgal interactions influence oxygen conditions above the zone of interaction, we suggest future studies explore the play a diminutive role in oxygen dynamics. As the metabolic byproducts of algal turf appear to (50µg/ml ampicillin) was added to thicker above algal turf and the zone of interaction (<500 – 2500µm). Oxygen extremes in the boundary layer (DBL) in light and dark above the surfaces of interaction was measured. As water flow increased, DBL height decreased, but remained for developing the model system to include surface wave as a primer for air-sea exchange of momentum and (turbulent) energy from atmosphere to the ocean. (Abstract ID 11767)

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FLOW-REGULATED, ALGAL TURF CONTROL OF OXYGEN DYNAMICS WITHIN INTERACTIONS OF MASSIVE PORITES SPP. AND ALGAL TURF

Extreme oxygen concentrations can lead to coral tissue necrosis. We examined how water flow and the members of coral-macroalgal interactions influence oxygen concentrations above the zone of interaction between massive Porites spp. and algal turf. Coral-macroalgal interactions were exposed to three flow speeds (0.7, 14 cm s⁻¹), and the height of the diffusive boundary layer (DBL) in light and dark above the surfaces of Porites, algal turf and their zone of interaction was measured. As water flow increased, DBL height decreased, but remained thicker above algal turf and the zone of interaction (~<00 – 2500µm). Oxygen extremes in light and dark above the zone of interaction were most similar to concentrations above algal turf. To assess the influence of microbes on oxygen concentrations above each surface, antibiotic (50g/ml ampicillin) was added to Porites-algal turf interactions; the results suggest microbes play a diminutive role in oxygen dynamics. As the metabolic byproducts of algal turf appear to influence oxygen concentrations above the zone of interaction, we suggest future studies explore the role of oxygen extremes on the outcome of coral-algal interactions. (Abstract ID 11955)

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RIP CURRENT VERTICAL STRUCTURE

Field observations of mean Eulerian rip current velocities are compared with numerical Delft3D model simulations to examine the mechanisms shaping the vertical structure of the flow under varying hydrodynamic conditions. Waves, bathymetry, tidal elevation and currents were measured at a beach in Monterey Bay, CA, comprised of quasi-periodic rip channels. Vertical rip current profiles were obtained using bottom mounted current profilers. In the rip channel, inside of the surf zone, the current was depth uniform, while farther offshore, outside of the surf zone, the current was surface dominated. In Delft3D, the hydrodynamic flow conditions were coupled to the short-wave propagation, and the effects of wave stresses, turbulent eddy viscosity, and Coriolis force were included. The effect of wave groups on the rip current vertical structure is evaluated by comparing simulations with regular unidirectional waves versus wave groups constructed from measured directional wave spectra. The response of the modeled velocity profiles to the (vertical) variation of turbulent eddy viscosity, Coriolis force, vortex force and wave forcing are evaluated to establish the dominant processes determining the vertical structure of rip current flows. (Abstract ID 10885)

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N AND P ACCUMULATION IN THALASSIOSIRA PSEUDONANA UNDER DIFFERENT N: P SUPPLY RATIOS AT SATURATING CONCENTRATIONS: IMPLICATIONS FOR FOOD WEBS

It is well established that the biomass N:P ratio of phytoplankton is highly dependent on the N:P availability ratio when one of the nutrients is supplied under growth-limiting conditions. Few data exist on the variability of cellular N:P when nutrients are supplied in excess, but at different ratios. We studied the effect of different N:P ratios (ranging from much less to much greater than, Redfield proportions) at saturating nutrient concentrations on the N:P ratio of the diatoms Thalassiosira pseudonana maintained in turbidostats at two light intensities. The cellular N:P ratio varied positively with supply ratio, but to a lesser proportional extent than the supply ratio. Cells growing under high light exhibited a greater N:P ratio range than cells grown under low light. These results suggest that phytoplankton in euphotic conditions continue to physiologically adjust their N:P ratios even when nutrients are at saturating levels. Thus, in the context of ecological stoichiometric theory, waters that are considered nutrient saturated for growth may still impose a ‘nutrient effect’ via the particulate N and P that becomes available to higher trophic levels. (Abstract ID 10095)

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BIOGEOCHEMICAL SENSING SYSTEMS FOR AUTONOMOUS PROFILING FLOATS

A bio-optical sensor system for profiling floats to be used for ocean color satellite calibration and validation and ocean carbon studies was developed. The challenge of realizing the biogeochemical float is in augmenting the proven Argo float with an expanded sensor system that is robust, efficient, and economical so as to achieve satisfactory mission duration. Sathalian and WET Labs jointly developed the sensor system and collaborated with Teledyne Webb Research to integrate it with the APEX float. The sensor system includes an integrating hub that manages up to six additional instruments. The hub controls power switching, implements sampling strategies, and logs data minimizing energy consumption and data size thus maximizing float mission duration. The modular sensor system design allows for building user specified variants. The initial system provided upwelling and downwelling radiometry at four wavelengths, scattering at three wavelengths, beam attenuation, chlorophyll, and CDOM measurements to complement core float sensors for pressure, temperature, salinity and dissolved oxygen. The system architecture and performance are described with emphasis on data quality and the impact on float energy budget and thus mission duration. Initial deployment results are presented. (Abstract ID 12980)

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ON THE CHANGING SEQUESTRATION OF NATURAL AND ANTHROPOGENIC CARBON AND EXPORT FROM THE WEDDELL GYRE AT DEPTH

In the Southern Ocean, the Weddell Gyre is regarded as the primary location for the formation of deep and bottom waters and sequestration of carbon, nutrients and atmospheric gases. Major quantities of dense, cold waters generated near and on the Antarctic continental shelf spill down the slopes entraining surrounding water masses as they descend. Circulating northwards the waters are subsequently exported into the mid-latitude Southern Ocean, spreading globally at depth, an integral component of the southern closure of the meridional overturning circulation. Measurements of CFCs, SF6 and the inorganic carbon system from two cruises - extending from the Antarctic Peninsula, along the South Scotia Ridge and the edge of the Weddell Basin to 30°E - conducted as part of the UK ANDREX (Antarctic Deep Water Rates of Export) project in 2009-2010 are used to investigate this process, in particular the accumulation, storage and transport of natural and anthropogenic carbon in Antarctic Bottom Water and its export from the gyre. Historical comparisons with GLODAP-based estimates enable the assessment of changing carbon inventories, fluxes and water mass formation rates within the region. (Abstract ID 12518)

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AN OBSERVATIONAL/MODELING INVESTIGATION OF THE MID-ATLANTIC COLD POOL: EVOLUTION AND VARIABILITY

The Mid-Atlantic (MA) Cold Pool (CP) is a distinctive along-shelf band of remnant winter water that is bottom-trapped over the continental shelf between Georges Bank (GB) and Cape Hatteras between May and November each year. CP presence strongly influences the MA ecosystem including fisheries. During the summer, CP water flows southwestward from GB, gradually warming and eroding due to a poorly understood blend of vertical and horizontal mixing processes; before finally losing its identity in early fall during a rapid turnover. Beginning in 2007, the fleet of Slocum gliders of the Mid Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) have been used in an ongoing series of cross-shelf and lateral zig-zag alongshelf water property transect measurements - enabling us to map CP configurations at different phases of CP seasonal evolution. The simultaneous glider optical measurements are being used to map some of the relevant oceanic biological fields. The assimilation of these glider data into a pair of MARACOOS numerical models is enabling more extensive mapping, volume estimation, and future CP dynamics elucidation and forecasting. (Abstract ID 12164)

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CHARACTERIZING THE SEA ICE ALGAL COMMUNITY OF THE BELLINGSHAUSEN/AMUNDSEN SEAS

While dense blooms of sea ice algae are known to form in the Ross and Weddell Seas, the ice-algal community of the Bellinghausen/Amundsen Seas has received little attention. However, recent modeling work suggests this region may be among the most favorable ice-algal habitat in the world, due to persistent summer sea ice cover. We examined the ice-algal community of the Bellinghausen/Amundsen Seas, sampling 16 stations in a variety of ice types at the height of the austral summer (December 2010-January 2011) for chlorophyll a (Chl a), accessory pigments, particulate carbon and nitrogen, and cell counts. Preliminary results indicate marked spatial variability, with concentrated ice-algal biomass at some stations (Chl a >240 µg L-1), and very little at others (Chl a <2 µg L-1). Half of all stations exhibited pronounced Chl a maxima in the bottom 10 cm of ice, but biomass maxima were also observed in the interior and at the top of ice cores. We will interpret these highly variable biomass distributions in the context of sea ice chemical (nutrients) and physical (snow cover, thickness, brine volume) characteristics. (Abstract ID 12525)

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SEA LEVEL ANOMALIES WITH A TIME SCALE OF WEEKS IN CHESAPEAKE BAY AND ALONG THE MID-ATLANTIC COAST

Non-tidal coastal sea level variability reflects the combined influence of a variety of processes, including storms and long-term global climate change. The focus of this study is on time scales between the synoptic scale of passing weather systems, including storms and fronts (days), and seasonal variations (months). In recent years, significant sea level anomalies with a time scale of weeks have been observed along the U.S. east coast. For example, in summer 2009, non-storm elevated water levels over a period of several weeks led to minor coastal flooding and prompted a NOAA investigation. During May 2011, an unusual high-water anomaly in mid-Atlantic coastal areas interfered with aerial mapping surveys of submerged aquatic vegetation (SAV) and led to concern about stress to SAV due to decreased light availability. In addition to individual event case studies, results from an analysis of a multi-station data set, using locations in the Chesapeake Bay and mid-Atlantic coast, will be reported. This broader analysis investigated defining characteristics, spatial coherence, and temporal trends of the sea level anomalies with a time scale of weeks. (Abstract ID 12274)
STOKES DRIFT DUE TO OCEAN SURFACE WAVES UNDER TROPICAL CYCLONE (HURRICANE) CONDITIONS

Significant efforts have been made to understand hurricane dynamics and improve hurricane track/trajectory forecasts. However, the complex mechanism by which hurricanes extract/dissipate energy at the air-sea interface is not fully understood. When hurricanes apply large wind stress at the air-sea interface, it enhances turbulent mixing below and increases the entrainment of cool water at the base of the mixed layer into the ocean mixed layer. Resulting sea surface temperature cooling, in turn, reduces air-sea heat fluxes that drive hurricanes. Recently, it has been found that upper ocean turbulent mixing may be significantly modified by surface ocean waves. Surface waves introduce net mass transport (Stokes drift) that interacts with turbulent eddies in a complex manner, depending on different wind and wave conditions (Langmuir turbulence). As a first step to investigate the Langmuir turbulence under hurricanes, the Stokes drift was determined for wave fields under stationary and translating hurricanes. The translating cases showed significant regions where wind and the Stokes drift were misaligned by more than 90 degrees, suggesting possible weakening of near surface turbulence due to surface waves. (Abstract ID 10001)

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TOWARDS THE ABILITY OF THE ADJOINT TECHNIQUE TO RECOVER DECadal VARIABILITY IN THE NORTH ATLANTIC

The Atlantic Meridional Overturning Circulation (AMOC) has an important influence on today’s climate. However, continuous decadal-scale observations of the AMOC are not ongoing. Therefore, available ocean observations are assimilated into numerical ocean models to estimate the AMOC’s mean state and its variability. However, different data assimilation products show rather different AMOC mean states and variability. To understand these differences, we consider a reversed data assimilation approach. We evaluate the principle ability of the adjoint technique to reproduce a given AMOC from a controlled setup using identical twin experiments. Without observational uncertainties an artificial perturbation producing an AMOC change should in principle be detectable in space and time. We investigate how far deviations between model and synthetic observations can be minimized in the presence of artificial observational uncertainties, subsampling synthetic observations and non-linear effects, as e.g., convective adjustment. The results are used to assess error estimates of present assimilation products and AMOC hindcast simulations. (Abstract ID 11022)

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A CLOSURE FOR SUB-MESO-SCALE PROCESSES IN THE OCEAN SURFACE MIXED LAYER

Linear stability analysis is used to construct a closure for sub-meso-scale eddy fluxes in the surface mixed layer. The linearized Navier Stokes equations using unstable mixed layer situations as basic state yield unstable wave solutions. The fastest growing mode of this eigenvalue problem is taken as representation for the vertical structure of the sub-meso-scale eddy fluxes -- i.e. in terms of diapycnal diffusivity and eddy streamfunction. Maximum growth rate and corresponding wave number of the fastest growing mode yield the magnitude of the diapycnal diffusivity and eddy streamfunction. A highly resolved mixed layer simulation is used to validate the parameterization by comparing the diagnosed eddy fluxes with their parameterized counterparts. It turns out that vertical structure and magnitude of the eddy fluxes are well captured. (Abstract ID 1029)

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MARINE VIRAL SURVIVAL SKILLS: HOW OCEANIC MICROBIAL VIRUSES SUCCEED IN THE SOUTHERN OCEAN

Microbial viruses play vital roles in marine ecosystems, but little is known about their ecology and genomic content in polar environments. Here we investigate the roles of microbial viruses during the spring and summer in the highly-productive ocean near the Western Antarctic Peninsula. Ecologically, there was a substantial shift between seasons as bacterial abundance, bacterioplankton production and viral abundance increased sharply, while the percent of bacteria containing experimentally inducible temperate viruses decreased from 6-27% in spring to undetectable levels in the more productive summer. Comparative metagenomics revealed that springtime induced temperate viruses included significantly more siphoviruses and podoviruses than the free viral assemblage, while both summer metagenomes mirrored the spring temperate viral assemblage. This suggests selection for the temperate viral strategy to survive extended periods of low productivity. Further, functional annotation of the viral metagenomes revealed many transcriptional regulators and cold-inducible genes hypothesized to boost host fitness in this variably productive and low temperature environment. These preliminary results indicate that temperate viruses may play an important and previously unrecognized role in the microbial ecology of the Antarctic marine ecosystem. (Abstract ID 10666)

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LARVAL CRASSOSTREA GIGAS GICALCIFICATION, BIOCHEMISTRY AND GROWTH: TOWARD AN ENERGETIC MECHANISM FOR ACIDIFICATION IMPACTS

Larval brachiopods are sensitive to decreases in pH and saturation state ($\Omega_{arag}$). The mechanisms for this sensitivity have not been fully described, in part because early shell formation is not thoroughly understood. We measured the elemental and isotopic composition of Crassostrea gigas larvae from fertilization to settlement size in a production hatchery setting. Larvae created inorganic shell and depleted organic carbon, including lipids, in the first two days, followed by an accumulation of lipid stores after the transition to more exogenous food sources. After 48 hours, bulk carbon partitioning was 68 % shell, with a maximum of 78 % by day five, followed by increasing organic:carbon. Carbon isotopes showed that inorganic shell mineral is primarily derived from DIC, with an increasing metabolic contribution in later larval stages following the reliance on exogenous food sources. We further distinguished between early shell layers with SEM imaging. These data highlight important links among ambient carbonate chemistry, energetic status, and early calcification in larval brachiopods. The energetic cost of initial shell development provides a clear mechanism for the susceptibility of early larval stages to ocean acidification. (Abstract ID 12599)

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BARITE IN SINKING PARTICULATE MATER IN THE WATER COLUMN OF THE SOUTHERN ATLANTIC OCEAN

Marine biogenic particulate barium in form of barite is known to be a recorder of biologic productivity within the photic zone, since its formation is strongly linked to the decay of biogenic debris. The ratio of organic carbon and biogenic barium describes a characteristic decrease with depth. The barite content of a one year (1998-1999) sediment trap time series (3200 m depth) from a mooring site (31.76°S;176°W, 64.07°E;176°W) southwest of Bermuda within the Bermuda Atlantic Time-series Study area has been analyzed and compared with organic carbon flux at depth and satellite chlorophyll-a data. Discrepancies between the known organic carbon/biogenic barium ratios at different depths present in the western Atlantic Ocean and those ratios observed in sediment traps hint to interannual variability of barite precipitation in the western Atlantic Ocean. Furthermore, compiled biogenic barium and barite data of sediment trap material of two sites in the subtropical North Atlantic (31.76°S;176°W, 64.07°E;176°W and 33.00°S;176°W, 22.00°E;176°W) at different depth levels also imply spatial differences in the organic carbon/biogenic barium – depth relation between the eastern and the western study sites. (Abstract ID 9852)

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OCEAN HEAT UPTAKE IN EDDY-RESOLVED AND EDDY-PARAMETERIZED CLIMATE SIMULATIONS

Will explicitly resolving ocean mesoscale eddies quantitatively alter projections of future climate change compared to projections in which the effects of mesoscale eddies are parameterized?
We address this question by comparing two experiments with the Community Climate System Model forced by a 1% per annum increase in the concentration of CO2. In the first experiment, the ocean component model has a nominal resolution of 1°, typical of contemporary coupled climate system models and includes a parameterization of mesoscale eddy mixing processes. In the second experiment the ocean component model has a resolution of 0.1°, thereby explicitly resolving the most energetic mesoscale eddies. In the control climate, both mean advection and vertical diffusion warm the deep ocean, while convection and mesoscale eddy fluxes cool the deep ocean. Under increasing greenhouse gases, the warming of the interior ocean is due primarily to a decline in the cooling by mesoscale eddies and convection. The model with parameterized eddies is able to capture the qualitative sense of the balances for both the control climate and transient climate change, but there are some quantitative differences. (Abstract ID 10663)

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SENSITIVITY ANALYSIS, DATA ASSIMILATION AND UNCERTAINTY QUANTIFICATION IN OCEAN MODELING

To be successful and deliver products on schedule, an operational ocean modeling center such as the Naval Oceanographic Office (NAVOCEANO) follows a strict production routine. For each model, observations are collected, collated and quality-controlled; these data are assimilated; ocean model projects the initial conditions forward, and products are generated. Within this process, we need to quantify introduced errors and supply an estimate of output accuracy. At the “front end,” the Navy Coupled Ocean Data Assimilation (NCOEDA) system provides error indicators for the analysis fields. Through ensembling, multiple versions of a model are run create an output that can be used to determine model variability or uncertainty. Using a system called AutoMetrics, the Naval Research Laboratory (NRL) Stennis Space Center and NAVOCEANO are developing automated procedures to compare observations with forecast model fields. The collection and analysis of these comparisons can lead to estimates of model skill in both space and time. The ultimate goal is the addition of uncertainty fields that would accompany our forecasts of temperature, salinity, and currents. The presentation will show some examples of NCOEDA, ensemble, and AutoMetrics results; demonstrate how they are being applied by ocean forecasters; and discuss how uncertainty estimates are being introduced into the NAVOCEANO modeling runstream. (Abstract ID 11181)

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NITRITE RESIDENCE TIMES IN THE PRIMARY AND SECONDARY NITRITE MAXIMA IN THE EASTERN TROPICAL PACIFIC: INSIGHTS FROM THE OXYGEN ISOTOPIC COMPOSITION

Nitrite is a central intermediate in the marine nitrogen cycle, and it is generally held in low concentrations in the ocean. However, nitrite accumulates at the base of the euphotic zone (primary nitrite maximum) and in the center of oxygen deficient zones (ODZs) in the secondary nitrite maximum. Here we introduce the idea of using static measurements of nitrite oxygen (O18) isotope signatures to quantify the rate of nitrite turnover. Three controlling factors were examined and used to estimate the residence time of nitrite. The oxygen isotopic composition of biologically produced nitrite was estimated using cultures of AOA and AOB, as well as natural seawater communities. Next, the rate and equilibrium isotope effect of abiotic O isotope exchange between nitrite and water were determined at a range of pH and temperatures relevant to seawater. These parameters, together with the isotope effects for nitrite oxidation and reduction were used to estimate the residence times of nitrite in the primary and secondary nitrite maxima in the Costa Rica Upwelling Dome and off the coast of Peru. (Abstract ID 9790)

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ON THE SIZE DISTRIBUTION, COMPOSITION, AND SOLUBILITY OF PACIFIC OCEAN AEROSOLS

Between 2004-2006, 48-hour integrated aerosol samples were collected during three Climate Variability and Predictability (CLIVAR)-CO, Repeat Hydrography sections in the Pacific Ocean. Our size-fractionating cascade impactor was equipped with four sampling stages with aerodynamic diameter cut-points of 3.2µm, 1.0µm, 0.56µm, and 0.056µm. Twenty-three samples were collected in the North Pacific Ocean along 30°N (Section P02) and eleven were collected in the eastern Pacific Ocean along 150°W (Section P16). Ultrapure water extracts of the soluble fraction were analyzed by HR-ICP-MS. These samples were subsequently analyzed by EDXRF to measure the insoluble fraction. Data reported includes five GEOTRACES key parameters (Fe, Al, Zn, Mn, and Cu) as well as V, Ti, Pb and the major anions sulfate and nitrate. These data will be interpreted in conjunction with simultaneously collected bulk aerosol data. (Abstract ID 11291)

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THE INFLUENCE OF SEASONAL NUTRIENT SUPPLY ON PHYTOPLANKTON BLOOMS IN A LOW-INFLOW ESTUARY

Drakes Estero, located in Point Reyes National Seashore, CA, is a low-inflow estuary (LIE). During the LIE season (July to October) nutrient supply to the estuary is via tidal fluxes from the adjacent ocean. During the non-LIE season (November to June) nutrients delivered via terrestrial runoff are likely to dominate. Additionally, oyster aquaculture may add to in situ concentrations. In May 2010 a study was initiated to investigate seasonal variation in nutrient supply and its potential influence on primary production. Measurements of nutrients, chlorophyll, primary productiation and phytoplankton nitrogen uptake, and phytoplankton species enumeration were made. During the LIE season a gradient of nutrient concentrations was observed with nitrate concentrations decreasing on the sea-to-land axis. The non-LIE season exhibited elevated ammonium concentrations at the landward end of the estuary. Throughout the year the DIN:PO4 decreased in the landward direction. Phytoplankton blooms occurred in the coastal and middle estuary during both seasons. This study will offer a mechanistic look at the consequences of seasonal variation in nitrogen sources on the phytoplankton ecology of Drakes Estero. (Abstract ID 12487)

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THE ORGANIC COMPLEXATION OF DISSOLVED FE ON LEG 1 OF THE US GEOTRACES NORTH ATLANTIC SECTION

Dissolved Fe speciation was measured in samples collected from depth profiles in the NE Atlantic as part of the first leg of the U.S. GEOTRACES North Atlantic Section cruise. The speciation of dissolved Fe was determined using competitive ligand exchange-adsorptive cathodic stripping voltammetry (CLE-ACSV) with salicylaldoxime as the added ligand. A comparison of results between samples analyzed fresh at sea and analyzed back onshore after freezing and thawing showed excellent agreement, indicating that freezing samples at ~20°C is a suitable storage technique for dissolved Fe speciation samples. Strong Fe-binding ligands were found in excess of dissolved Fe concentrations at all depths in the profiles. Excess Fe-binding ligand concentrations (e.g., [L1-][Fe]) were found to vary with depth, with largest variations observed near the surface and in benthic boundary layers. (Abstract ID 9874)

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EDDIES AS A SOURCE OF STRIATIONS IN TIME-AVERAGED SEA LEVEL ANOMALY

Eddies are investigated as the source of quasi-zonal patterns, or striations, in zonal geostrophic velocity (U) estimated from time-averaged sea level anomaly (SLA). Distinct four-year averages of SLA during 1993-2008 reveal striations in U1 which estimated from time-averaged SLA in the South Pacific (20°S–20°N) are characterized by speeds O(1 cm s-1), are separated meridionally by 200 km and appear to alternate in direction. Such patterns are similar to those observed in U1 which estimated from mean dynamic topography and Argo float measurements. Use of an eddy database in conjunction with a contour-identification and eddy removal algorithm demonstrates that quasi-zonal patterns are primarily the result of propagating eddies. Eddies account for 50−80% of the energy in the total observed U1 field and correlation coefficients between total observed and eddy-only U1 are 0.87–0.94. The latter illustrates that locations of striations match those created by eddies while the former allows for the existence of latent energy. Striations in sea surface temperature are also explored. Some attention is given to the abilities of the tracking and contour-identification/eddy removal algorithms to identify all eddy energy. (Abstract ID 10344)
COUPLED AIR-SEA-ICE MODELLING OF THE SVALBARD REGION

The Svalbard archipelago is an area of intense air-sea-ice interaction because the warm waters of the North Atlantic current meet the ice edge here. It is therefore a perfect evaluation region for a new coupled regional air-sea-ice modelling system. A new version of the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) model which now includes sea ice dynamics and thermodynamics is used in the study. Model runs are performed covering the Svalbard fjords and surrounding continental shelves with special emphasis on the Storfjorden region. A large polynya occurs in Storfjorden every winter; a 10-20 km wide area of open water where intense sea ice formation and resulting brine water production take place. While an earlier modelling study using ROMS with sea ice reproduced some key polynya events, the results were largely dependent upon coarse-scale atmospheric re-analysis that had systematic errors due to orographic effects of the surrounding mountains. It is shown that the new model system captures the orographic effects important for amplifying and steering the wind field which generates an ice conveyor belt, thereby enhancing ice production. (Abstract ID 10620)

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FIRST SEISMIC IMAGES OF THERMOHALINE STAIRCASES IN THE TYRRHENIAN SEA

We present the first seismically observed images of thermaline staircases in the centre of the Tyrrhenian Sea. The Tyrrhenian Sea is a deep, largely enclosed sea surrounded by a sharply grading continental shelf. Thermohaline staircases are well-defined, regular, step-like variations in vertical temperature and salinity gradients occurring in stable regions where temperature and salinity increase with depth compensating for density increases. They have been observed in the oceans. In response, we organized a research cruise in June, 2011 off Japan to study Fukushima-derived radionuclides in the waters and biota off Japan. This presentation will provide an overview of these successful sampling activities and our plans for analyses of a wide range of radionuclides. For this talk we will focus on the cesium-137 and cesium-134 surface distributions and vertical profiles obtained during this cruise. The highest cesium concentrations at that time were not necessarily at the closest sampling point 30 km from the Fukushima NPPs, but 70-100 km off shore. The data also suggests that the Kuroshio Current prevents the southward spreading of contaminated water. 134Cs/137Cs activity ratios (1.0 at source) indicate Fukushima-derived cesium out to at least 600 km off shore. These results are discussed in context of prior cesium levels in the waters off Japan and in comparison to radionuclide results from other studies in 2011 off Japan. (Abstract ID 10956)

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DOUBLE RIDGE INTERNAL TIDE INTERFERENCE AND ITS EFFECT ON TURBULENT DISSIPATION IN LUZON STRAIT

Little is known about the tidal dissipation processes that occur at subcritical ridges of strong internal tide generation sites, such as the parallel West and East ridges in Luzon Strait in the South China Sea. In this study we investigate the location of the dissipation hotspots, the mechanisms of energy dissipation, and the effect of the double ridge structure and three-dimensional bathymetry on the dissipation. For this purpose, we apply the MITgcm
in both three-dimensional and two-dimensional configurations along zonal transects. In agreement with observations, the two-dimensional simulations show the dissipation is mainly due to turbulent lee waves. During semi-diurnal tides, the internal waves from both ridges are in phase, causing stronger dissipation, whereas during diurnal tides the internal waves destructively interfere, causing weaker dissipation. The effect of the three-dimensional bathymetry on this interference is considered with the three-dimensional model. Preliminary three-dimensional simulations show the barotropic flow is channeled around rather than across the steep sub-ridges, affecting the dissipation in magnitude and location. (Abstract ID 9959)

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Dissolved nitrous oxide in the subsurface waters of the south atlantic ocean

Nitrous Oxide (N\textsubscript{2}O), an important greenhouse gas, is produced during nitrification and denitrification in the ocean interior. Full water column measurements of dissolved N\textsubscript{2}O were made in a pilot study along two recent sections in the South Atlantic as part of the global CLIVAR Repeat Hydrography/CO\textsubscript{2} Program. Dissolved N\textsubscript{2}O measurements were made on the same samples as for the anthropogenic tracers CFC-11, CFC-12 and sulfur hexafluoride. Dissolved N\textsubscript{2}O concentrations in near-surface waters were on average slightly above equilibrium with the atmosphere. Pronounced subsurface N\textsubscript{2}O maxima (2–6x atmospheric equilibrium) were present in upper waters, usually associated with high Apparent Oxygen Utilization. Deep and abyssal N\textsubscript{2}O concentrations were on average slightly above atmospheric equilibrium. Significant levels of the anthropogenic tracers were present in the N\textsubscript{2}O maxima, indicating decadal time-scale communication of these waters with the sea surface. These data can be used to estimate net N\textsubscript{2}O production rates. Including N\textsubscript{2}O measurements routinely on future CLIVAR cruises will allow the evolution of this signal in response to possible large scale changes in biogeochemical processes and ventilation in the global ocean to be determined. (Abstract ID 12366)

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The effects of acute high pCO\textsubscript{2} exposure on growth and survival of Crassostrea gigas larvae

Water conditions during upwelling events are characteristic of ocean acidification, where atmospheric CO\textsubscript{2} absorbed into the ocean lowers the pH levels and changes water chemistry. This study demonstrated the effects of acute high pCO\textsubscript{2} levels on larvae of the Pacific oyster, Crassostrea gigas. The objective was to determine if acute exposure (24 hours) of the oyster's eggs to high levels of pCO\textsubscript{2} followed by exposure to optimal conditions had a detrimental effect on subsequent larval development. It was observed that eggs exposed to high pCO\textsubscript{2} for 24 hours had a higher percentage of abnormal larvae and a smaller shell width than eggs initially exposed to ambient seawater. It was also observed that both the percentage and total number of normal larvae increased in the high pCO\textsubscript{2} treatment during the 11 day growth period. This result suggests that batched abnormal larvae can survive and recover into normal individuals if subsequently raised under normal CO\textsubscript{2} conditions. A greater understanding of larval recovery and its implications may lend insight into the physiological processes occurring in response to exposure to high pCO\textsubscript{2}. (Abstract ID 9973)

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Indian ocean salt transport using satellite observations and model simulations

In this study, we use salinity data from the Soil Moisture and Ocean Salinity (SMOS) mission, a 1/12° high resolution Hybrid Coordinate Ocean Model (HYCOM) and the Simple Ocean Data Assimilation (SODA) reanalysis to study salt transport in the monsoon-influenced Indian Ocean. Results show that the zonal component of the near surface salt transport was higher than the meridional component with the strongest seasonality observed along the Sri Lanka region while in the equatorial region it was almost entirely westward. Depth-integrated transport analyses indicate a northward transport of salt in bottom water layers and a southward transport of salt in surface layers. Salt transport generally increases southward with the highest transports occurring in the south (0°S–35°S) and a maximum at 30°S, a region influenced by the Circumpolar Deep Water and the Antarctic Bottom Water. EOF analysis show that the variability is primarily seasonally driven with the variability in currents being more important than the variability in salinity determining the long term variability in salt transport. (Abstract ID 9369)

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Sources of strong copper-binding ligands in antarctic peninsula surface waters

Copper-binding organic ligands were measured during winter in surface waters of the Antarctic Peninsula using competitive ligand exchange adsorptive cathodic stripping voltammetry with multiple competition strengths. Samples were taken in four distinct water masses including the Antarctic Circumpolar Current, Southern Antarctic Circumpolar Current Front, Bransfield Strait, and the shelf region. Strong copper-binding organic ligands, known to be produced by cyanobacteria and diatoms, were detected in each water mass despite the minimum in biological activity. The strongest copper-binding ligands were detected at the highest competition strength in the Antarctic Circumpolar Current, with an average conditional stability constant of K\textsubscript{CuL,Cu} = 10^{4.5±0.5}. The weakest ligands were found at the lowest competition strength in the shelf region with K\textsubscript{CuL,Cu} = 10^{3.5±1.0}. No ligands with stability constants less than K\textsubscript{CuL,Cu} = 10^{-5} were detected in the ACC at any competition strength, suggesting a shelf source of weak copper-binding ligands. Free copper concentrations, the biologically available form, were less than 10\textsuperscript{-13} M in all samples, nearing levels that may be limiting for some types of indubile iron acquisition. (Abstract ID 10763)

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On the relationship between warm water volume and el nino since 1955

At least since 1980, the "tilt" and the warm water volume (WWV) modes are the two most important modes of interannual variability in the equatorial Pacific. The tilt mode is approximately in phase with major ENSO indices, some of which are over 130 years long. By contrast, an annual-much WWV index exists only since 1980. The WWV mode leads the tilt mode by about a quarter of a period and it has been successfully used as a predictor of ENSO. However, in recent years, the lag between the indices has changed and predictions based on the WWV have failed. The main objective of this work is to find out if the lag between the tilt and WWV modes has changed also in the past. To investigate this, we constructed three monthly WWV index proxies which extend as far back as 1955 based on 1) in situ sea level and precipitation data, 2) NOAA gridded heat content data and 3) SODA-POP (Simple Ocean Data Assimilation) temperature profiles. We found that before 1980, the sea-level-based and the SODA indices show a clear reduction in the lag of best correlation with Nino3.4 The lag reduction is associated with the highest correlation with Nino3.4 over the whole record, suggesting that before 1980, in the present, the relative importance of the WWV mode with respect of the tilt mode had decreased. (Abstract ID 12771)

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Propagation features of decadal-scale subsurface signals in the north pacific ocean

The Kuroshio Extension supports both eastward and westward moving subsurface signals. These signals are important in regulating low-frequency air-sea interactions in the region. Typically studies of sea surface height anomalies report westward propagation and interpret these as Rossby waves, while investigations of upper ocean heat content find eastward propagation and cite mean flow advection as an underlying cause. Yet, heat content in general affects the velocity field and also evolves as a Rossby wave. We investigate this dichotomy using a 150-year CGCM integration and a 60-year eddy-resolving OGCM integration. Our analysis demonstrates the following. The signals associated with the first baroclinic mode are governed by the non-interaction theorems and propagate westward largely independently of the mean flow. The eastward-propagating signals are a mixture of higher baroclinic modes and density-compensated temperature and salinity anomalies. The result suggests that the commonly used indices of heat content of the upper ocean result from a mixture of different dynamics and vertical structures. (Abstract ID 11411)

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Inter-annual variations in temperature, salinity and oxygen off Wallops Island, VA

Human induced global warming has already started causing physical and biological impacts on both global and regional scales (IPCC, 2007). What is more troubling is that such impacts are occurring earlier and faster than scientists have predicted. The Mid-Atlantic Bight (MAB) shelf waters are one of the most productive in the world (Yoder et. al., 2002). However, the mid-shelf region of the MAB has some of the most stratified continental shelf waters and encompasses the location of the 1976 Anoxic Episode, where intense stratification was one important element of the synergism resulting in anoxia and extensive fish/shellfish mortalities (Campbell & O'Reilly, 1988). In this week we will analyze CTD data sampled off Wallops Island, VA from
2001 to 2011 and archived at the Marine Science Consortium, Wallops Island, VA. We will look at inter-annual trends in the temperature and salinity anomaly fields and relate them to oxygen data collected in the same region. The goal of this work will be to identify stratified regions and understand the variation of oxygen in these regions. (Abstract ID 11252)

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Carruthers, T. J. and L. Latasa, University of Plymouth, Plymouth, UK. To determine the rate and ratio of particulate organic matter remineralization by natural microbial populations

Recent studies of elemental stoichiometry of particulate and dissolved organic matter show large departures from Redfield trajectories driven by alterations in phytoplankton species composition, the molecular composition of organic matter and preferential remineralization of N and P by heterotrophic bacteria. The stoichiometric and molecular composition of photosynthetic microorganisms can control the rate and extent of remineralization, and thus, the recycling efficiency of oceanic systems. To investigate this process, we have harvested POM of variable and known molecular and elemental composition from cyanobacterial (TribacodesiumIMI101 and Prochlorococcus MED4) and eukaryotic cultures (Thalassioea pseudonana). We have introduced this material to natural heterotrophic bacterial populations collected in the oligotrophic North Pacific Subtropical Gyre and the upwelling regime off the Oregon coast and tracked the stoichiometric transformation of organic nitrogen and phosphorus to particulate (bacterial) and inorganic pools in both short (days) and long (months) term experiments. Ultimately, the rate and ratio of particulate matter remineralization derived from these experiments is relevant to the relationship between production and consumption of N and P in the open ocean. (Abstract ID 11947)

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CONSEQUENCES OF RESTRICTED GENE FLOW ACROSS A BROAD GEOGRAPHIC RANGE: OUT-BREEDING DEPRESSION AND LOCAL ADAPTATION IN AN INTERTIDAL COPEPOD

The intertidal copepod Tigriopus californicus exhibits restricted gene flow and extensive population divergence across its geographic range. Two important consequences of restricted gene flow are evident in this system. First, laboratory crosses show that genetic incompatibilities have evolved between populations resulting in reduced fitness of interpopulation hybrids (hybrid breakdown or out-breeding depression). Current evidence indicates that a primary mechanism underlying hybrid breakdown in this system is the disruption of interactions between nuclear and mitochondrial genes. Transcription of mtDNA appears to be reduced in hybrids due to population divergence between the mtDNA control region and the nuclear-encoded mitochondrial RNA polymerase complex; reduced transcription results in mitochondrial dysfunction and poor fitness. A second consequence of restricted gene flow is that populations have evolved differences in thermal tolerance consistent with their local environments. Using a RNA-seq approach, we observed marked population differences in gene expression across the transcriptome in response to acute thermal stress. Levels of up-regulation of heat shock genes were significantly higher in the thermal tolerant southern population compared to the more sensitive northern population suggesting local adaptation in gene expression. (Abstract ID 12657)

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CO-VARIATION OF INTERTIDAL MORPHOLOGY, BEDFORMS AND GRAIN SIZE ON A MACROTIDAL SAND BEACH: PRAA SANDS, UK.

To better understand the gradients in sediment transport on beaches, a 3-week experiment was carried out in May 2011 at Praa Sands, a steep energetic macrotidal beach in Cornwall, UK. Waves, currents, suspended sediment concentrations, and bed elevations/
bedforms were measured in a cross-shore and alongshore array across the sub-tidal and intertidal beach face. As well as repeat bathymetric surveys, a novel aspect of the experiment was the density of grain-size measurements, using a bed-sediment camera system for spatial surveys, and a wave-powered sediment camera to provide a time-series of sediment images under the waves. Bed sediment grain-size was highly variable. Sediment fining coincided broadly with areas of net accretion over individual tides, and coarsening with net depletion: a pattern more readily apparent during quiescent periods. We examine the effects of changes in grain size on morphological development, in the light of sediment transport models fed with accurate grain size information. In addition, grain-size changes are used to understand observed transitions between flat-bed and rippled bed states, and to assess the performance of ripple predictors. (Abstract ID 10168)

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DEVELOPMENT OF A MOORING BASED IN-SITU CALIBRATION SYSTEM FOR AANDERAA OXYGEN SENSORS

Oxygen-based mass balance estimates of biological carbon export require accurate in-situ O2 measurements. Aanderaa optodes are more stable than Clark electrode style sensors but still exhibit some drift and require extensive initial calibration. Aandreaa optodes measure the pO2 in a medium and have been shown to work in both air and water. We have developed an in-situ calibration system using atmospheric air as a standard. The optode is housed on the mooring in a subsurface chamber and regularly exposed to ocean water during normal sampling. During each calibration period, pumped atmospheric air displaces air from the optode housing, which is then sealed. The pressure and temperature of the air inside the housing is measured, allowing calculation of the pO2. Comparison of the calculated pO2 to the optode measurement of the isolated air allows calibration of the optode. Lab experiments calibrating optodes in both air and water validate this method of in-situ calibration and indicate that the presence or absence of an optical isolation layer on the optode face may impact the measurement in air. (Abstract ID 11579)

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LABORATORY STUDIES OF GROWTH AND GRAZING

Large blooms of symbiont-containing green Noctiluca scintillans have recently become more common in the Northern Arabian Sea. Experiments were performed to determine the relative importance of light, nutrients and heterotrophy to the growth of these green Noctiluca scintillans. Green Noctiluca scintillans incubated in filtered ambient Arabian Sea water grew faster in sunlight compared to those held in the dark, and even faster when f/20 levels of inorganic nutrients were added. When green Noctiluca scintillans were incubated with a concentrated natural food assemblage, growth rates were similar to cells in light with added nutrients. Faster division rates resulted in smaller cells and only a slight increase in biomass. The growth rates of the "green" symbiont-containing Noctiluca scintillans were also compared to the "red" strictly heterotrophic Noctiluca scintillans found on the Texas coast. Green Noctiluca scintillans generally grew faster than red Noctiluca scintillans at low food concentrations (below 0.1 mg C per liter), but slower than red Noctiluca scintillans at high food concentrations. The only zooplankton grazers that were observed to feed on Noctiluca scintillans in the Arabian Sea were salps, which appeared in dense patches within the bloom area. (Abstract ID 9754)

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Noctiluca scintillans after the Hebei Spirit oil spill on the west coast of Korea

In order to assess the short-term effects of the oil spill on phytoplankton and crustaceans, their condition, reproductive activity, and biochemical composition were investigated from August 2009 to October 2010 after the Hebei Spirit oil spill at Malipo (OS) on the west coast of Korea. No significant differences were found in water temperature and food indices between the two sites. At an adjacent control (CS), dry tissue weight (DW) of a standard animal remained at low levels in late summer and increased throughout the autumn–winter, peaking in spring, when protein and carbohydrate were at highest levels, and followed by a sharp decline throughout the summer. In contrast, although DW recorded a weak peak in July, no seasonal fluctuation was found at the OS. Maximum values of all the biometric components at the OS did not exceed the winter values at CS. Histological observation showed a seasonal cycle in gametogenic development, gonad maturity index peaking in summer in both sites. Egg weight (EW) was much higher at the CS than at the OS in June–July. The EW peaked in June at the CS and July 1-month later at the OS. The EW dropped in July at both sites, indicating spawning of the oysters. Our results demonstrated that despite a similarity in environmental condition, between-site difference in gross values of the biometric components of the oysters are likely to reflect the effects of the oil spillage on the phytoplankton 2–3 years after the accident at the OS. (Abstract ID 11113)
OCEANIC DYNAMICS ASSOCIATED WITH ENSO IN AFFECTING THE SST VARIATION IN THE WESTERN PACIFIC/PHILIPPINE SEA SECTOR

During the warm phase of El Niño-Southern Oscillation (ENSO), sea surface temperature (SST) in the western Pacific/Philippine Sea sector exhibits anomalous cooling. Compared to the warm anomalies in the eastern Pacific, the magnitude of the cooling is relatively small (0.2-0.7°C), yet the impact on the regional climate is significant. It is found that the correlation between the interannual variations of net heat flux and SST tendency is weak in the tropical western Pacific, and that the Philippine Sea generally receives positive surface heat flux during El Niño. The involvement of oceanic dynamics in generating the cold SST anomalies has been proposed, but the actual oceanic processes are not clear. The oceanic variability of this region associated with ENSO is investigated using data from the three dimensional, eddy-resolving Ocean General Circulation Model for the Earth Simulator (OFES). The 1997/98 El Niño event is chosen as an example. OFES results indicate that the dynamical process of the thermocline upwelling in this region involves both the local effect related to the current variability and non-local waves. The thermocline variation is essential for producing strong and large cooling off the equator in the Western Pacific while the contribution of vertical entrainment is mostly important. (Abstract ID 11431)

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LONG-TERM DEVELOPMENT OF HYPOXIA IN THE BALTIC SEA COASTAL ZONE

The Baltic Sea has the largest area on the globe with eutrophication-induced hypoxia averaging 49,000 km² over the last 50 years. In addition, we have identified 115 sites that have experienced hypoxia during the period 1955-2009 increasing the global total to ca. 500 sites. Some of the most severe hypoxic conditions are in the South Baltic and the Gulf of Bothnia, and these regions are the subject of the present study. Several sites in the southern and western Baltic Sea have experienced hypoxic conditions since the 1950s, and these sites have been selected for detailed analysis. The study will assess the causes of hypoxia and the impact on the ecosystem, and will address the potential for recovery from hypoxia. (Abstract ID 16767)

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El Niño-Southern Oscillation (ENSO) is a major driver of climatic variability in the Pacific Ocean, and it has significant impacts on the atmosphere and ocean. The study of ENSO will provide insights into the mechanisms that control the oceanic and atmospheric variability on interannual timescales. (Abstract ID 12572)

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How does the Mesoscale Eddy-Driven Current in the South China Sea Affect Coastal Ecosystems?

The Mesoscale Eddy-Driven Current (MEDC) is a prominent feature of the South China Sea (SCS) circulation, characterized by the presence of eddies that rotate along the SCS coastline. These eddies play a crucial role in the transfer of heat, salt, and nutrients, influencing the biological productivity and ecological processes in the region. The study aims to investigate the dynamics of the MEDC and its impact on the coastal ecosystems, focusing on the interannual variability and the influence of environmental factors. (Abstract ID 16768)

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WIND MEDIATED EDDY DEFORMATION AND EDDY CONFINEMENT IN THE WAKE OF A MOUNTAINOUS ISLAND

Madeira Island mountains are known to induce the occurrence of atmospheric wakes manifested with the formation of Von Karman Vortex Streets. Oceanic eddies are also frequently observed. Using a two-dimensional, simplified numerical model, a wind stress term was introduced in the quasi-geostrophic equation. Constant and variable wind was superimposed on an oceanic channel with neutral side boundaries, prescribed inflow, and radiation outflow conditions. Results showed that the generation of oceanic vorticity, at the island's flanks, contributed to the increase of oceanic vorticity. Variable wind contributed to the asymmetry of successive eddy-shedding periods. Wind forcing over the open-ocean, continued to contribute to oceanic eddy asymmetry as well as to progressive eddy deformation. In the open-ocean, wind also helps confine eddies onto a corridor. For the no eddy-shedding wake regime (weak oceanic Re), wind forcing strongly contributed to the stretching of the ocean 'jet-like' features, consistent with the Swedrup transport theory. Realistic numerical experiments using the Regional Ocean Modeling System (ROMS), forced by the Weather and Research and Forecasting model (WRF), showed that the use of high-resolution winds contributed to the generation of local oceanic vorticity. As suggested by the idealized numerical experiments, eddies were also aligned with the wind-induced wake. Cycliconic and anticyclonic eddies revealed different response to the atmospheric wake. (Abstract ID 11109)

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VARIE D DEPENDANCE OF EDDY DEFORMATION RESULTS AND IMPLICATIONS FOR WIND-CAPED Eddy DEFORMATION PARAMETERS AND SCATTER
Whitecap coverage (W) parameterizations have been used to estimate the transfer velocity of CO2 and to predict the production of primary marine aerosols. W scales with wave energy dissipation, and is often represented in terms of wind speed. Historical measurements of W exhibit 3 orders of magnitude of scatter, some of which is probably due to variation of measurement technique. Recent measurements of W exhibit less scatter, but still vary by about a factor of 10. Here we explore the possibility that some of this scatter is driven by variations in whitecap foam decay rate, which is usually assumed to be constant. An analysis of foam decay rates observed off Martha's Vineyard over the course of several days will be presented. The area of individual whitecaps is observed to decay quasi-exponentially, with decay constants ranging from 0.5 to 8 seconds. Foam decay rates vary with breaking wave intensity. However, ensemble averages across a range of event intensities on different days also show statistically significant variability. The implications of this result for the observed variability in whitecap coverage will be discussed. (Abstract ID 11497)

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PREDATOR INDUCED HATCHING-PLASTICITY IN NUDIBRANCH SPECIES ARMINA CALIFORNICA
Predator induced hatching-plasticity has been recently demonstrated in a few species of marine organisms. This phenomenon has increased our knowledge of understanding life cycles. To continue this trend a species of nudibranch, Armina californica, was collected and tested for the presence of hatching plasticity when egg masses were chemically exposed to a possible predatory subtidal shrimp. Shrimp were placed in small buckets on a sea water table with continuous water flow into the buckets. Egg masses were split into four equal pieces with two assigned predator present treatments and two with predator absent, and then placed in tea strainers within the buckets. Results found that exposed to predator present chemical cues embryos would accelerate their hatching time by an average of 2.2 days compared with embryos not exposed to predators. This is consistent with expected adaptive response. Future work could be done to examine embryo size and number, and during experiment observations suggest that species possibly exhibits intercapsular cannibalism. (Abstract ID 12899)

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CHANGES IN COMPOUND SPECIFIC 15N AMINO ACID SIGNATURES AND D/I RATIOS IN MARINE DISSOLVED ORGANIC MATTER INDUCED BY HETEROTROPHIC BACTERIAL REWORKING
Stable isotopes are powerful tools for following the flow of carbon (C) and nitrogen (N) through biogeochemical processes in marine ecosystems. Marine dissolved organic matter (DOM) is one of the largest reservoirs of reduced nitrogen and carbon on earth, however its sources and reactivity still remain poorly understood. Stable carbon (δ13C) and nitrogen (δ15N) isotopic analysis of individual amino acids (AA) are rapidly developing as important new tracers for differing DOM autotrophic sources. However the influences of direct cellular AA excretion and, in particular, of heterotrophic bacterial degradation on δ15N-AA patterns are critical, but poorly constrained, factors. We tested differences in δ15N signatures of individual amino acids from DOM freshly produced by autotrophic sources vs. changes after heterotrophic bacterial reworking, comparing both to signatures of corresponding fresh algal biomass. The degradation results were also contrasted with changes in enantiomeric ratios of the same amino acid pool. Together, our results suggest that δ15N-AA patterns coupled to D/L ratios constitute a new approach elucidating microbial effects on long-term preservation of DOM in the water column. (Abstract ID 11180)

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SELF-INDUCED SHEAR FLOWS BY INTERNAL WAVES
Internal waves moving in stratified fluids generate their own shear flows that can become unstable to Kelvin-Helmholtz roll-ups for sufficiently large amplitudes. This talk will present a combined theoretical and numerical study of this instability starting with the spectral analysis of the corresponding non-self adjoint Taylor-Goldstein equation for parallel shears. Mode evolution in this set-up, and in particular non-normal mode growth and/ or decay in addition to true spectral instability, helps explain some of the features observed in a numerical study of internal wave propagation. In particular, the talk will present results on how perturbations in the path of large internal solitary waves with pockets of unstable shear flow at their peaks trigger instabilities, and how these waves can in fact act as suppressors of disturbances by entraining their energy into the main flow. (Abstract ID 10633)

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LONG-TERM BENTHIC BOUNDARY LAYER MONITORING AT THE MISSISSIPPI CANYON BLOCK 118 HYDRATES OBSERVATORY
Since 2006 an experimental seafloor mooring, the benthic bottom layer array (BBLA), has been repeatedly deployed in the Northern Gulf of Mexico at the Mississippi Canyon Block 118 hydrate observatory site. The BBLA is a modular, fully self contained observatory node that can be relocated using a ship and hydro wire. It is designed to operate on less than two Watts for durations of up to one year. This hydrate observatory node provides a baseline for studying natural temporal variations in benthic water column chemistry associated with the Woodsey Mound cold seep site. Located less than 10 nautical miles from the Macondo well, the ongoing BBLA deployments provide a comparative baseline of pre and post-spill benthic water column chemistry, including hydrocarbon levels. We present an overview of the Woodsey Mound cold seep site and BBLA deployment results, along with an outline of the BBLA architecture, and an introduction to innovative technologies that are significantly extending its operational endurance. (Abstract ID 12681)

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USING EXCITATION EMISSION SPECTROSCOPY TO ASSESS THE POTENTIAL IMPACT OF RIVERINE DISSOLVED ORGANIC MATTER ON BIOGEOCHEMICAL PROCESSES
Climate change is expected to alter the delivery of terrestrial organic matter (OM) and nutrients to downstream aquatic environments. Here, the sources and composition of OM exported from forested and wetland sub-environments within Tiакinas Creek, Virginia (USA) were compared during base-flow and storm flow conditions using excitation emission spectroscopy (EEMS) combined with hydrologic monitoring and measurement of the fluxes of nutrients and dissolved organic nitrogen and carbon. Stable isotopic composition of stream particulate OM was compared to end-members of terrestrial and wetland sources to serve as an additional identifier of OM sources. DOM reactivity was assessed using microbial, photochemical and nutrient addition experiments for surface water that was exported. Preliminary data indicate that base-flow samples from both the forest and wetland sites have a combined terrestrial and microbial source, with wetland DOM collected during baseflow containing more soil-derived terrestrial DOM. The composition and flux of DOM are expected to differ during baseflow and storm flow and between forested and wetland environments, which will lead to variability in the reactivity and impact of DOM exported to downstream aquatic systems. (Abstract ID 11448)
Our goal is to understand the impact of changing sea-ice conditions on planktonic food web dynamics during spring sea-ice conditions. Van Keuren, D., University of Rhode Island, Narragansett, RI, USA, jvkdvk@yahoo.com Ross, C., Oregon State University, Corvallis, OR, USA, celiaross@hotmail.com Sherr, B. F., Oregon State University, Corvallis, OR, USA, sherrb@coas.oregonstate.edu

The increasing occurrence of harmful algal blooms (HABs) has prompted studies aimed at determining biotic and abiotic factors which may promote bloom initiation, maintenance, and decline. Although many studies have tried to evaluate the effectiveness of "top-down" or "bottom-up" control of HABs, there is evidence to support both mechanisms. Protozoan grazers are likely candidates for "top-down" control of HAB species since they have the potential to increase their populations at growth rates similar to those found for many HAB species. However, it is difficult to determine if protozoan grazers are feeding on HAB species based on microscopic observations alone. PCR amplification of genetic material, focused on a species- or genus-specific HAB gene, will more precisely determine if an individual grazer has ingested a HAB species during controlled grazing experiments; these results can then be tested in natural grazer assemblages. Long-term grazing experiments will show whether a particular grazer can be an effective "top-down" control of a HAB species. The dinoflagellates Noctiluca scintillans and Protoceratium sp. are the grazers included in this study. (Abstract ID 10251)

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USING PARTNERSHIPS TO INCREASE DIVERSITY IN THE OCEAN SCIENCE WORKFORCE: NC OPT-ED AND COSEE SE

The North Carolina Alliance to Create Opportunity Through Education (NC OPT-ED) involves statewide institutions that are committed to diversifying the science, mathematics, technology and engineering workforce, including the professorate. NC OPT-ED collaborates with educational programs at all levels (K-16 and graduate) to recruit, mentor, and graduate underrepresented minority students from STEM doctoral programs. In December 2010, NC OPT-ED participated in a workshop hosted by the Center for Ocean Sciences Education South East and NC State University designed to form regional partnerships and action plans for activities that would increase diversity in the ocean sciences workforce. As a direct result of that workshop two NC ocean scientists were invited to present on marine science careers at the 10th Annual NC OPT-ED Alliance Day, reaching over 500 middle and high school students. Establishment of partnerships between existing collaborative networks whose common goal is increasing diversity in STEM fields can dramatically increase the number of students exposed to the ocean sciences. (Abstract ID 11136)

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LINKING MELTING ICE TO VARIABILITY IN THE COPPER RIVER PLUMES AND COASTAL GULF OF ALASKA

The Copper River is the largest point source of freshwater to the northern Gulf of Alaska, and the coastal ocean is connected hydrologically, biogeochemically and biologically with the upwelling systems of the watershed. The Copper River watershed (and much of southeastern Alaska) is heavily glaciated, and losses in ice mass have been documented in recent decades. The freshening trend in the surface ocean from meltwater has lead to myriad changes in the Alaska Coastal Current. Using historical data, and the results of recent COASTAL GULF OF ALASKA

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FEEDING AND REPRODUCTION OF MESOZOOPLANKTON IN THE BERING SEA DURING SPRING SEA-ICE CONDITIONS

Our goal is to understand the impact of changing sea-ice conditions on planktonic food web structure and function by describing mesozooplankton and microzooplankton trophic linkages and the fate of phytoplankton blooms in the Bering Sea during spring. During three research cruises in 2008, 2009 and 2010, as part of the BEST-BISERP program, we conducted experiments with dominant mesozooplankton to determine feeding rates on phytoplankton, ice-algae, and microzooplankton. Most mesozooplankton exhibited a saturating feeding response to increasing chlorophyll concentration. All species were found to be omnivorous: some had a strong preference for microzooplankton, while others exhibited no strong preference for any prey type. Based on enriched treatments with ice-algae, it appeared that most could significantly increase their ingestion rates by feeding in close association with the ice. Overall, mesozooplankton grazing-impacts appeared to be minimal at most bloom locations. Egg production rate (EPR) experiments with productively active copepod species were also conducted. The EPR of Calanus spp. in early spring was asymptotically related to both ingestion rate and ambient food concentration, indicating that reproduction depended on ingested food. (Abstract ID 12700)

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SIMULATING THE ADIABATIC INTERIOR OF THE SOUTHERN OCEAN WITH AN EDDYING Z-COORDINATE MODEL

Southern Ocean (and North Atlantic) tracer release experiments have confirmed that the ocean interior, below the surface mixed layer and away from rough bathymetry, are predominantly adiabatic, with low diapycnal mixing rates. At the same time mesoscale eddies are actively stir and mix tracers along tilted neutral surfaces. Maintaining appropriately low levels of diapycnal mixing has proved challenging for z coordinate ocean models, particularly in eddying regimes. Mesoscale eddies are associated with frontal processes and steep isopycnal slopes. Unless care is taken, this can lead to spurious diapycnal fluxes in z-coordinate models. Here we use several metrics that quantify the rate of spurious mixing implied by advection schemes commonly used in ocean models. We demonstrate that a second-order moment (SOM) scheme based on the work of Prather results in physically acceptable diapycnal mixing (i.e. below 10^{-3} m^2/s). In particular, as a consequence of improved adiabatic interior, the diagnosed residual-mean overturning circulation now aligns with neutral surfaces and allows fluid parcels to rise from the interior to the surface without the need to invoke strong diapycnal processes. Climatic implications are further illustrated by use of various tracers (surface age tracers and point-wise tracer releases mimicking tracer field experiments). (Abstract ID 10688)

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TRENDS IN MOC AND MERIDIONAL HEAT TRANSPORT IN THE SOUTH ATLANTIC IN A NUMERICAL EXPERIMENT WITH HYCOM FOR 1960 – 2010

A 1/4-degree implementation of HYCOM, with 22 hybrid layers, was forced with monthly means of NCEP reanalysis for the period 1948-2010. The results show a positive trend in sea surface temperature and salinity in the subtropical South Atlantic, in the period from 1970 to 2010. Possibly as consequence of changes in the westerlies, the model presents a poleward shift of the zero-line sea surface height in the Subtropical Front, near the Agulhas retroflection, suggesting a widening of the connection between the South Atlantic and Indian Ocean. The results also show a negative trend in the meridional overturning circulation and meridional heat transport across different latitudes in the South Atlantic. (Abstract ID 10734)

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ADVANCING THE CARIBBEAN COASTAL OCEAN OBSERVING SYSTEM

Prior to the implementation of the Caribbean Coastal Ocean Observing System (CarICOOS), real-time observations of basic oceanic variables such as waves and currents were nonexistent in the US Caribbean, making it arguably the most under-observed coastal region in the US. Since its inception in 2006, the design of the CarICOOS observing system has been based on sector-focused needs assessment and consultation with stakeholders. Such consultations highlighted the need for operational instrumented buoy platforms to provide data on winds, waves, currents and water quality. It was also concluded that given the difficulty and expense of deploying such platforms, the number of assets should be optimized to provide representative coverage at key locations in the PR / USVI archipelago. In addition, a suite of numerical models of winds, waves, currents and storm surge are currently being implemented for the region and validated with observation data from the CarICOOS buoy network.
with our observational assets. In this presentation we outline our current status and present our five year plan to further advance and ensure the long-term success of the Caribbean Coastal Ocean Observing System. (Abstract ID 12891)

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CLIMATE CHANGE IMPACTS ON THE ORGANIC CARBON CYCLE AT THE LAND-OCEAN INTERFACE

The anticipated effects of climate change on estuaries are likely to be both numerous and complex. A key function of estuaries is the transfer and transformation of carbon and biogenic elements between land and ocean systems. Climate change has the potential to influence the carbon cycle in estuaries through anticipated changes to oceanic matter production, transformation and export. Estuarine biogeochemical processes will likely be altered by: 1) sea level rise and increased storm intensity which will amplify the erosion and transfer of terrigenous materials, 2) increases in water temperatures which will enhance the rates of biological and biogeochemical processes (e.g., enzyme kinetics, decomposition rates, and remineralization), while simultaneously decreasing the concentration of dissolved oxygen, 3) changes in particle (or sediment) loadings in response to altered patterns of precipitation and river runoff, and 4) altered inputs of nutrients and dissolved organic material to coastal waters, also resulting from changing precipitation and runoff. In this presentation, we review the effects of climate change on the cycling of carbon in estuaries, with a focus on the temperate estuaries of North America. (Abstract ID 9907)

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THE RELATIONSHIP BETWEEN SURFACE METEOROLOGICAL OBSERVATIONS AND MODES OF CLIMATE VARIABILITY IN THE LARSEN ICE SHELF SYSTEM, ANTARCTICA

Rapid regional warming over the northeast Antarctic Peninsula in the last fifty years is thought to have contributed to the retreat and disintegration of the Larsen A and B ice shelves. While recent laboratory and modeling studies have linked increases in summer temperatures to the positive trend in the Southern Annular Mode (SAM) climate index via the strengthening of the circumpolar westerlies, field data to test these hypotheses have generally been lacking. As part of the LARISSA (LARsen Ice Shelf System, Antarctica) project, we analyzed data from long-term weather stations as well as additional ground stations adjacent to the Larsen B embayment to explore the response of near-surface meteorological conditions to changes in climate indices. Preliminary field results indicate that increases in SAM are indeed associated with increased wind velocity and temperature as well as decreased surface air pressure leading to favorable melt conditions, as proposed by models. Foehn (downslope, warm) wind events were also significantly more frequent during periods of positive SAM. Such conditions may have large impacts upon the surface temperature of the newly opened Larsen B embayment. (Abstract ID 12670)

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CARBON FIXATION AND PHOSPHORUS TURNOVER IN SURFACE WATERS OF THE EASTERN TROPICAL SOUTH PACIFIC (ETSP)

Rates of inorganic carbon uptake and phosphate turnover were determined on a cruise in the ETSP during Mar & Apr 2011 at several stations on transects along 10oS and 20oS, from the seaward end of the southern transect. Similarly, phosphate turnover was most rapid (~0.08 h-1) at the seaward end of the northern transect and lowest (1.56 h-1) at the northern transect for the first couple of decades after the diversion. By the 1950s alterations to the supply of sediment initiated a regressive stage of delta development, and a hurricane in 1961 deflected the delta westward creating the asymmetric sub-aqueous delta. Asymmetric progradation created a broad shoal to west where wave action is dampened allowing for sediment accumulate at rates of -2 cm/yr. East of the river mouth, where the supply of sediment is now reduced, sediment deposited rapidly during the initial phases of progradation have been reworked and transported across the shelf to deeper water away from the delta. (Abstract ID 99482)

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RECONSTRUCTING THE LIFE OF A PELAGIC SHARK USING STABLE ISOTOPE ANALYSIS

Salmon sharks (Lamna ditropis) are wide-ranging apex predators in the North Pacific. As apex predators they likely play an important role in North Pacific marine ecosystems, yet virtually nothing is known about how habitat use and trophic ecology shifts during ontogeny. We used
stable isotope analysis (SIA) of salmon shark vertebrae to elucidate ontogenetic changes in habitat. The tissue in each annulus of a salmon shark’s vertebrae provides an isotopic record that reflects movements and foraging integrated over a year of a shark’s life. By serially sampling vertebral annuli for stable isotope ratios of carbon (13C/12C) and nitrogen (15N/14N) we were able to reconstruct ontogenetic changes in habitat use for individual sharks. We used a basic isoscape characterizing the major biogeographical provinces of the eastern North Pacific to estimate use of different regions. Electronic tagging data were used to infer SIA results by characterizing annual patterns of ecoregion residence. Integrating electronic tag and stable isotope data provides a unique and powerful way to study the ecology and life history of these important and difficult to study predators. (Abstract ID 12427)

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The influence of hydrodynamic processes on zooplankton transport and distributions in the North Western Mediterranean sea estimated from a Lagrangian model. A Lagrangian module has been developed and coupled with the 3D circulation model ‘Symphonie’ to study the influence of hydrodynamic processes on zooplankton transport and distributions in the North Western Mediterranean Sea. We simulate the trajectories of passive and vertically migrating zooplankton within in a domain extends between longitude 1.5°W and 10.9°E and latitude 38.28°N and 56.1°N. In order to classify different zones of the NWM as aggregative or dispersive, we divided the model domain into 9 sectors. The model is firstly used in forward procedures to study teleconnectivity between different regions of the NWM sea. The individuals are released from March to October from different places of the NWM and tracked for 40 days either as passive zooplankton or with a simple diel vertical migration (DVM) pattern. Then, the model is used in backward procedure to study the origin of organisms drifted to the coastal line all around the NWM sea. This backward procedure is particularly interesting to investigate the patterns of distribution of the jellyfish Pelagia noctiluca from areas where coastal jellyfish invasion have been observed, on the French Riviera, the Gulf of Lions and the Catalan and Balearics seas. The simulations offer a tool to suggest potential pathways of jellyfish transports in the NWM sea. (Abstract ID 9684)

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LONG-TERM ACCUMULATION OF DOC IN THE UPPER LAYER AT BATS The stock of dissolved organic carbon (DOC) experiences regular annual patterns of euphotic zone build-up, redistribution and export due to mixing and net remineralization within the mesopelagic zone at BATS. Imprinted on the annual periodicity of DOC has been a significant long-term trend in which >1 mol / m2 DOC has further accumulated within the surface 800 m. Throughout the BATS time series record there have been multi-year periods where the annual maximum mixed layer depth has systematically shifted to less than 200 m during which net DOC accumulation has occurred within the euphotic zone. The formation and delivery of DOC-enhriched subtropical mode water also appears to be an important contributor to the accumulation observed in the mesopelagic zone. We will discuss the local and advective processes that affect the long-term trends in DOM accumulation in relation to previous data illustrating how DOM character is altered in time and space within the surface layer at BATS. (Abstract ID 10586)

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LOW TEMPERATURE CONSTRAIN GROWTH RATE BUT NOT GROWTH EFFICIENCY OR INSTANTANEOUS GRAZING RATE OF ANTARCTIC MICROZOOPLAGNKTON Low environmental temperature has a significant, but still poorly quantified effect on the ingestion rates, growth rates and gross growth efficiencies of herbivorous polar microzooplankton. These features were investigated in field and laboratory experiments involving cultured isolates and natural communities from the Ross Sea, Antarctica. Ingestion rates of natural microzooplankton assemblages determined by the uptake of fluorescently labeled algae were low in field experiments relative to rates reported for clustics from temperate environments. However, instantaneous ingestion rates of the Antarctic ciliate, Strombidium sp., in laboratory experiments conducted at low temperature varied greatly with physiological state. Strombidiumvaried prior to exposure to high prey abundances had instantaneous specific ingestion rates significantly higher than ingestion rates of the same species measured during balanced growth. Low temperature constrained digestion but apparently not instantaneous ingestion rates. Growth efficiencies were markedly decreased by low temperature. These results support the contention that low temperature strongly reduces growth rate but not growth efficiency of Antarctic protists, and highlight the need for caution when designing short-term experiments to measure ingestion rates of polar microzooplankton. (Abstract ID 12284)

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MODELING THE MODIFICATION OF ORGANIC MATTER SINKING BY METAZOANS Metazoans have multiple impacts on the sinking flux of organic matter, through the packaging of fecal pellets, daily vertical migration, and long-term storage of nutrients. However, these ecosystem processes are difficult to discern on a global scale, given the scarcity of observations and the variability in the ocean environment. Here, we use the Biogeochemistry with Light Iron Nutrients and Gases (BLING) model to test the sensitivity of global biogeochemistry to specific metazoan activities. BLING is a structurally-efficient global model that uses a simple treatment of ecosystem structure to predict biomass and export, founded on the use of diagnostic tracers (i.e. tracers that are not subject to advection and diffusion, and do not conserve mass). We include organisms from different trophic levels in a computationally simple way by subdividing the prognostic organic matter tracer into organic matter components that evolve in time as diagnostic tracers. In this framework, we perform sensitivity tests to study how different parameterizations of particle modification influence the three-dimensional distribution of remineralization and export. (Abstract ID 12569)

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LONG-TERM ACCUMULATION OF DOC IN THE UPPER LAYER AT BATS The Southern Ocean is the largest High Nitrate Low Chlorophyll (HNLC) region of the world’s oceans where primary productivity is primarily iron limited. Despite being an HNLC region, phytoplankton blooms occur annually and persist through the summer. A question that remains unanswered is what sustains blooms in the summer when presumably nutrients in the mixed layer have been depleted. The input of Fe to the euphotic zone depends in part on mixed-layer dynamics. The turbulent mixing caused by winds, along with the radiative forcing, prescribe the mixed layer depth (MLD). Changes in the MLD may facilitate the entrainment of Fe. In this work we explore the potential influence of nutrient entrainment on summer blooms by correlating CHL-a with physical variables such as SST and wind speed intensity (WSFP) using satellite estimates. We find SST fluctuations have the largest influence on CHL-a variability with statistically significant correlations over large areas in the Southern Ocean. The influence of WSFP on CHL-a variability shows more complex patterns. However, significant positive correlations suggest strong winds have a measurable influence in sustaining summer phytoplankton blooms. (Abstract ID 11883)

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LEAD, CADMIUM AND COPPER CONCENTRATIONS AND LEAD ISOTOPIC DISTRIBUTION IN SEAWATER, SEDIMENTS AND CORAL IN THE NORTHERN PERSIAN (ARABIAN) GULF NEAR KUWAIT The objective of this study is to reconstruct chronologies of trace metals in the northern Arabian Gulf Kuwaiti marine environment, influenced by the Shatt al-Al Arab River’s load, using sediment cores and corals, and compare the historical variability to recent seawater data. Pb, Cd and Cu concentrations in seawater and sediments of the northern Persian (Arabian) Gulf were determined using isotope dilution (seawater and sediment Pb) and indium internal standard (sediment Cd and Cu) plasma mass spectrometry. Pb, Cd and Cu concentrations in seawater are high in the northern stations, including Kuwait Bay, Awhah and south of Buhayla Island. They show combined anthropogenic and riverine sources, while waters near two coral reefs by Kubar and Qaruh islands show high Pb, but low Cd and Cu. Surface sediment samples show metal enrichment in Kuwait Bay as expected for elements with anthropogenic enhancements. The 206/207Pb isotope data shows a large range, implying a variable mix of sources. The objective of this study is to reconstruct chronologies of trace metals in the northern Arabian Gulf Kuwaiti marine environment, influenced by the Shatt al-Al Arab River’s load, using sediment cores and corals, and compare the historical variability to recent seawater data. Pb, Cd and Cu concentrations in seawater and sediments of the northern Persian (Arabian) Gulf were determined using isotope dilution (seawater and sediment Pb) and indium internal standard (sediment Cd and Cu) plasma mass spectrometry. Pb, Cd and Cu concentrations in seawater are high in the northern stations, including Kuwait Bay, Awhah and south of Buhayla Island. They show combined anthropogenic and riverine sources, while waters near two coral reefs by Kubar and Qaruh islands show high Pb, but low Cd and Cu. Surface sediment samples show metal enrichment in Kuwait Bay as expected for elements with anthropogenic enhancements. The 206/207Pb isotope data shows a large range, implying a variable mix of sources.
We demonstrate here that short-lived marine mollusk shells from Peru can be used as a quantitative paleoclimate archive for SST seasonal amplitude and ENSO variability in the tropical Pacific cold tongue. Because of low sea water δ18O variability on the Peruvian coast, quantitative paleoclimate archives for SST seasonal amplitude and ENSO variability in the SEASONALITY RECORDED BY SHORT-LIVED MARINE MOLLUSK SHELLS FROM PERU are quantitatively estimated by Monte Carlo simulations (MoCo program available at www.isem.cmu.edu/spip.php?rubrique472). \textit{Var(ΔT)} calculated from a shell sample yields a reliable estimate of the amplitude of ENSO variability. The uncertainty of these estimates, which depends on the sample size, stochastic noise, and biological limitations, can be quantitatively estimated by Monte Carlo simulations (MoCo program available at www.isem.cmu.edu/spip.php?rubrique472). This approach was applied to a modern reference for SST seasonality and ENSO activity. The SST seasonal amplitude \textit{(ΔT)} is strongly correlated to \textit{El Niño}+1 index. Therefore, \textit{Var(ΔT)} calculated from a shell sample yields relative measures of past changes in SST seasonality and ENSO activity, and are independent from the paleotemperature proxy model. We propose a comparison with coral records and model outputs based on ENSO anomaly frequency distributions. (Abstract ID 9869)

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PLANKTONIC DIVERSITY IN LAGUNA GRANDE, PUERTO RICO

Laguna Grande is a 0.87 km² coastal lagoon located on the northeast coast of Puerto Rico. It is connected to Las Crobas Bay through a narrow 1.5 km-long channel. The lagoon and the channel are bordered almost entirely by Rhizophora mangle (Llaneza 1758). The water in Laguna Grande sustains high concentrations of the dinoflagellate 	extit{Pyrodinium bahamense} var. 	extit{bahamense} (Plate 1906), the organism responsible for most of the bioluminescence in the lagoon. Since 2004 we have been collecting water samples from Laguna Grande in order to study different aspects of the population ecology of dinoflagellates \textit{P. bahamense} var. 	extit{bahamense} and 	extit{Ceratium furca} (Ehrenberg 1834) Claparède & Lachmann 1869. High resolution images of planktonic organisms were taken during this research using Hamamatatsu Orca and Nikon DS series cameras, connected to a Nikon Eclipse E-600 microscope. Using these images we preliminarily identified organisms to the most specific taxonomic level that was feasible. We have identified at least 26 different taxa, including eight dinoflagellates, nine diatoms, two tintinnids, one vorticellid, one chaetognath, one medusae larvae, three arthropod larvae and one polychaete larva. (Abstract ID 9925)

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READING BETWEEN THE LINES: BIVALVE GROWTH RATE AND ISOTOPIC VARIABILITY ACROSS THE BARENTS SEA POLAR FRONT

We examined shell growth patterns and tissue stable isotopic composition (δ13C, δ15N) of the Hairy cockle (\textit{Clistocardiun clathrum}) in the northwestern Barents Sea to evaluate the influence of different water masses and the polar front on growth rates and food supply over seasonal to decadal scales. Overall shell growth rates were highest in Atlantic water, intermediate in Arctic water, and lowest at the Polar Front. Temporal patterns of ontogenetically-adjusted growth (SGI) were correlated with regional climatic oscillation modes and local sea ice, with the highest growth associated with colder periods with more sea ice. Stable isotopic values of tissues progressively increased from Arctic to Atlantic waters, with the latter enriched in δ13C by up to 2.1% and δ15N by 1.5%. There were distinct seasonal and water mass variations in stable isotopic and C:N values, indicating both spatial and temporal variability in food supplies to the bivalves in this region. Integrating results of sclerochronological and stable isotopic analyses results provides additional insights on differences in food sources and pelagic-benthic coupling between water masses of the Barents Sea on small spatial scales. (Abstract ID 11058)

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URBAN SOURCES AND REMOTE SINKS OF MARINE DEBRIS ON HAWAII ISLAND

Beach clean-up efforts by the Hawaii Wildlife Fund remove an average of 16 metric tons of plastic debris from the remote southeastern coastline of Hawaii Island annually since 2003. This coastline includes the infamous “Funk Beach” on Kamilo Point. Although much of the debris is fishing-based (such as nets), or of foreign origin (identified via foreign-language markings), some debris may have local sources. To identify the potential for locally-sourced debris, we installed floating boxes below storm water outfalls in Hilo, the island’s largest city, population ~40,000. The boxes trap floating litter washed down flood-control channels before it reaches the ocean. We quantified the amount and type of debris that was collected behind the boxes, and related the timing of debris movement to precipitation events. Releases of floating drifters offshore of Hilo and other population centers on the island mimicked the fate of Hawaii-sourced debris. Retention-boom monitoring and drifter recoveries are ongoing, but show how the build-up of debris at remote locations on Pacific islands is both an international and local problem. (Abstract ID 11543)

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AN OMP-BASED APPROACH FOR DECONVOLVING SIMULTANEOUS TRENDS IN PROCESSES CONTROLLING SUBANTARCTIC MODE WATER PROPERTY DISTRIBUTIONS FROM HYDROGRAPHIC SECTIONS

Inferring long term trends in the processes that control mode water properties from pairs of hydrographic sections is complicated by shorter term variability resulting from frontal movements and transient eddies. Additionally, examining changes in the relationships between physical and biogeochemical properties (e.g. eMLR) in Subantarctic Mode Water (SAMW) is complicated by the influence of long term warming and freshening trends upon the physical properties themselves. Here we present an OMP-based inverse model that estimates changes in the relative influence of processes from differences in measurements of physical properties, nutrient concentrations, and carbonate system parameters, and that allows for the influences of vertical displacements of water masses. Application of this model to SAMW suggests long term warming and freshening trends in the intermediate and mode water masses forming in the Southeastern Pacific that are consistent with other published estimates obtained using data with higher temporal coverage. (Abstract ID 12297)

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IMPACT OF OCEAN ACIDIFICATION ON ENERGETICS AND DEVELOPMENT OF PORCELAIN CRAB EARLY LIFE STAGES

Oceans are acidifying due to absorbing increased atmospheric CO2. Few studies assess impacts on coastal organisms and their early life stages. Porcelain crabs are common intertidal inhabitants with a complex life cycle. Little is known about the physiological mechanisms allowing larvae to transition from a stable CO2 environment (pelagic) to a habitat with CO2 fluctuations (intertidal). Are stages differentially affected by CO2? If so, which are most vulnerable? Embryos, larvae and juvenile 	extit{Porcellio petrobiolaris} were reared in ambient pH (8.0) and low pH (7.6). Metabolic rate, total protein, dry weight, lipid content and survival were determined at each stage. Results suggest significant maternal effects, however embryonic metabolism was 5% lower in individuals reared in low pH, while larval and juveniles displayed a trend of increased metabolic rate compared to control (7% and 39% higher, respectively). Alternatively, no differences were observed in larval dry weight or survival of larvae and juveniles. Certain stages may compensate for high CO2, however tolerance differs between clutches. Understanding responses to OA at different stages may indicate physiological mechanisms allowing organisms to persist in an acidifying ocean. (Abstract ID 12624)

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UNCERTAINTY IN DETECTION OF HISTORICAL OCEAN CLIMATE VARIABILITY

This presentation explores the usefulness of past oceanic and atmospheric observing systems in detecting extreme tropical climate events through a set of observing system simulation experiments. In these experiments an initial simulation of the evolving ocean state during 1995-1998 is sub-sampled using the same distribution of surface and subsurface observations as exists in successive decades. The result is a set of synthetic ocean observation re-samples of the massive primarily tropical/subtropical climate anomalies of the 1995-1998 years. These synthetic observation re-samples are then assimilated into a general circulation ocean model using a conventional assimilation scheme. The results indicate that prior to the 1940s the historical observing network alone was only able to resolve limited aspects of ENSO. In contrast, by the 1960s the observing system was sufficient to resolve ENSO without additional wind information. When historical surface forcing is also included (with its estimated uncertainty) tropical ocean climate variability is reproducible even back to the early years of the 20th century. (Abstract ID 11575)
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DUAL USE OF A SEDIMENT MIXING TANK FOR CALIBRATING ACOUSTIC BACKSCATTER AND DIRECT DOPPLER MEASUREMENT OF SETTLING VELOCITY

While the Acoustic Doppler Velocimeter (ADV) is designed to determine fluid velocity, it is important to recognize that it is actually the velocity of the scatterers themselves that is measured. Thus in a calibration tank designed to relate sediment-induced backscatter to sediment concentration, the vertical velocity registered by an ADV at a given point is actually the true fluid velocity plus the sediment’s settling velocity. And absent net vertical volume flux, the average vertical velocity registered by an ADV across a horizontal plane is equal to the mean sediment settling velocity. For this study, a series of ADV calibrations were run in a 118 liter re-circulating tank for six sand sizes between 63 and 150 microns. A grid of ADV measurements distributed in a horizontal plane across the tank revealed that the mean vertical velocity registered by the ADV in each case was indeed consistent with each grain size’s settling velocity as independently measured by a “rapid sand analyze” settling tube. In addition, a systematic increase in backscatter intensity for a given sand concentration was observed with increasing grain size. (Abstract ID 12707)

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TRACKING THE EVOLUTION OF SUPER TYPHOON MEGI WITH SAR

Super Typhoon Megi developed on October 13, 2010 in the Western Pacific, crossed the Philippines on October 18 and made landfall in China on October 23. As part of the ONR sponsored Impacts of Typhoons on the Ocean in the Pacific program, twelve SAR images of Megi were acquired between October 14, 2010 in the Pacific and October 21, 2010 as the typhoon approached China. Six different satellites with X- and C-band radars were used to provide daily coverage and monitor the evolution of the typhoon. The 20 m to 150 m resolution imagery provides a unique ability to capture the small scale changes of the eye of the typhoon. Imagery shows a concentric eye wall structure develop on the approach to the Philippines. After the storm crossed the Philippines and entered the South China Sea, the eye became disfigured and disorganized. The SAR imagery shows the reorganization of the typhoon in the South China Sea as Migi intensified prior to making landfall in China. Comparisons with in situ measurements and model results will also be presented. (Abstract ID 12001)

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PRESENCE AND FATE OF SR-90 IN SEAWATER OFF JAPAN AS A CONSEQUENCE OF THE FUKUSHIMA DAI-I-CHI NUCLEAR ACCIDENT

As a consequence of the Fukushima Dai-ichi nuclear accident, significant amounts of artificial radionuclides were released to the environment. The aim of this work, as part of a major collaborative effort, was to evaluate the presence and fate of 90Sr released to the marine system. Strontium-90 is a fission product originated in nuclear reactors that is present in the environment. A total of 58 samples from the surface waters and vertical profiles were collected and analyzed for 90Sr through the measurement of its decay product 90Y via radiochemical purification and beta counting. Preliminary results showed 90Sr concentrations enhanced by at least one order of magnitude at some stations. (Abstract ID 11054)

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USE OF NITRATE AND NITRITE ISOTOPE TO STUDY NITROGEN CYCLING IN OCEANIC OXYGEN DEFICIENT ZONES

Oxygen deficient zones (ODZs) in the eastern tropical Pacific Ocean are important for marine nitrogen cycling and loss of fixed (bioavailable) nitrogen (N). Understanding the transformations of N in these regions requires a combination of approaches, including assessments of microbial distributions, activities, and stable isotope ratio measurements, which integrate over space and time. The measurement of nitrate and nitrite N and O isotopes provides insight into the coupled transformations of N in and around the ODZ. Here we present coupled nitrate and nitrite isotope data from the eastern tropical south Pacific Ocean from cruises in 2005 and 2010, which extended from coastal upwelling off of Peru into the subtropical south Pacific. They show increases in nitrate 815N and 818O values, and a corresponding increase in nitrite 815N, as nitrate concentrations decrease along isopycnal surfaces cutting through the ODZ. Above the ODZ, nitrate 815N values decrease again to values as low as -20‰. These patterns are indicative of recycling of N between nitrate and nitrite pools in and around the ODZ, as well as N2 production and loss from the system. (Abstract ID 9910)

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THE AVHRR PATHFINDER SEA SURFACE TEMPERATURE CLIMATE DATA RECORD

Recently, the National Oceanographic Data Center (NODC) and the University of Miami released the latest version of the AVHRR Pathfinder Sea Surface Temperature (SST) climate data record (CDR) as part of the NOAA CDR program. This new Pathfinder Version 5.2 (PFV5.2) data set spans 1981-2010 and represents a significant step forward in the maturity of the SST CDR. Compliant with the Group for High Resolution SST (GHRSST) Data Specification version 2.0 (GDS2), produced using the freely-available SeaDAS software environment, and accepted as the first ocean CDR by the NOAA CDR Program, the PFV5.2 data are more complete, understandable, and accessible than any previous version. Full documentation, software, and ancillary data are available to ensure reproducibility of the CDR. Evaluations of the new PFV5.2 data set will be presented, highlighting strengths and the new capabilities now possible through its GDS2 compliance. These new capabilities include being able to examine sea ice fraction, aerosol loading, and wind speed information on the same time-space grid. The evaluations will also highlight shortcomings that are being addressed in the future Pathfinder Version 6. This 6th generation of Pathfinder is currently under development and its progress in reducing seasonal and latitudinal varying biases present in PFV5.2 will be reviewed along with descriptions of the techniques to be used in generating the GHRSST-mandated uncertainty estimates for each SST observation. (Abstract ID 4621)

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FEEDING ECOLOGY AND METABOLISM OF EUCALANUS INERMINIS IN THE EASTERN TROPICAL PACIFIC OCEAN: IMPLICATIONS FOR VERTICAL CARBON TRANSPORT

The eastern tropical Pacific Ocean contains one of the most severe oxygen minimum zones (OMZs). *Eucalanus inermis* is an abundant copepod species in this region, and shows a bimodal vertical distribution with major abundance peaks in the upper OMZ and near the chlorophyll maximum. Our study examined feeding preferences and metabolic rates of individuals residing at the two depths. Lipid analyses of copepods and potential food suggested that *E. inermis* adult females fed primarily near the chlorophyll maximum. Results from metabolic experiments indicated that shallow-dwelling *E. inermis* utilized primarily proteins for catabolism, while individuals collected from depth learned more towards lipid catabolism. Additionally, OMZ conditions of lower temperature and oxygen led to increased percentages of nitrogen excretion in the form of urea. This presents a scenario in which *E. inermis* provides net carbon transport from the shallow depths to the upper OMZ, although the amount and type of carbon which is remineralized at each depth via metabolism is likely different between the two groups. (Abstract ID 10839)

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SWASH-CUSP INTERACTIONS ON A REFLECTIVE BEACH

Steep beaches commonly adopt a cuspate form, the result of swash-topography interactions associated with the feedback between cusps and swash. These interactions, in turn, affect local swash-swash interactions in a longshore variable way. The final result is a time-varying cusp response that includes growth, decay and varying length scales, none of which is currently predictable. The goal of the present workshop is to understand these swash interactions and their interplay over a well-developed cuspathe beach. In June, 2010, five Argus cameras were installed at Massaguacu Beach, Brazil. This foreshore is steep, commonly cuspy and highly variable over short time scales. To approximate topography at any time, a generic cusp terrain model was used to simulate the evolution of the swash zone. This foreshore is steep, commonly cuspy and highly variable over short time scales. To approximate topography at any time, a generic cusp terrain model was used to simulate the evolution of the swash zone. This foreshore is steep, commonly cuspy and highly variable over short time scales. To approximate topography at any time, a generic cusp terrain model was used to simulate the evolution of the swash zone. This foreshore is steep, commonly cuspy and highly variable over short time scales. To approximate topography at any time, a generic cusp terrain model was used to simulate the evolution of the swash zone. This foreshore is steep, commonly cuspy and highly variable over short time scales.
Variability in wind stress curl and sea surface temperature (SST) fronts near Cape Frio (42°W, 22°S) is tightly coupled. Multi-year SST observations obtained from the Group for High Resolution Sea Surface Temperature (GHRSSST) and winds from QuikSCAT are combined with numerical modeling simulations to quantify how much of the temperature variability is driven by the wind stress curl, and how much of the wind stress curl variability is driven by SST fronts via air sea interactions. Analyses show that both the temporal and the spatial variability in wind stress curl are highly correlated with variability in SST gradients, suggesting that a significant fraction of the wind stress curl variability is associated with air sea interactions. Once in wind stress curl are highly correlated with variability in SST gradients, suggesting that a significant fraction of the wind stress curl variability is associated with air sea interactions. Once in wind stress curl are highly correlated with variability in SST gradients, suggesting that a significant fraction of the wind stress curl variability is associated with air sea interactions.
The formation, destruction, and transport of SAMW are examined using a eddy-permitting ocean circulation model constrained to a large observational dataset - the Southern Ocean State Estimate. Both a freshwater flux (net precipitation causing freshening) and an air-sea heat flux (which can be of either sign) significantly contribute to buoyancy fluxes in the SAMW density range complicating estimates of formation rates. Transformation occurs both at the surface due to air-sea buoyancy fluxes, and in the interior due to mixing; the relative roles of these two processes varies across different ocean sectors. For the years 2005 and 2006, SAMW (26.7°C, sigma theta = 27.0) was predominantly formed in the Indian Ocean both by the air-sea buoyancy fluxes and by interior mixing. In the Atlantic sector of the Southern Ocean the same mechanism was used to destroy interior mixing, while it was transported southward in the Pacific. The formation of SAMW in the Southern Ocean surface formation of SAMW was insignificant and SAMW was destroyed by interior mixing. SAMW is transported northward in all three ocean sectors. (Abstract ID 10863)

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As part of a coordinated observational and modeling program sponsored by ONR to study submesoscale lateral mixing, multiple releases of fluorescein dye were injected at 35 m depth during June 2011 and tracked using a towed Moving Vessel Profiler system. Two different sites in the Sargasso Sea were selected for these dye releases: a region with low horizontal strain near the center of a cyclonic eddy; and near a density front with strong velocity gradients. In order to observe the evolution of the dye as accurately as possible, considerable effort was focused on determining the response function of the temperature, conductivity and fluorescence sensors. We investigate the diapycnal diffusion of the fluorescein patch in the two study sites by examining the dye distribution in density space. The characteristics of the diffusion in both the high and low shear/strain regions are discussed. (Abstract ID 11627)

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RELATIONSHIPS BETWEEN THE PARTICULATE ORGANIC CARBON, PLANKTON COMPOSITION AND OPTICAL PROPERTIES DURING NORTH ATLANTIC BLOOM 2008

The co-variability of optical scattering and particulate organic carbon (POC) provides a basis for estimating POC from ocean color satellite and in-situ measurements by autonomous platforms on larger spatial and temporal scales that surpass traditional (and limited) discrete water sampling and chemical analysis. These proxies when applied globally, however, overlook the inherent dependence of POC-optical relationship on plankton community and particulate composition. During the North Atlantic Bloom experiment of 2008 (NAB08), we accrued a large dataset consisting of >300 POC samples and simultaneous chlorophyll fluorescence (ChlF), particulate attenuation (c_p) and particulate backscattering (b_p). An optical ‘community index’ (ChlF/c_p) differed between plankton community types, reflecting changes in community composition and phytoplankton physiological status. A shift in surface plankton community composition was reflected in POC/c_p, but not in POC/b_p. Both POC/ c_p and c_p decreased with depth as a function of changing particle composition and organic content. Results of a detailed analysis of previously published POC optical proxies indicate that knowledge of both community and particulate composition is needed for successful application of carbon proxies in the ocean. (Abstract ID 11214)

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NORTH ATLANTIC BLOOM 2008 WEBINAR SERIES

The 2008 North Atlantic Bloom Experiment (NAB08) was a collaborative effort to observe an entire phytoplankton spring bloom and included the use of heavily-instrumented autonomous platforms that sampled biogeochemical parameters relevant to aspects of the bloom. To broadly disseminate results and contribute to the public’s understanding of ocean science, NAB08 participants collaborated with the Center for Ocean Sciences Education Excellence (COSEE) - Ocean Systems to present a series of five webinars describing the motivations and findings of this multidisciplinary experiment. Weekly webinars targeted a wide community of educators, scientists, and students and used interactive concept maps enriched with educational assets to deconstruct and present complex ocean science content. The series allowed geographically separated NAB08 scientists to reach participants from 21 different U.S. states and several countries. Guided-inquiry datasets, utilizing NAB08 data, were developed, presented and made available to download at each webinar. Post-webinar evaluation showed that 31% of the audience was comprised of researchers and 51% of educators. A high audience retention rate demonstrated the effectiveness of a coordinated series of webinars on a complex scientific endeavor. (Abstract ID 9966)

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CONNECTING OCEAN SCIENTISTS WITH FUTURE EDUCATORS - COSEE FLORIDAS RESEARCH EXPERIENCE FOR PRE-SERVICE TEACHERS

To bring real world ocean science into the classroom, COSEE Florida’s Research Experience for Pre-Service Teachers (REPT) program provides an opportunity for future science teachers to work with marine scientists on research projects. In 2011, six middle school education majors at Indian River State College in Fort Pierce, FL, participated in a seven week summer experience. Scientist teams at Harbor Branch Oceanographic Institute, Smithsonian Marine Station, and Ocean Research & Conservation Association each mentored two students for 20 hours of research per week with 5 hours of support from IBSC faculty. Mentors helped students develop a scientific poster describing their research and guided them in the production of a video vignette addressing a misconception about the nature of science. The program provided future teachers with an authentic and deeper understanding of scientific practices and gave ocean scientists a meaningful opportunity to contribute to ocean science education. In future years, COSEE Florida will focus on enhancing mentoring skills and work to adapt the model for use by scientists in other academic or research settings as a broader impacts activity. (Abstract ID 11538)

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THE DISTRIBUTION OF MANGANESE IN THE SOUTHWESTERN EAST/JAPAN SEA

The distribution of total dissolved Mn was determined in the southwestern East/Japan Sea three times on April 2006, May 2007 and August 2007. Water samples were taken at recommended standard water sampling depths. Sampling sites covered water depths from 516 to 2308 m. The concentrations of manganese changed greatly by sites from 2.0 to 1.49 nM in surface waters. The vertical profiles of manganese show high concentrations at the sea surface and rapid decrease to mid-depths (800-1000m). Below 1000m water depths, the manganese concentrations increased rapidly downward the water column at most sites of the study area. The manganese concentrations vary with depth from 0.9-380 nM. The surface high and downward decreasing trend in the manganese concentrations is interpreted such that manganese is desorbed from the atmospherically driven particles at the surface waters and then scavenged by particles on the way to deposition to the seafloor. The downward increasing manganese concentrations below 1000m water depths, which is occurring over the whole study area, indicate that there may be significant benthic fluxes of dissolved manganese from sediment. The findings suggest benthic fluxes together with atmospheric input of manganese may contribute greatly to the mass balance of manganese in the East/Japan Sea. (Abstract ID 10594)
The Northern Gulf of Mexico (NGOM) is a complex but poorly quantified coastal ocean margin, and its contribution to the North American carbon budget is not well known. The strength of the biological carbon pump and, specifically, the balance between autotrophic (photosynthesis) and heterotrophic (respiration) processes are important in influencing carbon dynamics in the NGOM. A key to understanding variations in the strength of the biological pump is information about phytoplankton community structure and light absorbing properties. The coastal margins of NGOM were extensively sampled as a part of the GulfCarbon program and associated projects funded through NSF, NASA and NOAA, with the goal of characterizing the taxonomic composition, size indices, biomass and associated bio-optical properties of the phytoplankton community. Results showed distinct spatial and temporal patterns in the observed variables. Key environmental drivers appear to be seasonal variations in freshwater discharge and nutrient dynamics. Results also suggested the importance of vertical mixing, wind and current dynamics within the region. These findings should help to refine regional carbon fluxes and thus modeling efforts in estimating the North American carbon budget. (Abstract ID 10749)

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PHYTOPLANKTON COMMUNITY DISTRIBUTION AND LIGHT ABSORPTION PROPERTIES IN THE NORTHERN GULF OF MEXICO

Regions of permanent water column suboxia or anoxia are well-recognized centers of fixed nitrogen loss. Along the California Current, coastal upwelling drives the seasonal formation of hypoxia over the continental shelf but only occasionally are suboxic/anoxic conditions observed. Using data spanning a decade of observations from the Oregon coast, we find evidence of substantial fixed N-loss (from N\textsubscript{2}) that vary in concert with temporal changes in water column oxygen. Constraints based on DICR, AOU, stoichiometries and N2Ar suggest that N\textsubscript{2} anomalies serve as a coherent proxy for N-loss in the system. Observations of strong negative N\textsubscript{2} anomalies despite the absence of water column suboxia point to a dominant role for sedimentary N-loss. Slope–shelf contrasts further indicate that N-losses are not due to advection but are generated locally over the mid-shelf. We further evaluate observed N-loss in relation to modeled sedimentary N-loss under expected and enhanced sensitivity to water advection but are generated locally over the mid-shelf. We further evaluate observed N-loss for sedimentary N-loss. Slope–shelf contrasts further indicate that N-losses are not due to negative N\textsubscript{*} anomalies despite the absence of water column suboxia point to a dominant role that N\textsubscript{*} anomalies serve as a coherent proxy for N-loss in the system. Observations of strong evidence of substantial fixed N-loss (from N\textsubscript{*}) that vary in concert with temporal changes in water column oxygen. Our results support the idea that the enhancement of water column hypoxia can greatly accentuate the magnitude of sedimentary N-losses from productive, carbon-rich upwelling shelves. (Abstract ID 11722)

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EFFECTS OF OCEAN ACIDIFICATION ON PHYSIOLOGICAL AND SWIMMING PERFORMANCE OF LARVAL ECHINOIDS

Planktonic larvae of many marine invertebrates, particularly those in extratropical and upwelling areas, often experience pH fluctuations and therefore may be pre-adapted to ocean acidification (OA). Previous OA studies have focused on larval mortality, with less emphasis on sublethal effects. Observed sublethal effects could nonetheless have significant population-level impacts by affecting larval dispersal and survival. We compared OA sensitivity in four different echinoids ([A]mphiura \textit{filarina}[s], \textit{B}rissopsis \textit{hydria}, \textit{D}endraster excentric\textit{us}, \textit{S}trongylocentrotus \textit{purpuratus}) differing in habitats and/or ambient pH during their spawning season. We monitored OA impacts on physiologies (growth, feeding and respiration) and quantified swimming behaviors using non-invasive video tracking. Because environmental variables (prey and predator abundance, advective currents) usually vary with depth, vertical swimming strongly affects larval dispersal and survival. Our results suggest that OA delayed larval growth across species, but that OA-induced morphological and behavioral changes varied between species. For at least one echinoid, \textit{D. excentric\textit{us}}, OA-induced morphological changes appeared to impact feeding but not swimming, implying a functional trade-off. Species-specific abilities to cope with future ocean conditions. (Abstract ID 12562)

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SCIENTIFIC PROCESS IN PRACTICE, AN ACTIVITY BASED SEMINAR FOR BEGINNING OCEANOGRAPHY MAJORS

"Scientific process in practice" was a 2 hour long, weekly, activity based seminar designed to explicitly teach scientific process skills. This seminar complemented an existing, mandatory field course for entering oceanography majors. The goal of the seminar was to help students succeed in the field course and future science courses by 1) developing information literacy skills; 2) practicing articulation of testable hypotheses; and 3) studying the form of scientific presentation. We assessed the effectiveness of the seminar qualitatively and quantitatively. Over 90% of the students' stated in their course evaluations that class sessions were always interesting and engaging. Examples of activities included citation format detective, figure critique speed dating, and statistics learning carousel. Pre- and post-course surveys showed that the seminar improved students self-efficacy towards conducting scientific research. Relative to students enrolled in the field course alone, students in the complementary seminar showed greater gains in the Student Understanding of Scientific Inquiry Survey. Our results suggest that an explicit, inquiry-based courses focusing on transferrable skills can help improve students' learning experience and understanding of science. (Abstract ID 12572)

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PROJECTED MIXED LAYER DEPTH CHANGE IN THE NORTH PACIFIC OCEAN AND ITS IMPACT ON PRIMARY PRODUCTION

This study examines changes in the mixed layer depth (MLD) in the North Pacific Ocean (NP) in response to global warming and their impacts on primary production by comparing outputs from eleven models of the coupled model intercomparison projects phase 3 (CMIP3). We find consistent MLD changes in future in the NP from most of the eleven CMIP3 models: a shoaling in the KE region and a deepening north of the Kuroshio front. The shoaling is attributable to the weakening in the windstress and the associated decrease in the ocean cooling in the KE, whereas the deepening is mainly driven by the northeasterly wind in the KE. In the 21st century, the entrainment production, estimated by MLD changes, in the KE will decrease by 107–403% and spring blooms will occur 0–13 earlier in response to the changes in MLD in the KE region. Despite the consistent changes, the magnitude of changes in primary production and the timing of the spring blooms are quite different depending on models and latitudes. (Abstract ID 10202)
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MICROZOOPLANKTON GRAZING IMPACT IN THE EAST CHINA SEA
The size dependent phytoplankton growth and mortality rate, according to Metabolic Theory in Ecology, together shape its size structure, which would critically regulate the nutrient and energy transfer efficiency. This study aims to identify the detailed size specific growth and mortality of microphytoplankton, on which studies are scarce. We first hypothesize that the size-specific growth rate and mortality scales with the body size with an exponent of -1/4 after temperature correction in natural microphytoplankton assemblage. We simultaneously measure the high resolution size specific growth and mortality rate of microzooplankton by incorporating the FlowCAM into dilution technique, which were conducted in the East China Sea from 2010 to 2011. Our results first illustrate that, under log scale, the mass-specific growth rates positively scales with body mass, while the mortality rates show insignificant relationship with body size. We further suggest that grazing impact also exhibit non-significant regression with body size. The well coupled size-specific growth and mortality rates, on the other hand, implies that the microzooplankton community would selectively feed on those fast growers. This detailed information would shine light on the dynamic of microphytoplankton size structure. Keywords: Dilution experiment, Microzooplankton grazing, East China Sea, Size specific growth rate, Size specific mortality rate (Abstract ID 9595)

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KUROSHIO-INDUCED WAVE IN THE LEE OF GREEN ISLAND
The Kuroshio's pathway runs parallel to Taiwan's eastern coastline with a width of ~100 km and a current speed of 1-1.5 m/s-1. The wave induced by current-island interaction could significantly change the current's flow patterns and properties. In this study, vertical profiles of shipboard Lowered-ADCP and CTD reveal large differences in flow characteristics upstream and leeward of Green Island, located southeast of Taiwan in the main Kuroshio axis. Two stages of wave evolution were observed respectively from two separated legs of shipboard measurement. In the first stage, a trapped eddy emerges to the leeward side of island, followed by a tail with Vortex Street-like structure. In the second stage, the trapped eddy sheds from the leeward side to ~6 km downstream north of the island and a rudimentary eddy appears at the island's leeward side. The wave water is colder, saltier, and has a higher chlorophyll a, and produces ~50 % more diatoms compared to the open ocean, suggesting that the vertical shear drives the turbulent mixing and thus produce the cold and salty dome in the wake. (Abstract ID 10104)

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WHY DOES THE LOOP CURRENT HAVE SEASONAL PREFERENCES FOR SHEDDING EDDIES?
The Loop Current is the major source of the Gulf Stream; it carries waters that make up almost all of the upper limb of the meridional overturning circulation of the tropical and subtropical North Atlantic Ocean, and thus can have significant impact on the global climate. In particular, the heat and salt) that the Loop Current carries play an important role in regulating the weather and climate of the continental US. The Loop Current is well-known for its highly nonlinear and apparently erratic behavior of shedding warm eddies, yet since the early 60's some oceanographers suspected some seasonal preferences for eddy-shedding. I will explain why this must be so using observational data as well as analytical and numerical model analyses. (Abstract ID 9629)

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OCEANIC THERMAL VARIATIONS UNDER TYPHOOON LUPEIT (2009)
Three surface buoys equipped with surface meteorological sensors and subsurface temperature sensors were deployed in the northwestern Pacific. Typhoon Lupit (2009), a category-5 typhoon in Saffir-Simpson hurricane scale, passed over one buoy with its eye and another buoy with its eye wall when it weakened from category 3 to 2. All buoys worked well except with a few instrument failures after Lupit passage. Highest wind speed of 60 m/s and lowest
air pressure of 941 mb were recorded under the eye. Sea surface temperature (SST) dropped by 3.5 °C under the eye and 4.5 °C under the eye wall. Meanwhile, temperature in the upper thermocline increased first before decreasing, indicating the domination of vertical mixing in the forced stage. Upper ocean heat content in the top 100 m showed post-tropical near-inertial oscillation for 5 days and did not bounce back thereafter. In addition to the seasonal cooling, satellite-observed sea surface height anomaly suggested that a cold eddy was also responsible for the long-lasting cooling. (Abstract ID 10831)

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AN ASSESSMENT OF OCEANIC VARIABILITY FOR 1960-2010 FROM THE GFDL ENSEMBLE COUPLED DATA ASSIMILATION

The Geophysical Fluid Dynamics Laboratory (GFDL) has developed an Ensemble Coupled Data Assimilation (ECDA) system based on the fully coupled climate model, CM2.1, in order to obtain accurate oceanic initial conditions that are balanced with the climate prediction model. This study provides a comprehensive evaluation for the oceanic variability from the latest version of the ECDA analyzed for 51 years, 1960-2010. Meridional oceanic heat transport, net ocean surface heat flux, wind stress, sea surface height, top 300m heat content (HC300), tropical temperature, salinity and currents are compared with various in situ observations and reanalyses. Results show that the ECDA agrees well with observations in both climatology and variability for 51 years. While systematic model errors are mostly corrected with the coupled data assimilation, some model biases have not been completed eliminated. In terms of the climate variability, the ECDA provides good simulations of the dominant oceanic signals associated with ENSO, IOD, PDO, and AMOC during the whole analyzed period, 1960-2010. (Abstract ID 10675)

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DYNAMICS OF LATERAL CIRCULATION IN A COASTAL PLAIN ESTUARY.

A dense 10-element mooring array was deployed in the James River Estuary to quantify the structure of lateral, along-channel and vertical flows in order to quantify the role of lateral advection in rectifying estuarine exchange flow. During the deployment, stratification varied by a factor of 5 over the spring/neap cycle, with near-tides characterized by enhanced exchange flow and modestly reduced lateral flows. Lateral flows were highly coherent across the array with their structure, magnitude and dynamical balance consistent with the superposition of Ekman processes and differential advection. Lateral flows tended to be stronger than a simple Ekman scaling on flood tide and slightly weaker on ebb. The mooring array was sufficiently dense to infer tidal period vertical motion that, together with the lateral circulation, revealed laterally asymmetric closed secondary circulation cells with peak vertical velocities of 0.5 mm/s. These 3-D velocity fields will be used to estimate advective accelerations and determine their influence on tidal and subtidal dynamics. In addition, results will be placed in context with estimates of mixing determined from concurrent dye experiments and microstructure data. (Abstract ID 12049)

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BLENDING SEA SURFACE SALINITY DATA FROM IN SITU PLATFORMS AND MULTIPLE SATELLITES

On the weekly basis, there are several thousands sea surface salinity (SSS) measurements from in situ platforms (e.g., satellite drifting buoys, moorings, ships, and profiling floats). Today, there are two remote sensing satellites (SMOS, Aquarius/SAC-D) that measure the ocean brightness temperature that can be used to retrieve SSS. To blend these SSS data with apparently different spatial and temporal resolutions as well as error statistics, we are proposing a two-dimensional variational (MS-2DVAR) blending algorithm, which is successfully used to blend the sea surface temperature (SST) data from in situ platforms and multiple satellites (http://sst.jpl.nasa.gov). The 2DVAR method considers inhomogeneous and anisotropic background error covariance specifically developed to emphasize regional characteristics in SST and SSS. We will present the results of using the 2DVAR to blend SSS data from in situ platforms and multiple satellites. (Abstract ID 10828)

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RAPID VARIABILITY OF OCEANIC JETS DRIVEN BY EDDY-TOPOGRAPHY INTERACTION

Recent observations of the Southern Ocean from fixed moorings and satellite altimetry have revealed that the jets (or "fronts") that make up the Antarctic Circumpolar Current show peculiar variability in the vicinity of large, sub-surface topographic features. Two (or more) jets that pass near the same topographic feature display anti-correlated behaviour, where one jet will increase in strength at the expense of others. This variability can manifest itself in dramatic ways, with a particular jet changing its "preference" for a topographic feature. For example, a jet that previously skirted a plateau to the north, can very rapidly shift to skirt the plateau to the south. Shifts in the latitudinal position of jets of more than 10 degrees have been observed. We will present a theory explaining the variability of surface currents, built on the results of an idealised numerical model. We posit that it is the interaction of turbulent eddies and topographically driven flow in the abyssal layers that explains the observed variation in surface mean currents. The feedback of mean flow onto the eddies will also be discussed. (Abstract ID 10650)

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A NEAR FUNDAMENTAL DEcadal DATA RECORD OF AIRs infrared BRIGHTNESS TEMPERATUREs

Aqua provides a direct measurement of the surface infrared radiation for nine years from a single satellite platform with two completely independent instruments (AIRS and MODIS). We produced a 0.5x1.0 deg, lat-lon daily gridded potential fundamental decadal data record (FDDR) of AIRS surface brightness temperatures (BT) in the 4u and 12u windows. We show on a decadal time scale correlations of surface BT with GISS global surface temperatures are 0.79 and 0.85, respectively. The FDDR global annual surface BT warming trend is 0.15°C per decade in the 3.8u. The warming trend is 0.17°C and 0.03°C per decade, respectively in the Polar Regions. The southern Polar Region trend is twice the northern trend. By convolving AIRS with the MODIS SRF, a seasonal comparison with MODIS shows a difference of 0.05°C. We are also verifying the instruments have not degraded by comparing AIRS convolved and MODIS for the same day in September for each of 10 years. We conjecture that direct satellite level IR radiance sounding observations will yield the first FDDR. (Abstract ID 10607)

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THE IMPACT OF AN INVASIVE BIVALVE ON TWO SYSTEMS WITH DIFFERENT NUTRIMENT CONCENTRATIONS

Invasive bivalve species have proved to be problematic worldwide as they cause changes in both benthic and pelagic zones, linking these two normally distinct areas. One such bivalve is Corbicula fluminea, a clam species that has spread internationally due to humans. Mesocosm studies were conducted to determine the impact of C. fluminea on the phytoplankton community and nutrient concentration. Two different lake systems were replicated: one mesotrophic, one eutrophic. Four treatments were used in order to determine whether the impact of C. fluminea varies with sediment presence or absence. The initial nutrient level does not seem to influence the impacts of C. fluminea as similar fluctuations in phytoplankton biomass and nutrient concentrations were observed in both experiments. Nutrient concentrations, specifically nitrate and phosphate, were affected more by the presence of sediment than the presence of C. fluminea. The clams seem to prevent pennate diatoms from dominating the phytoplankton community. This study depicts the impact an invasive bivalve introduced through anthropogenic activities can have on differing environments. (Abstract ID 12191)

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MONITORING IN SITU Tidal SCALE AND SURFACE AQUFER RECHARGE AND DISCHARGE ON WALLOPS ISLAND, VIRGINIA

Wallops Island, a barrier island on Virginia's eastern shore, is home to NASA's Wallops Flight Facility. The island often experiences major erosion, flooding, and overwash in times of elevated sea-level, however little is known about local tide and wave height conditions along the shoreline. We collected baseline tidal and aquifer data between April -October 2011 using SOLINST dataloggers. In-situ tidal range and tide cycle data allows us to investigate the impact
of tides on aquifer discharge and recharge rates. There is an observable signal in the aquifer that correlates to daily tide data from nearby Curtis Merritt Harbor. These data also show that the surface aquifer recharges approximately 45 minutes after rainfall events. Beginning in November 2011, NASA plans to replenish the beach in order to minimize damage to existing infrastructure. In order to support NASAs effort to develop a shoreline management plan, we will continue data collection through 2012 and compare conditions pre and post-replenishment to determine what impacts, if any, beach replenishment has on the natural barrier island system. (Abstract ID 11742)

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NITROGEN-LOSS PATHWAYS IN THE SAN PEDRO AND SANTA MONICA BASINS DETECTED FROM N2/AR RATIOS AND NITRATE ISOTOPES

Nitrogen cycling dynamics were investigated in the Santa Monica (SMB) and nearby San Pedro Basin (SPB) in 2011. The relationship between the excess N2 (determined from high-precision N2/Ar ratios) and corresponding nitrate deficit was assessed in this system where sedimentary N loss processes are expected to dominate. During summer in the SPB, excess N2 reached a maximum of 28μM of N in the oxygen deficient waters below the sill depth, which agreed well with N loss expected according to the nitrate deficit. In contrast, excess N2 in the SMB during winter 2011 was 18 to 63% greater than that expected from the nitrate deficit. In both basins no enrichment in 15N and 18O-nitrate was observed, which is expected when dissimilatory nitrate reduction occurs in the water column, hence supporting the theory that N loss in this system occurs solely in the sediment. The spatial and temporal variability of excess N2 will be discussed along with potential processes leading to the deviation observed between excess N2 and the nitrate deficit in the SMB and potential implications for the global N budget. (Abstract ID 11729)

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OBTAINING QUALITY AC-S METER SPECTRA: A METHOD FOR TEMPERATURE AND RESIDUAL SCATTERING CORRECTIONS

The ac-spectra (ac-s) in situ spectrophotometer (WET Labs) measures the absorption a(λ) and beam attenuation c(λ) spectra of water samples, either in the laboratory or the field. The high spectral resolution (1 nm) of the instrument allows for precise temperature and scattering corrections to be applied during data processing. Here we present ac-s data collected in the Gulf of Maine as part of the 2011 Ocean Optics Summer Course. We show a technique for deriving accurate water temperature from the residual correction of the a(λ) and c(λ) data, and explore a method for diagnosing errors induced by variable flow-rate of the instrument package. We also examine a method to correct for residual scattering in the a(λ) data and simultaneously separate a(λ) into a(λ) and a(λ) components. All of these steps, displayed here in a schematic diagram, are critical for accurate calibration-independent in-situ corrections of ac-s data. Determining appropriate processing and correction methods for ac-s data is essential for the field of optical oceanography, as hyperspectral measurements are increasingly used to both diagnose in-situ properties and relate them to remotely sensed quantities. (Abstract ID 10093)

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IMPACT OF RESOLUTION ON THE GULF STREAM SEPARATION AND PATHWAY

The accurate representation of western boundary currents’ separation and pathways in eddy-resolving numerical models remains a challenge. The Gulf Stream separation and pathway

are investigated in a series of nested configurations of increasing horizontal resolution (1/12°, 1/29°, 1/50° and 1/100°) using the Hybrid Coordinate Ocean Model (HYCOM). The regional configuration is centered over Cape Hatteras and is nested within a global 1/12° HYCOM simulation. Each sensitivity experiment is integrated for 5 years, starts from the same ocean state, and is forced with the 0.5° NOLAPS atmospheric fields used in the global simulation. In addition to the impact of the horizontal resolution, we will also report on the sensitivity of the solution to a) boundary condition formulation and strength, b) representation of the Deep Western Boundary Current, c) bottom topography, and c) the surface forcing. Energy and vorticity budgets are used to analyze the simulations and quantify the differences. (Abstract ID 11658)

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UNCERTAINTIES IN AIR-SEA BOUNDARY FORCING AND IMPLICATIONS FOR OCEAN MODELING AND STATE ESTIMATION

We investigate the uncertainties related to atmospheric fields from reanalysis products used in forcing ocean models. Reanalysis products from (1) European Centre for Medium Weather Forecasts (ERA-Interim), (2) Common Reference Ocean–Ice Experiments (CORE-2), (3) Japanese Reanalysis Project (JRA-25) and (4) National Centers for Environmental Prediction/ National Center for Atmospheric Research (NCEP/NCAR) are evaluated globally against satellite-derived observations for eight different fields (zonal and meridional wind stress, precipitation, specific humidity, river runoff, surface air temperature, downwelling longwave and shortwave radiation fluxes). No single product is found to agree better in all fields with satellite-derived observations. Time-mean and time-variable errors are estimated separately and mapped globally in space, based on 14-day average fields to focus on interannual periods. Precipitation and wind stress show largest uncertainties amongst all the fields. Furthermore, we use each set of atmospheric fields to force the same MITgcm ocean model setup from 2000-2005. Respective solutions are compared to determine different uncertainties in the ocean state due to uncertainties in atmospheric forcing. The spatial (vertical, horizontal) and temporal extent of ocean state errors are presented. (Abstract ID 11357)

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BIO-OPTICAL PROPERTIES AND IN-WATER CONSTITUENT RELATIONSHIPS IN THE CHUKCHI AND BEAUFORT REGIONS OF THE ARCTIC OCEAN

During the two-year ICESCAPE campaign to the Chukchi and Beaufort regions of the Arctic Ocean we performed coincident, near surface water column measurements of apparent and inherent optical properties, phytoplankton pigments, CDOM and particle absorption, and dissolved and particulate organic carbon, at 34 stations. We analyzed the absorption and scattering components of calculated remote sensing reflectances in the context of the measured dissolved and particle loads, in order to improve our understanding of the uncertainty sources for bio-optical parameters in this high-latitude environment. Relatively higher CDOM and detrital absorption components, as well as sharp near-surface vertical stratification, influence the accurate retrieval of phytoplankton pigments and other biogeochemical constituents with standard remote sensing algorithms. Our results have implications for the calibration and validation of current and future ocean color mission through improved algorithm development. (Abstract ID 12065)

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MARINE PHOTOSYNTHETIC PLANKTON DYNAMICS: WHERE ARE WE AFTER 50 YEARS?

Over the past decades new information from emerging technologies has added to early conceptual models of marine photosynthetic plankton abundance and distribution. The important marine photosynthetic planktonic groups have been revised and what regulates their growth and abundance better defined. Still many questions remain. Why and when do certain groups bloom/dominante? How do they spread and where do they hide? What keeps others...
from proliferating? This type of information is important for a variety of reasons including: 1) determining the health of the oceans; 2) predicting how ocean ecosystems will change in the future; 3) understanding evolution and growth of harmful algal blooms. This presentation first reviews early conceptual models regarding what determines the different life forms of marine photosynthetic plankton. It then highlights the results from interdisciplinary studies and time series studies and how these have changed the early views. We conclude by speculating about the present state-of-the-art and what might be the next steps for the field. (Abstract ID 10419)

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LASER FLUORESCENCE PHYTOPLANKTON ANALYSIS ACROSS A FRONTAL ZONE IN THE CALIFORNIA CURRENT ECOSYSTEM

Spatial variability of chlorophyll, phycoerythrin, chromophoric dissolved organic matter, and variable fluorescence, Fv/Fm, were analyzed using Advanced Laser Fluorometer (ALF) to assess chlorophyll concentration (Chl), autotrophic and Synechococcus carbon biomass (AC and SYN). Three distinct autotrophic assemblages were identified. The fluorescence retrievals were 3-4 times higher in cooler mesotrophic waters north of the front than in warm oligotrophic waters to the south. Northern waters were also distinguished by a subsurface pigment maximum of blue-water type of Synechococcus and by the presence of green-water Synechococcus and cryptophytes. The highest Chl and AC values were found in a 20-40 m diatom-dominated maximum at the front, accompanied by elevated Fv/Fm and minimal SYN. The underway ALF sampling detected an abrupt transition from low to high SYN occurred at the front on the northern side of a sharp salinity gradient. Strong regression relationships were found for chlorophyll fluorescence vs. Chl (R2=0.95) and AC (R2=0.79). Synechococcus-specific phycoerythrin fluorescence (FPE12) and SYN also highly correlated in surface waters (R2=0.95). Increased chlorophyll fluorescence yield in the diatom-dominated front waters and increase in FPE12/SYN with depth were observed. (Abstract ID 11920)

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PHYTOPLANKTON FLUORESCENCE FILLING THE GAP BETWEEN OBSERVATIONS AND UNDERSTANDING

Measuring in vivo fluorescence from phytoplankton photosynthetic pigments provides information about their biomass, physiology, photosynthetic rates, and community structure. Such measurements are sensitive, non-intrusive, rapid, and easy to conduct. However, the interpretation of fluorescence data remains challenging: applying insights gained in the laboratory to measurements taken in natural aquatic environments is difficult, and understanding the sources of variability observed in the field is complex. Nevertheless, from satellites to flow cytometers, from emission-excitation spectra to time-resolved measurements, a broad array of tools and protocols have been developed and utilized to address specific scientific questions. Recent advances in autonomous platform technology and the development of more informative and sophisticated instruments and techniques provide new unique observational and analytical capabilities. Yet, there seems to be a growing gap between our ability to make observations using the available technology and our capacity to interpret these observations for improved characterizations of the natural aquatic environments. This talk provides overviews of various aspects of phytoplankton fluorescence with an emphasis on the interpretation and better understanding of in vivo and in situ field measurements. (Abstract ID 11641)

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INCREASED BIOLOGICAL CO2 UPTAKE FOLLOWING SEA-ICE RETREAT IN THE PACIFIC SECTOR OF THE ARCTIC OCEAN

The retreat of sea-ice into the Arctic Ocean basins in recent summers may have increased ocean biological production and uptake of atmospheric CO2. Reports of high pCO2 and decreased nutrient availability in the southern Canada Basin, however, suggested that marine productivity may have decreased and any enhancement of the Arctic Ocean CO2 sink short-lived. Contributing to this important debate, we report results from summer 2008 and 2010 during the Chinese Arctic Research Expeditions to the western Arctic Ocean basins up to 88°N. Our results revealed that a low pCO2 zone had formed in the rapid sea-ice melting areas (~80°N) but high pCO2, existed in the nearly ice-free southern basins, which were in contrast to the more uniform distribution observed under ice-covered waters in 1994. Evidence also suggested that high biological production and CO2 removal rates had followed the retreat of sea-ice, advancing from ~75°N in the 1990s and early 2000s to ~87°N in recent summers. These findings provide a more complete basis for predicting the Arctic Ocean’s response to future climate change. (Abstract ID 12033)

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MODEL ASSESSMENT OF INUNDATION AT THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT FACILITY AND INITIAL SPREAD OF RADIONUCLIDES IN THE COASTAL OCEAN

A nested global-coastal FVCOM system has been used to investigate coastal inundation along northeast Honshu Island caused by the March 11 2011 earthquake. After successfully reproducing sea level recorded at coastal tidal gauges and measured inundation areas in the region, the model system was used to examine in detail the coastal flooding that led to major damage at the Fukushima Dai-ichi nuclear power plant facility and subsequent release of radionuclides into coastal waters and initial spread across the shelf into deeper water. With 5-m grid resolution around the facility, model results suggest that the breakwaters (designed to protect harbor in front of the facility from offshore waves) tended to guide the tsunami waves around the breakwaters and intensify flooding along the coast just to the north and south of the facility. The retreat of the flood waters appears to cause much of the damage to the facility. Model results show that the initial trajectories, dispersion and settlement of radionuclides released at the facility were influenced over the shelf by tidal flushing, wind driving and meso-scale features. (Abstract ID 10772)

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SEASONAL VARIATION OF ORGANIC CARBON CONSUMPTION BY PLANKTONIC COMMUNITIES IN THE EAST CHINA SEA

Previous studies demonstrate that organic carbon consumption in the East China Sea (ECS) was high in summer, and the rate was significantly related to fluvial discharge from the Changjiang River. There is, however, rare data on this related issue in other seasons. In this study, we tend to evaluate and compare the seasonal variation of organic carbon consumption by planktonic communities (e.g., planktonic community respiration, CR) in the ECS. Results showed that the highest CR rate was found in spring and summer, and it was mainly attributed to higher planktonic biomass. This could be evidenced from the significant relationship observed between CR and particulate organic carbon (p < 0.001). Lower rate of CR was observed in autumn and winter. In addition to planktonic biomass, rate of CR during this period was also dependent on water temperature. Significant multiple linear regression observed between CR versus POC and temperature (p < 0.05) could support this assumption. Overall, our results suggest that planktonic biomass and temperature effect are needed to be considered when estimation of planktonic metabolism in the ECS. (Abstract ID 9810)
The importance of bottom topography in the dynamics of eddies and eddy-driven oceanic jets are examined here, using analytical and numerical techniques. The eddies and jets emerge as a result of baroclinic instability of a quasi-geostrophic zonal flow pertinent to this problem. Idealized topography has a form of a constant slope in the meridional and zonal directions, as well as an isolated meridional ridge. Analytical linear analysis demonstrates that even a small zonal slope can destabilize a flow that would be otherwise stable in the absence of topography. In contrast, the meridional slope can stabilize/destabilize a zonal background flow only through intensifying/weakening the background potential vorticity beyond a known critical value. The unstable modes have a shape of slanted "noodle" modes, whose spatial structure is further discussed in relation to the shape of topography. The nonlinear evolution of these growing modes leads to the formation of intensified oceanic jets. (Abstract ID 9900)

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EDDIES AND JETS

This study describes characteristics of eddy heat and salt transports, in the basin-scale circulation as well as in the embedded mesoscale eddy found in the South China Sea. We first showed the features of turbulent heat and salt transports in mesoscale eddies using sea level anomaly data, in situ hydrographic data, and 375 Argo profiles. We found that the transports were horizontally variable due to asymmetric distributions of temperature and salinity anomalies and that they were vertically correlated with the thermocline and halocline depths in the eddies. An existing barrier layer caused the halocline and eddy salt transport to be relatively shallow. We then analyzed the transports in the basin-scale circulation using an eddy diffusivity method and the sea surface height data, the Argo profiles, and the climatological hydrographic data. We found that relatively large poleward eddy heat transports occurred to the east of Vietnam in summer and to the west of the Luzon Islands in winter, while a large equatorward heat transport was located to the west of the Luzon Strait in winter. The eddy salt transports were mostly similar to the heat transports but in the equatorward direction due to the fact that the mean salinity in the upper layer in the SCS tended to decrease toward the equator. Using a 2-layer reduced-gravity model, we conducted a baroclinic instability study and showed that the baroclinic instability was critical to the seasonal tendency to decrease toward the equator. Using a 2-layer reduced-gravity model, we conducted a baroclinic instability study and showed that the baroclinic instability was critical to the seasonal tendency to decrease toward the equator. (Abstract ID 10464)

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PREY BACTERIAL SPECIES ORDER THE COMMUNITY STRUCTURE OF THEIR PREDATOR, BACTERIOVORAX

The role of predation in altering microbial communities has been studied for decades but few examples are known for bacterial predators. Bacteriovorax halophila, a prokaryote that preys on susceptible Gram-negative bacteria. Here we report the response of native Bacteriovorax to six prey. Water samples collected from Dry Bar, Apalachicola Bay were respectively spiked with indigenous Vibrio spp., Pseudoalteromonas spp., and Photobacterium spp. V. vulnificus and V. parahaemolyticus were included as reference strains. A clinical strain of V. vulnificus was also included to test strain-specific variations. At 24 hour intervals, optical density and abundance of Bacteriovorax were measured over five days. The predominant Bacteriovorax clones were selected and analyzed by 16S rRNA gene amplification and sequencing. The bacterial community parameters in shaping Bacteriovorax communities in aquatic systems. (Abstract ID 10842)

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SOUTHERN HEMISPHERE EXTRA-TROPICAL FORCING ON ENSO - OBSERVATION AND MODEL COMPARISONS

The development of ENSO and its impacts on climate are well-known from the literatures, however, the origins of ENSO indeed remains unknown. Recently, two types of ENSO are further defined; Eastern-Pacific ENSO (EP ENSO) and Central-Pacific ENSO (CP ENSO), respectively. Recent studies indicate that they are driven by different driving mechanisms which require better understanding. Here, we discussed these driving mechanisms and how ENSO is generated resulting from the southern hemisphere extra-tropical influences. It is found that EP ENSO becomes more prominent since 1977 and leads EP ENSO for about 12 months with increasing correlation during the recent decades. Around two to three years before the occurrence of EP ENSO, warm Sea Surface Temperature anomaly (SST)) and negative Sea Level Pressure anomaly (SLP) propagate eastward from the Southern Pacific toward South America through the ocean-atmosphere coupled Antarctic Circumpolar Wave (ACW). In the tropic, the warm SSTa and negative SLPa also propagate eastward through the low-frequency component of Global ENSO Waves (GEW) and enhances the occurrence of EP ENSO. The evolving of ENSO after 1977 could be due to the large pattern changes of ACW and GEW after the 1976/1977 region shift. Further coupled model results show that the ACW indeed affects the occurrence of EP ENSO while there is no direct link with CP ENSO. (Abstract ID 11222)

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NUMERICAL MODELING OF HYDRODYNAMICS AND SEDIMENT TRANSPORT OF NEW RIVER INLET (NC) USING NEARCOM-TVD

A new version of the Nearshore Community Model System (NearCoM-TVD) is utilized in this study to investigate hydrodynamics, sediment transport and morphological evolution of New River Inlet, NC. We focus on how the interaction between waves and strong tidal current near the inlet can change the pattern of wave and current fields and the resulting sediment transport. NearCoM version 4 was the main product in the NOAA Nearshore Community Model initiative in 2002. Since then, several enhancements to NearCoM has been made. The wave model SWAN was integrated with SHOREICIRC and the coupled model is also incorporated with large-scale forcing to expand its applicability to inner shelf and river/inlet (Shi et al. 2011, J. Geophys. Res., 116). Recently, SHOREICIRC is enhanced with a hybrid MUSCLE-TVD scheme and the resulting NearCoM-TVD is parallelized using MPI. To simulate the hydrodynamics of New River Inlet, the model is forced with tidal harmonic constants and offshore wave conditions. With a high grid resolution, the model predicts detailed flow structures and complex interactions between waves, currents, sediment transport and morphological evolution over a time-span of months. (Abstract ID 9741)

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GEOCHEMICAL, SEDIMENTOLOGICAL, AND STRATIGRAPHIC REFLECTIONS OF A LATE CAMBRIAN GLOBAL PALEOCEANOGRAPHIC EVENT

A Late Cambrian global paleoceanographic event has been indicated by a trilobite mass extinction and a worldwide positive excursion in marine carbon isotope records in phase with an excursion in sulfur isotope records. This paleoceanographic event was possibly accompanied with a global change in paleoclimate and eustasy which was partly evinced by sedimentological and stratigraphic study. The present study shows high-resolution geochemical, sedimentological, and stratigraphic evidence of the perturbation in carbon isotope values, faunal assemblages, and relative sea level in the North China Platform—a vast epeiric platform (ca. 1500 km east-west and 1000 km north-south). A well-correlated (ca. 100 km in distance) truncation surface of a strongly deformed limestone bed, missing of a trilobite bionome (Prochuanxia), and an abrupt increase in carbon isotope value collectively indicate a significant hiatus in the succession. Preliminary intra- and interplatform correlations of the sedimentological and stratigraphic feature across this event zone suggest possible global cooling and eustatic fall during the middle to late Cambrian of the greenhouse period. (Abstract ID 9600)

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DATA-ASSIMILATIVE MODELING INVESTIGATION OF GULF STREAM WARM-CORE RING INTERACTION WITH CONTINENTAL SHELF AND SLOPE

A coastal data assimilation system was constructed based on Regional Ocean Modeling System (ROMS) Incremental Strong constraint 4D Variational (IS4DVAR) data assimilation algorithm. The model (MARGOM) encompassing coastal ocean in Northeast US assimilates satellite observed sea surface height and sea surface temperature, in-situ temperature and salinity profiles from expendable bathythermograph, Argo floats, CTD stations and glider transects. Two-month continuous assimilation experiment was performed over April-May 2006 to simulate the evolution of a large Gulf Stream Warm Core Ring (WCR) event. The data assimilative MARGOM model well reproduced the temporal and spatial variations of this WRC. Interaction of WCR with continental shelf and slope induced significant offshore transport and altered the shelfbreak frontal system dramatically. Eddy induced water transport and its associated biological implication are further investigated using an idealized biological model simulation. (Abstract ID 11272)
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CSEOE GOES INTERNATIONAL: CSEOE CHINA

The Centers of Ocean Sciences Education Excellence (CSEOE) has formed a national US network of scientists, educators, and facilitators that promote ocean literacy and a broadening of the impacts of ocean research. Following the idea of “One World, One Ocean”, CSEOE has begun to extend its network internationally. A CSEOE China Planning workshop, held in March 2010 in Beijing, China, brought together ocean scientists, students, CSEOE representatives and government officials to exchange information focused on ocean science education in the United States and China and to explore the possibility of establishing a Center for Ocean Science Education Excellence in China. Following the two-day workshop, US delegates visited Xiamen University in Xiamen and Ocean University in China in Qingdao. The State Oceanic Administration of China supported the subsequent development of CSEOE China, a network which now includes 12 leading ocean institutions in China. Continuing networks of graduate students and faculty, inclusion of CSEOE China into the CSEOE Network, and translation of the Ocean Literacy documents into Chinese are some examples of international cooperation that could broaden to other countries worldwide. (Abstract ID 11189)

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SOURCES OF OUTWELLED DISSOLVED ORGANIC MATTER IN SALT MARSHES

An observation network has been deployed in Snipe Creek, FL, to estimate dissolved organic carbon (DOC) and chromophoric dissolved organic matter (CDOM) sources and fluxes from a pristine, shallow salt marsh in the Big Bend region of Florida. Snipe Creek drains approximately 2.5 km2 of salt marsh with average daily tidal variations of about 1 meter. Continuous monitoring of CDOM along with discrete measurements of DOC suggest that small variations in tidal height result in factor of two differences in the up-creek endmember. Rapid in-mash processing by bacterial and photodegradation processes as well as widely varying drainage areas lead to different export fluxes during each individual ebb tide. Additionally, incubations of creek water exposed to natural sunlight suggest that 10-25% of the creek DOM could be due to photodissolution of respaced sediments. Overall, high temporal and spatial resolution measurements of DOM in Snipe Creek suggest that a sea-level rise as small as 1-2 centimeters could lead to a large change in the quantity and quality of outwelled DOM to coastal waters. (Abstract ID 10108)

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INTERPRETING THERMOCLINE STRIATIONS IN THE SUBTROPICAL GYRE FROM THE PERSPECTIVE OF MIXING/TRANSPORT, AND THE ENERGY SPECTRUM

Thermocline striations in the subtropical gyre are embedded in the large-scale gyre-structured mean flow. In previous work (Chen, thesis in preparation), a simple theoretical model was developed and used to investigate mechanisms for striation formation in a subtropical gyre. Eddies propagating in fixed directions produce kinematic striations, and the same mechanisms describes striation formation in the realistic ECCO2 state estimate. Here the questions are posed as to whether striations are, at least in part, components of the eddy field appearing in regions of the variability frequency-wavenumber spectrum, and whether they are also dynamical quantities with mixing and transport contributions. A randomly forced barotropic quasi-geostrophic model having an arbitrary constant mean flow imposed is used. Striations are bands in the low-frequency component of the eddy field, align with the eddy propagation direction, and exchange energy with the high frequency eddies. Depending on the mean flow direction/magnitude/stratification, striations can be identified either with the jets described by Rhines, or as bands produced by small eddies propagating in fixed directions. These questions are also being investigated in a 1.5 layer model with a subtropical gyre and in the ECCO2 state estimate. (Abstract ID 10028)

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ACROSS-STREAM MOMENTUM BUDGET OF POSITIVELY AND NEGATIVELY BUOYANT RIVER OUTFLOWS

The rapid spreading and mixing in the near-field region of river plumes have profound influences on the far-field plume evolution. Yet, the dynamics as the plume transitions from a near-field inertial jet and far-field geostrophic currents remains poorly understood. In this study, we use a 3D hydrodynamic model (ROMS) to investigate the across-stream momentum budget along the plume streamlines on sloping shelves. Both positively (hypopycnal) and negatively buoyant (hyperpycnal) plumes are considered. The hyperpycnal cases are motivated by outflows of mountainous rivers which occasionally have enough sediment to be denser than the ambient seawater. It is found that the layer-averaged, across-stream momentum balance of positively buoyant plumes is cycle-geostrophic: a balance between Coriolis, centrifugal, and pressure gradient forces. In the near-field, the balance is principally between centrifugal and pressure gradient, whereas in the far-field the flow approaches the geostrophic balance. The transition appears to coincide with an along-stream location beyond which the flow switches from critical to sub-critical. For negatively buoyant plumes, before the plumes divide as undercurrents, the across-stream momentum balance is between pressure gradient and centrifugal, just as in surface plumes. In the far-field where the plume hugs the sea-floor, bottom friction dominates the across-stream momentum budget (Ekman balance), and an ageostrophic secondary circulation is evident. (Abstract ID 11076)

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MULTI-DECADAL SEA LEVEL AND GYRE CIRCULATION VARIABILITY IN THE NORTHWESTERN TROPICAL PACIFIC OCEAN

Sea level rise with the trend > 10mm/yr has been observed in the tropical western Pacific Ocean over the 1993–2009 period. This rate is three times faster than the global mean value of the sea level rise. Analyses of the satellite altimeter data and repeat hydrographic data along 137ºE reveal that this regionally enhanced sea level rise is thermosteric in nature and vertically confined to a patch in the upper ocean above the 12 deg C isotherm. Dynamically, this regional sea level trend is accompanied by southward migration and strengthening of the North Pacific Current (NEC) and North Pacific Countercurrent (NECC). Using a 1.5 layer reduced-gravity model forced by the ECMWF reanalysis wind stress data, the authors find that both the observed sea level rise and the NEC/NECC's southward migrating and strengthening trends are largely attributable to the upper ocean watermass redistribution caused by the surface wind stresses of the recently strengthened atmospheric Walker circulation. Based on the long-term model simulation, it is further found that the observed southward migrating and strengthening trends of the NEC and NECC began in the early 1990s. In the two decades prior to 1993, the NEC and NECC had weakened and migrated northward in response to a decrease in the trade winds across the tropical Pacific Ocean. (Abstract ID 12276)

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MULTI-SCALE COUPLED OBSERVATIONS AND MODELING OF TYPHOON FANAPI (2010)

The goal of ITOP/TCS10 is to better understand and predict TC formation and intensity change through a comprehensive observation of TC structure and its oceanic and atmospheric environment over a broad spatial and time scales. Typhoon Fanapi provided a perfect opportunity to study the entire evolution from a tropical depression to a typhoon. An objective cloud-cluster tracking method is used to identify the TC precursor clusters leading up to the initial formation of the TD and later becomes Typhoon Fanapi. Using hourly satellite IR images, the ITOP/TCS10 field experiments were designed to follow the developing TC through its lifecycle with extensive observations of pre-, during- and post-TC oceanic and atmospheric conditions. More than 800 GPS dropsondes and 900 AXBTs/AXCTs as well as drifters and floats were deployed in TCs from August-October 2010, including Typhoon Fanapi. A unique observation in Typhoon Fanapi is the development of a stable boundary layer in the near-storm cold wake region. The coupled model forecasts show that the near surface air in the stable boundary layer tends to penetrate further inward into the TC inner core region and eyewall than the air in unstable and neutral boundary where some high theta-e air goes into rainbands. It indicates that the cool-SST induced stable boundary may have a direct impact on TC structure and intensity. Observations and a combined tracer and trajectory analysis in the coupled model will be presented. (Abstract ID 12868)

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VIRUSES INFECTING FRESHWATER FILAMENTOUS CYANOBACTERIA REPRESENT A PREVIOUSLY UNRECOGNIZED EVOLUTIONARY LINEAGE OF CYANOPHAGES

Cyanobacteria and their phages are important members of aquatic systems. However, very little is known about the genomic diversity of phages which infect other cyanobacteria, outside the Synechococcus and Prochlorococcus genus. Here, we sequenced the genome of two cyanomyophages, A-1(L) and N-1, infecting the freshwater filamentous heterocyst-forming cyanobacteria Nostoc sp. PCC7120, Notoce sp. PC7210. Their genomes exhibit no similarity with previously sequenced cyanophages and the majority of their predicted genes have no detectable homologues. Many predicted genes with known functions are highly similar to those in filamentous cyanobacteria, for example, they contain a distinct DNA polymerase B closely related to those found in plasmids of the cyanobacteria Cyanothece sp. PCC7428, Notoce sp. PCC7120 and Anabaena variabilis ATCC29413. Together these polymerase sequences form a
distinct group which is more related to the substantial proto-bacterial DNA polymerase group than to other viral DNA polymerases, suggesting it was acquired from a proto-bacterial by a phage and then transferred to the cyanobacterial plasmid. The sequencing of these cyanophages has demonstrated that over evolutionary time gene transfers have forged the genetic makeup of cyanophages and their Nostoc hosts. (Abstract ID 116820)

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OCEAN MIXING AND AIR-SEA HEAT FLUXES CAUSED BY TROPICAL CYCLONES ON BASIN AND ANNUAL SCALE

As a strong heat engine of the ocean, tropical cyclones provide an effective mechanism to transport heat, mass and nutrient in the ocean. Evidence indicates that these relatively small scale and transient events can influence larger scale dynamical processes in both the ocean and atmosphere. However, a clear understanding of tropical cyclones’ climate impacts, such as vertical mixing in the ocean, and air-sea heat fluxes, are limited by lack of all-weather-in-situ observations with sufficient horizontal, vertical and temporal coverage and resolution. In this study, for the first time, we use global covering, vertical resolving Argo profiling data to estimate the cumulative effects of tropical cyclones by analyzing the vertical thermal changes down to 2000 meters before and after storm passages during 2004-2011 period. We estimate climatologies of both ocean mixing and net air-sea heat fluxes induced by tropical cyclones. Our results show strong subsurface mixing (up to 200m depth) and main thermocline mixing (400-800m) that presents much deeper ocean mixing than previous assumptions. This strong mixing in ocean pumps about 0.81 PW heat downward from surface to deeper ocean. In addition, tropical cyclones convey about 1.0 PW heat annually from the ocean to the atmosphere, equal to about 9.1 W/m2, which accounts for about 10% of the global ocean heat budget. It suggests tropical cyclones provide a viable mechanism to close the ocean heat budget. (Abstract ID 98080)

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ESTUARINE RESPONSE TO SEA-LEVEL RISE: A NUMERICAL STUDY OF CHESEPAKE AND DELAWARE BAYS

Global sea-level has risen at a rate of 1.6 mm/yr during the past half century and is expected to increase at a substantially greater rate during the 21st century. The rising of sea-level affects salinity structure and circulation in estuaries. Sea-level rise tends to lead salt intrusion into estuaries, therefore increasing stratification. On the other hand, however, sea-level rise also likely leads to a larger tidal range, therefore increasing tidal mixing. The competition between the two responses determines the influence of sea-level rise on estuarine stratification. Estuarine circulation relies on along-estuary density gradient and vertical mixing, hence, indirectly responses to sea-level rise. To understand the influences of sea-level rise on estuarine physical processes, we have developed a numerical model using FVCOM and will carry out a series of process-oriented numerical experiments. The model domain covers Chesapeake and Delaware Bays and part of middle Atlantic Bight. Since the Chesapeake and Delaware Bays are two common types of estuaries, comparisons of the two estuaries will help gain insights into the effects of climate change on estuarine physical processes in general. (Abstract ID 106869)

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ASSESSING ATLANTIC OVERTURNING CIRCULATION (AMOC) IN CMIP5 MODELS

Meridional mass transport streamfunctions from CMIP5 models presently available at PCMDI data server are examined. Measured by maximum overturning streamfunction at 30N, most models do not show a significant trend of AMOC in their historical simulations (1850-2005). Moreover, the spread of AMOC amplitudes across models is narrowed compared to CMIP3 runs, even though the spread is still larger than internal variability of any one particular model. With the exception of one model, the simulated mean AMOCs averaged between 1850 and 2005 by all models are within the observational range of 11-22 Sv. Under “representative concentration pathways” RCP2.6 and RCP4.5 forcing scenarios, all models show a decrease of AMOC. In the first half of the 21st century, but the majority of the models also indicate a rebound of AMOC starting in mid century around 2060, BEFORE the radiative forcing peaks at 2100. This recovery is more robust under RCP2.6 forcing than under RCP4.5 forcing, and the rate of recovery is also faster in the former. All available models show a continuous decrease of AMOC throughout the 21st century under RCP8.5 forcing; in the case of RCP8.5 forcing, the rates of decrease are similar across all models (only one model provides RCP8.5 forcing output). A few models have extended runs to year 2300 where the radiative forcing stabilizes after year 2100, all these runs show a slow recovery of AMOC after 2100. (Abstract ID 116825)

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INTERANNUAL VARIABILITY OF HIGH-WIND OCCURRENCE IN THE SOUTHERN INDIAN OCEAN

High winds (>20m/s) pose great danger for navigation and are important for surface fluxes and ocean mixing. In this study, interannual variability of high-wind occurrence in the Southern Indian Ocean is investigated based on observations from the satellite-borne Special Sensor Microwave Imager (SSMI). Climatology maps show that high wind frequency (HWF) is the highest in boreal summer, and is close to zero in boreal winter. Remarkable interannual variability of summer HWF is found on the warm flank of Subantarctic front between 50°-90°E (CSAF99) and off southern tip of Africa (SF). On interannual scales, HWF in SF region (subpolar region) has significant negative (positive) correlation with the southern annular mode index. During a positive SAM phase, decreases (increases) in the mean westerlies cause HWF to decrease in SF regions (subpolar region). In the vicinity of the SAF, HWF is significantly correlated with the difference between sea surface temperature and surface air temperature (SST-SAT), indicative of the importance of atmospheric instability. Cross-frontal wind and an SST gradient are important for the instability of marine atmospheric boundary layer on the warm flank of the SST front. In addition to distinct interannual variability, HWF in the SAF region also presents remarkable decadal variability. (Abstract ID 96703)

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A 3D EULERIAN-EULERIAN TWO-PHASE MODEL FOR SEDIMENT TRANSPORT

Significant research efforts have been made in modeling sediment transport using a two-phase flow approach. However, existing models are limited to one-dimensional-vertical (1DV) for wave-induced transport or two-dimensional-vertical (2DV) for steady flow. These models are also based on a Reynolds-averaged approach for turbulent flow and hence turbulence-sediment interactions cannot be resolved. Moreover, processes such as bedform dynamics and plug flow cannot be captured with a 1DV model. Here, we develop a 3D two-phase model to investigate sediment transport driven by combined wave and current flows. The numerical model is based on a four-way coupled Eulerian two-phase flow formulation with appropriate closure on particle stresses. At a first step, more efficient 2D/3D Reynolds-averaged approach with a k-ε turbulence closure is adopted to model bedform migration and plug flow driven by oscillatory flow. Model results are validated with published data in steady channel and U-tube flows. Model results are also compared to recent video observations from U-tube experiments performed at the Naval Research Laboratory using nycor (-1.17) sediments that demonstrate the generation of plug flow around flow reversal under sheet flow conditions. (Abstract ID 96441)

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TRACKING ANOMALOUS SEA SURFACE TEMPERATURE VARIABILITY OF THE NORDIC SEAS, 1982-2010

We are interested in using satellite SST to track conditions in the Nordic Seas region of the North Atlantic because of the existence of a multi-decade long record (1982-2010) with good spatial coverage. Here we begin by evaluating Pathfinder version 5 remotely sensed infrared SST in comparison with two SST analysis products and with in situ observations. We identify and remove biases including a -0.35C for SST < 40C and a positive bias for lower temperatures. The corrected SST shows a warming trend over the nearly 40-year period in all ice-free regions north of 50DN, but is highest in the Labrador Sea. There is a clear relationship between SST and 0/300m heat content on interannual time scales for three regions: western North Atlantic, Nordic and Barents Seas. The highest correlation between these variables of 0.88 occurs in winter in the Barents Sea. In the Nordic Seas interannual correlations (stratified seasonally) vary from 0.75 in winter to 0.69 in summer. A detailed examination of the SST data reveals a slow counterclockwise propagation of SST anomalies in the Nordic Seas and to the north in the Barents Sea with an approximate timescale of 7-8 years. Possible causes of this striking feature will be discussed. (Abstract ID 11178)

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A COMPARISON OF RECENT OBSERVATIONS IN DRAKE PASSAGE FROM THE CDRAKE EXPERIMENT TO THE SOUTHERN OCEAN STATE ESTIMATE
Accurate model simulation of the ocean requires reproducing several metrics, including ocean heat content, geopotential height, mass transport, and eddy kinetic energy. We use observations from the recent cDrake experiment to evaluate the representation of these metrics in the Drake Passage in a Southern Ocean state estimate (SOSE). The observations consist of near-bottom currents, bottom pressure, and round-trip vertical acoustical travel time between sea floor and sea surface from an array of bottom-moored Current and Pressure-recording Inverted Echo Sounders (CPIES) deployed from 2007 to 2011, as well as hydrography and direct velocity observations from multiple cruises. The cDrake transport line (21 CPIES) spans 800 km across Drake Passage. The cDrake local dynamics array (21 CPIES) has spatial resolution sufficient to capture mesoscale eddies within the region of maximum surface variability between the Subantarctic and Polar Fronts. The SOSE is an eddy-permitting version of the MITgcm which is least-squares fit to ocean observations using the adjoint method. The independent cDrake observations are used here to evaluate the state estimate in Drake Passage prior to assimilation. (Abstract ID 10654)

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BENTHIC SHELF EXCHANGE AND OBSERVATIONS OF BOTTOM BOUNDARY LAYER INTRUSIONS IN SOUTHERN MONTEREY BAY, CALIFORNIA, USA

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SUBTHERMOCLINE EDDIES NEAR THE MINDANAO CURRENT/UNDERCURRENT IN AN EDDY-RESOLVING GCM

The OGCM for the Earth Simulator (OFES) is used to study the properties and variabilities of the subtropical thermocline eddies in the vicinity of the western boundary current east of the Philippine coast. The pathways of the subtropical thermocline eddies are also discussed. (Abstract ID 10621)

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THERMAL IMAGING OF THE SURFZONE DURING SURF ZONE OPTICS

In the nearshore and surfzone, significant progress has been made in understanding EO and radar signatures, but thermal infrared remote sensing is generally unused and consequently untested. However, the sea surface in the nearshore is rich in observable natural temperature variation directly related to dominant physical processes including waves, wave breaking, turbulence, and currents. In September 2010, thermal imaging cameras mounted on fixed and airborne platforms were used to observe surfzone processes at the Field Research Facility on Duck NC as part of the Surf Zone Optics (SZO) and Data Assimilation and Remote Sensing for Littoral Application (DARLA) experiments. Preliminary analysis showed expected observable signals primarily waves made visible by the slope modulatation of emissivity and reflectivity, thermally bright breaking wave crests, and disturbance of the thin surface thermal layers by turbulence and wave breaking. However, unexpected signatures were observed, including rapid cooling of residual foam left by breaking waves. In addition to analysis of these thermal signatures, we will demonstrate initial application of thermal imaging to estimate large-scale surface currents, wave field properties, and wave breaking. (Abstract ID 10041)

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ACCURATE AND PRECISE DETERMINATION OF TROPHIC POSITION OF ORGANISMS BASED ON NITROGEN ISOTOPIC COMPOSITION OF AMINO ACIDS

Knowledge of the trophic position (TP) of organisms in food webs allows understanding of biomass flow and trophic linkages in complex networks of ecosystems. Stable isotope analysis of amino acids is a new method with the capability to estimate trophic position of various organisms in food webs. This approach is based on contrasting isotopic fractionation during metabolic processes between two common amino acids: glutamic acid (Glu) shows significant 15N-enrichment...
of +8.0 permil, whereas phenylalanine (Phe) shows little change in d15N values (by +0.4 permil). Recently, we established a number of natural and laboratory grown organisms a general equation for the estimation: TP = [(d15NGlu – d15NPhe + b)/7.6 + 1] where b represents the isotopic difference between Glu and Phe in primary producers (~3-4 permil for aquatic cyanobacteria and algae, +8.0 permil for terrestrial C3, and ~0.4 permil for terrestrial C4 plants).

In the presentation, we briefly review this new method and show its application to natural organisms in aquatic and terrestrial food webs. (Abstract ID 10118)

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LANGMUIR CIRCULATION: AN AGENT FOR VERTICAL RE-STRAFFICATION?

The impact of surface waves on the stability of submesoscale lateral fronts in the ocean surface boundary layer is investigated using the stratified, rotating Crag-Leibovich (CL) equations. Through the action of the CL vortex force, down-front propagating surface waves fundamentally alter the super-inertial, two-dimensional (down-front invariant) linear stability of these fronts, with the classical symmetric instability mode being replaced by a hybrid Langmuir-circulation/symmetric mode. The hybrid mode is shown to exhibit much larger growth rates than the pure symmetric mode, to exist in a regime in which the vertical Richardson number is greater than one, and to accomplish significant cross-isopycnal transport. Non-hydrostatic numerical simulations reveal that the nonlinear evolution of this hybrid instability mode can lead to rapid, i.e. super-inertial, vertical restratification of the mixed layer. Remarkably, Langmuir circulation – generally viewed as a prominent vertical mixing mechanism in the upper ocean – may thus play a pivotal role in mixed layer restratification. (Abstract ID 11319)

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MODELING OF HYPOXIA FORMATION IN YEONGSAN RIVER ESTUARY, KOREA (USING 3-D MODEL)

Recurrent hypoxic or anoxic conditions in the bottom water during the summer have been posing threats to the ecosystem health in Yeongsan River estuary, Korea, since the construction of a sea wall in 1981. As a part of developing integrated estuarine management system, mechanisms of hypoxia formation were captured using a 3-D hydrodynamic-water quality model EFDC/Environmental Fluid Dynamics Code describing phytoplankton-DO-C-N-P-Si coupled cycle and particle movement. Analysis of particle movement calculated along the bottom of the narrow estuary toward the sea wall by high oxygen consumption, toward the hypoxic area near the sea wall due to estuarine circulation in summer rainy season. The concentration of dissolved oxygen decreases rapidly as the oxygen rich coastal water flows along the bottom of the narrow estuary toward the sea wall by high oxygen consumption, which is related with severe organic enrichment of the bottom water sediment. Formation of hypoxic conditions is thus closely related with the timing and the amount of freshwater discharge from the sea wall. (Abstract ID 12622)

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DETERMINATION OF TROPHIC LEVEL OF BENTHIC ORGANISM AND FISHES IN SOMJIN ESTUARY, KOREA

This study was conducted to identify the food web structure in Seonjin Estuary using d13C and d15N isotope ratio. d13C of benthic macro invertebrates living in Seonjin estuary were classified into two groups. Deposit feeders such as Macroth主编illum abbreviatus and Macroth主编illum japonicus showed relatively enriched carbon isotope ratios than filter feeders such as Crassostrea gigas and Cyclina sinensis. In terms of iso-source mixing model, the main diet source of Macroth主编illum abbreviatus was seagrass while main diet source of Crassostrea gigas was POM. d15N of benthic macro invertebrates exhibited small variation between species except polychaete spp. Distribution of d13C of fish was similar to d13C of benthic macro invertebrates and d15N were more enriched than benthic macro invertebrates. We concluded that both POM and seagrass are important diet source for benthic macro invertebrates and fish in Seonjin estuary. In addition, the trophic levels of organisms living in Seonjin estuary are compared by nitrogen isotope ratios of individual amino acids (etc. phenylalanine and glutamic acid). (Abstract ID 11000)

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SURFACE GEOSPHERIC CURRENT ESTIMATED FROM ALTIMETER AND SURFACE DRIFTER DATA IN THE JAPAN/EAST SEA

In order to estimate surface geospheric currents in the Japan/East Sea mean dynamic topography (MDT) was calculated from the steric height relative to 500 dbar and surface drifter dataset. Sea level anomalies (SLA) were derived from the satellite altimeter data and, then, SLA data were added to MDT to make absolute dynamic topography (ADT). Surface geospheric currents were calculated from the ADT from 2002 to 2005. Accuracy and characteristics of the estimated surface geospheric current were analyzed. Correlation coefficients between the satellite altimeter-derived surface geospheric currents and surface currents estimated from surface drifter trajectories were 0.71 and 0.72 for the eastward (u) and northward (v) velocities, respectively. Correlation coefficients between the satellite altimeter-derived surface geospheric currents and surface currents measured by ship-mounted ADCP in the western part of Ulleung Island were 0.61 and 0.52 for u and v, respectively. Correlation coefficients between the satellite altimeter-derived surface geospheric currents and bottom-mounted ADCP between Ulleung Island and Dok Island from 2002 to 2004 were 0.75 and 0.70 for u and v, respectively. (Abstract ID 12716)

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INTERACTIONS BETWEEN OSMOTIC STRESS AND DARK-INDUCED CELL DEATH IN THE HALOTOLERANT UNICELLULAR CHLOROPHYTUM DUNALIELLA TERTIOLECTA

The unicellular chlorophyte alga, Dunaliella tertiolecta can tolerate a broad range of salinities from below 0.05 M (3 ppt) to above 5 M NaCl (300 ppt): virtually the solubility limit of NaCl by accumulating glycerol and lipids as compatible solutes. We studied interactions between salinity and cell death induced by the stress of light deprivation by monitoring physiological and biochemical responses. At 4 X normal sea water salinity (1.6 M NaCl), D. tertiolecta survived more than twice as long in darkness as at normal salinity, and showed more gradual declines of photosynthetic capability (Fv/Fm). No indication of cell lysis (declines in cell numbers or particulate C) or increases in caspase-like protease activities (associated with programmed cell death) were observed. The same results were seen with an equivalent osmotic shock using sorbitol, indicating the prolonged survival is due to osmotic rather than ionic components of salt stress. Although the mechanism of cell death suppression is unknown, it offers a tool to dissect cell death pathways and may be of relevance in understanding the prevalence and significance of cell death in species that live in environments like estuaries where salinity varies. (Abstract ID 12496)

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INFLUENCE OF FRESHWATER INFLOWS ON THE NUTRIENT DYNAMICS AND WATER QUALITY IN YEONGSAN RIVER ESTUARY, KOREA

Changes in freshwater inflows and hydrodynamics after the construction of a seawall in 1981 have significantly affected the water quality and recurrent hypoxia in the bottom water has been posing threats to the ecosystem health in the shallow macrotidal Yeongsan River estuary, Korea. In addition, Yeongsan River estuary is subjected to further modifications in freshwater inflows and hydrodynamics after the construction of a seawall in 1981. Nutrient fluxes & budgets in different freshwater inflow conditions were discharges were analyzed, and short-term responses following freshwater discharges were monitored several times from June 2010 to September 2011. Clear increase of nutrient and organic matter concentrations was detected during high inflow periods especially in summer. Signals of freshwater inflows lasted several days showing a gradient from the seaward toward the mouth of the estuary. Nutrient fluxes & budgets in different freshwater inflow conditions were calculated using a mass balance model. (Abstract ID 11059)
more than 95% appearance in most stations. Opportunistic species such as agglutinated foraminifera were increased. Temporal improvement of the pollution after the flooding residual flow is showed at the shallow depth during spring period. The residual flow was changed, due to barotropic forcing with river discharge and long-term tidal components. (Abstract ID 12846)

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THE SPATIAL AND TEMPORAL VARIABILITY OF SURFACE PCO2 IN THE WESTERN NORTH PACIFIC AND THE EAST CHINA SEA DURING 2006–2010

We examined the spatial and temporal variability of partial pressure of CO2 (pCO2) in surface seawater in the western North Pacific and the East China Sea based on surface pCO2, temperature and salinity continuously measured on board R/V Onnuri in September 2006, October 2007, and June 2008, 2009 and 2010. The western North Pacific and the East China Sea were distinguished in not only sea surface temperature and salinity but also pCO2 distributions. The surface pCO2 showed higher values in the lower latitude (the western North Pacific) than those in the higher latitude (the East China Sea) in wide ranges. In the western North Pacific, the seasonal and interannual variations of surface pCO2 distributions were small. On the contrary, those were wide and significant in the East China Sea. The western North Pacific acted as a weak or moderate source of CO2, of which fluxes ranging from 0.07 to 0.48 mmol m-2 day-1 at all times. However, the East China Sea acted as a sink of CO2 in both spring and summer. The fluxes ranged from -0.45 to -6.11 mmol m-2 day-1. (Abstract ID 11005)

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OCCURRENCE OF HYPOXIA AND ROLE OF OXYGEN DEMAND IN WATER COLUMN AND SEDIMENT IN YEONSAN ESTUARY

Vertical distribution of temperature, salinity and dissolved oxygen (DO) concentration were measured to verify the spatial and temporal variability of suboxic or hypoxic water at the Yeongsan estuary of Korea peninsula in July and September of 2011. Intact sediment cores and bottom water samples were taken for bottom water oxygen demand (BWOD), sediment oxygen demand (SOD) and denitrification measurement. In July when the freshwater input was high, strong vertical stratification was observed, but vertical segregations of DO concentration were not evident. In September when freshwater input was low, degree of stratification was low, but DO concentration rapidly decreased within the top 5m. In particular, bottom water DO concentration in near of the dam was relatively lower than other sites. The BWOD was higher near the Yeongsan Dam and generally decreased seaward. Suboxic condition occurred near the Yeongsan Dam seems to be the result of high BWOD and SOD as well as the limited water movement in the site. (Abstract ID 12744)

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THE DISPERSION OF RADIOACTIVE WATER RELEASED FROM THE FUKUSHIMA DAIICHI NUCLEAR POWER-PLANTS

We use a numerical model to investigate the dispersion of radioactive water released from the Fukushima Daiichi Nuclear Power-plants (FDNP) on March 2011. The numerical model is based on a three dimensional particle random-walk model and a z-coordinate ocean general circulation model developed at the Earth Simulator Center, JAMSTEC. Radionuclide concentrations are obtained from the density of particles per unit volume water. Experiments have been carried out for 157Cs for 4 months and the results show that coastal currents and meso-scale open oceanic eddies having large influence on the behavior of the radionuclides. The radionuclides in coastal currents remain along the coast where the one in meso-scale open oceanic eddies rapidly escape to the interior of the Pacific along the Kuroshio extension. The seaward radionuclides deeply penetrate into the deep layer corresponding to the deepening of the mixed layer of the Kuroshio. (Abstract ID 11025)
VIRAL CONTROL OF AUTOTROPHIC VS. HETEROTROPHIC BACTERIA IN THE SURFACE OCEAN: ECOLOGICAL NETWORKS LINKING VIRUSES AND BACTERIA

Identifying relationships in complex communities drives our ecological understanding of the natural world. We investigated top-down controls, specifically myxoviruses, of bacterial community structure. The myxovirus superfamily is diverse, typically accounts for ~60% of the viral community in surface water, has a broad host range, and is detectable through cultivation-independent means. Samples for DNA and auxiliary measures were collected at USGS Microbial Observatory at the San Pedro Ocean Time-series station. Community structure was analyzed by: ARISA for bacteria and g23 TRLFP for myxoviruses. We examined a 3 year time-series (3/2008-1/2011) to determine principal drivers of community shifts and how their relative importance may vary over time. We also examined coherence between relationships from 5m and chlorophyll maximum depths. Correlational analyses yield networks that are inherently complex yet can provide insight on viral controls of bacteria for which no cultured phages are currently known to exist, such as SAR11. Through our network and time-series analysis, we can indicate key clusters of important factors - as it is unlikely that a single parameter controls microbial communities. (Abstract ID 10119)

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GLOBAL COMPARISON OF TROPHIC POSITIONS OF MESOPELAGIC MYCTOPHIDS AND STOMIIDS USING AMINO ACID NITROGEN ISOTOPIC ANALYSES

We examined the biogeographical and ecological mechanisms responsible for variability in bulk and amino acid (AA) stable nitrogen isotope compositions in two important mesopelagic fish families, Myctopidae and Stomiidae, from five globally distributed regions. Using the δ15N values of individual AAs we quantified trophic positions (TPs) of these fishes. Despite variability in bulk tissue δ15N values, TPs are nearly uniform within both families of fishes across all regions. Differences in the bulk and AA δ15N values reflect region-specific water mass biogeochemistry controlling δ15N values at the base of the food web and these differences are inherited by the fishes analyzed. TPs calculated from AA isotopic analyses for myctophids (TP ~2.9) approximate expectations from stomach content (SC) studies describing these fishes as zooplanktivorous (TP ~3.2). In contrast, TPs calculated from AA analyses for stomiids (TP ~3.2) were lower than expected given previous SC studies, which report that stomiids are piscivorous (TP ~4.1) across all regions. Our TP estimates suggest that stomiids are more similar to myctophids and are not strict piscivores, calling for possible reevaluation of the trophic roles of these fishes. (Abstract ID 10769)

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COMPOUND SPECIFIC STABLE CARBON ISOTOPE ANALYSIS OF AMINO ACIDS IN BONE COLLAGEN TO RECONSTRUCT HUMAN PALAEODEITIS USING LC-IRMS

Compound-specific carbon isotopic analysis of amino acids in bone collagen is a valuable tool for the reconstruction of human palaeodietics. The recent development of coupling liquid chromatography to IRMS enables online carbon isotope ratio measurement of amino acids without adding extra carbon to analytes. We used LC-IRMS techniques to measure the 613C values of amino acids in bone collagen of humans (n = 9) and animals (n = 27) from archaeological sites. The isotopic results revealed that human and faunal species in the sites had similar patterns in both EAAs and NEAAs. All amino acids in marine animals were 13C-enriched relative to those of the terrestrial animals. The average marine-terrestrial 613C offset was 6‰ in EAA and 8‰ in NEAA. The 613C isotopic differences in amino acids between two faunas were the largest for glycine and serine (NEAA) and the smallest for phenylalanine (EAA). Threeeine among the EAAAs had a large difference (~8‰) in 613C values. These amino acids can be possible new isotopic markers that he used to distinguish between marine and terrestrial diets in palaeodiетics. (Abstract ID 10474)

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ENGAGING STUDENTS, EDUCATORS, AND SCIENTISTS IN A COMMUNITY OF PRACTICE

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SURFACE WAVE MEASUREMENTS USING SHIP MOUNTED ULTRASONIC ALTIMETER

Experimental studies of surface wave effects on air-sea fluxes and ocean circulation require accurate measurements of the waves. We present a robust new method for measuring 1D surfac e wave spectra using ship mounted ultrasonic altimeter combined with an accelerometer. The altimeter is mounted at the bow of the ship and used when the ship is on station facing the wind and the waves. The accelerometer is used to correct for ship motion. We present results from two recent field studies. The results are compared both with data from a conventional wave ridge buoy and wave model analyses when direct observations are not available. We find good agreement with regard to integrated parameters such as significant wave height and also with regard to spectral shape. (Abstract ID 10981)

STABILITY OF CADMIUM COMPLEXES WITH THE SIDEROPHORE DESFERRIOXAMINE B (DFOB), a group of organic ligands that facilitate uptake of the micronutrient Fe(III) but also form very stable complexes with many divalent metals. Stability constants of bidentate, tetradentate, and hexadentate Cd–DFOB complexes were determined by potentiometric titration in a non-complexing medium (NaClO₄) at seawater ionic strength. Non-linear regressions of the data were performed with FITEQ, a program that has been used to interpret the observed precipitation of a polynuclear complex at high Cd:DFOB ratios. The stability constant of the mononuclear bidentate Cd–DFOB complex was found to be log α = 7. Subsequent modeling with MINEQL showed that, even in the absence of Fe(III), DFOB complexation has no effect for Cd uptake in the upper ocean. (Abstract ID 9626)
and high freshwater inflows, and the effects on salinity intrusion are quantified. Rising sea levels reduce the impact of bottom-generated turbulence causing less vertical mixing. The increased flow depth also creates stronger gravitational circulation and higher vertical stratification. When coupled with reduced vertical mixing, this results in enhanced salinity intrusion in North San Francisco Bay. While higher sea levels lead to more salinity intrusion, the relative effect of sea-level rise is greatest under low flow conditions owing to the predominance of vertical mixing when the vertical stratification is weakest. These effects are quantified through power-law fits relating the salinity intrusion length, X, to changes in sea-level and flow rate. The power laws are used to determine necessary flow rates to maintain current salinity standards under the different sea-level rise scenarios. (Abstract ID 9460)

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EXAMINING THE BINDING OF RADIONUCLIDES WITH MARINE BIOPOLYMERS, A COMPARATIVE STUDY ON TH, PA, BE, PO AND PB ISOTOPES

Both exopolymersic substances (EPS) from marine phytoplankton and natural colloidal macromolecular organic matter (COM) are able to strongly bind different natural radioisotopes that are used as geochemical tracers in marine systems, e.g., for POC flux dynamics and organic carbon cycling in the ocean, and aggregate. To study binding ability and aggregation propensity of different marine colloids and phytoplankton EPS, the chemical composition of radioactive metal-carrying biopolymers is currently being investigated to relate radionuclide binding to chemical composition of individual biomolecules. By separating and identifying radiotopic organic-carrier molecules, we found that the most efficient binding of many of these isotopes likely occurs to acid polysaccharide- and protein-containing biomolecules, i.e., proteoglycans, glycoproteins and sideropheric moieties. Furthermore, compared to silica particles and diatom frustules that were cleaned to selectively remove organic matter, particle-water partition coefficients (Kd) of selected radionuclides were greatly enhanced and showed high selectivity when diatom-associated organic matter was present. This suggests that chemical composition and types of organic functional groups are indeed crucial factors in the fractionation of all selected radionuclides in seawater. (Abstract ID 10365)

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BIO-CONCENTRATION, BIO-MAGNIFICATION AND TROPHIC TRANSFER OF TRACE METALS OF MARINE ZOOPLANKTONS: ACTIVE OR PASSIVE

Bioactive trace elements (Cu, Ni, Cd, Zn and Fe) were taken up by phytoplankton in euphotic zone through various biological processes. As these elements came into the aquatic food chain, accumulated in the organism in the process of trophic transfer, any unassimilated trace elements are rapidly packaged into fecal pellets and transported out of surface waters. However, bio-concentration or trophic transfer of trace metals is caused by the dietary behavior or metabolic functions of zooplankton remain a main issue for biogeochemical cycle of trace metals in marine environment. Using ultradian size fraction techniques, elemental and metals concentration of selected zooplankton at various growth stages were analyzed. It was found, on average, that only ~75% of trace metals measured were intercellular. Mean concentrations of selected trace elements in zooplankton were increased with sizes, and the TM/Carbon ratio changed for different element of different rate at different growth stage. Fecal pellets, ecoskeleltons, and intracellular materials all show different metal concentration levels, degraded/released metal into the water columns at different rate. However, for Cd, concentration decreased with increasing sizes. These evidences suggest active accumulation of essential metals, not passively; and metal detoxification is actively involved in plankton life cycles which have profound impact on trace metals biogeochemistry in the ocean. (Abstract ID 1074)

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THE OCEAN LITERACY PRINCIPLES—UNDERSTANDING THE IMPACT OF THIS EDUCATOR-SCIENTIST COLLABORATION ON PUBLIC UNDERSTANDING OF SCIENCE

This paper explores ongoing efforts to measure the impact of the Ocean Literacy Principles and the related materials that have resulted from educator-scientist collaborations led by the Center for Ocean Sciences Education Excellence—California (COSEE—CA). More specifically, COSEE—CA researchers have developed a survey that measures understanding and attitudes about the ocean and the role that ocean sciences play in supporting understanding of Earth systems by asking questions related to 4 dimensions: knowledge, attitudes, behaviors, and exposure. The instrument has been developed with the goal of yielding a tool that is easy to administer and analyze so that it will have maximum utility and flexibility. This measurement tool supports formative efforts (e.g. guiding the kinds of interventions used for targeted audience) and summative evaluation (e.g. measuring the impact of educational outreach efforts). This paper describes what we have learned to date through the developing and administering this instrument. It also discusses the potential uses for the instrument across the COSEE Network and beyond to measure impact of education and outreach efforts on the ocean literacy of target audiences. (Abstract ID 10907)

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PROCESSES LEADING TO 210-PO AND 210-PB DISEQUILIBRUM ALONG THE GEOTRACES MERIDIONAL TRANSIENT OF THE WESTERN NORTH ATLANTIC

A western North Atlantic transect made in spring 2010 during GEOTRACES cruise GA02 that sampled 11 stations to 1000 m for the natural radionuclides 210Po/210Pb (granddaughter/parent) couple. A distinct 210Pb surface maximum in temperate subarctic waters corresponds to a maximum in excess 210Pb at depth. Auxiliary data show distinct productivity focused at the gyre boundary. This area is apparently deficient in Fe along the NADW subduction, deposition of Saharan dust is evident from auxiliary Fe and Al data. Here a CM/Carbon ratio changed for different element of different rate at different growth stage. One such hot spot is Bering Canyon in the southeastern Bering Sea, where the gyre boundary. This area is apparently deficient in Fe along the NADW subduction, deposition of Saharan dust is evident from auxiliary Fe and Al data. Here a CM/Carbon ratio changed for different element of different rate at different growth stage. 

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ADAPTIVE SAMPLING OF A BIOLOGICAL HOT SPOT IN THE BERING SEA USING AERIAL SURVEILLANCE

A biological hot spot in the ocean is a region with a high rate of energy transfer between trophic levels. One such hot spot is Bering Canyon in the southeastern Bering Sea, where strong tidal currents combined with a steep shelf break produce strong localized upwelling, and flow through the Aleutian passes bring productive Pacific Ocean water into the Bering Sea.
At top trophic levels, the energy transfer rate is not constant, but is concentrated in intense, ephemeral foraging events. This situation offers an ideal application for adaptive sampling using aerial surveillance to locate these foraging events and direct a surface vessel to obtain more detailed observations. In the example presented, three foraging events were located using an aircraft equipped with oceanographic lidar supplemental visual observations. A chartered commercial fishing vessel equipped with 38 kHz acoustics, and nets was directed toward one of these events where high concentrations of copepods, euphausiids, walleye pollock (Theragra chalcogramma), Pacific herring (Clupea pallasi), shearmovers (Procellaridae), and humpback whales (Megaptera novaeangliae) were documented. (Abstract ID 9571)

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CHANGES IN THE TROPIC DYNAMICS OF THE WESTERN ENGLISH CHANNEL

Climate and anthropogenic changes can drive relevant changes in the dynamic of the trophic components of marine ecosystems, influencing their status and productivity. These changes can be investigated through the analysis of time series collected by long-term monitoring stations. In this work, we investigated the changes in the trend and relationships among the trophic components of the English Channel (UK), in relation to changes in climate forcings. Long-term time series of phytoplankton and upper trophic taxa sampled at the Western Channel Observatory were decomposed by using Dynamic Harmonic Regression (DHR) models, coupled with a Kalman filtering algorithm. The results show that changes in the physical forcings (e.g., sea surface temperature and wind intensity) impacted the community composition and the abundance of indicator taxa (e.g., calanoids). Correlation analysis among the long term components of the time series indicated changes in the trophic relationship between primary and secondary producers. This work points out that climate events can induce fast changes in the trophic relationships in marine food webs, with potential impacts on fish abundance. (Abstract ID 10038)

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CLIMATE MIGRATION CHANGES PENGUIN DISTRIBUTIONS ON THE WEST ANTARCTIC PENINSULA

Rapid climate change in Antarctica appears to be altering the distribution and abundance of penguin breeding colonies. Adélie, Chinstrap and Gentoo penguins may differ in terms of their habitat use and distribution, and how their current habitat ranges may continue to be altered by future climate changes. Climate shift in more favorable conditions to the south, thus, illustrating where range expansion and contraction is occurring. Former ideal Adélie habitats are now becoming more suitable for Chinstrap and Gentoo penguins. These models may also describe uncolonized locations where range expansion and contraction is occurring. Former ideal Adélie habitats are now becoming more suitable for Chinstrap and Gentoo penguins. These models may also describe uncolonized locations where

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CONTROLS ON PHYTOPLANKTON CELL SIZE DISTRIBUTIONS IN CONTRASTING PHYSICAL ENVIRONMENTS

Phytoplankton cell size is often thought of as a master trait, influencing both the trophic structure of marine ecosystems and important biogeochemical fluxes, such as carbon export from the photic zone. In phytoplankton, small cell sizes generally confer an advantage in terms of resource acquisition in low light and nutrient scarce environments, and the effective use of already-acquired resources. Large cell sizes can be advantageous in terms of avoiding predation, and for nutrient storage in variable environments. We investigate the relative importance of bottom-up and top-down controls on phytoplankton cell size in contrasting physical environments using an individual-based evolutionary ecosystem model (EVE), including a physiologically consistent model for sub-cellular resource allocation, size-dependent predation, and cell size as an evolvable trait. Coupled to the MIT OGCM, we use the model to derive dynamic optimal size-class distributions at representative 1-D sites, which are also compared with in situ data. Particular attention is given to both drivers for global patterns in phytoplankton cell size, and changes in the cell size distribution during phytoplankton bloom periods. (Abstract ID 11125)

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A COMPARISON OF ON-SITE AND REMOTE EXPLORATION IN THE DEEP OCEAN

Deep-sea exploration is the very discovery of discovery in modern science. Plunging the depths of yet unexplored seafloor to investigate some of the most extreme and unique ecosystems is a challenge; however as it informative. However, this information is not easily accessible and the methods by which scientists investigate these habitats are evolving to meet this challenge. One such method being developed is remote communications technology that allows scientists to engage in exploration virtually from shore-based laboratories. As a doctoral student in marine ecology at Duke University, I have had unique opportunities using different technologies to participate in both exploration and research. Specifically, I have embarked on field expeditions aboard research vessels such as R/V Oceanus of the Woods Hole Oceanographic Institute and utilized state of the art satellite technology on a 'virtual cruise' with the NOAA Okeanos Explorer. In this poster presentation, I will discuss the scope and nature of deep-sea research, and compare and contrast the experiences between on-site oceanographic field research and the novel computerized 'virtual cruises' that are reshaping the accessibility of deep-ocean research. (Abstract ID 10482)

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ISLAND EFFECT: A BIO-ARGO FLOAT INVESTIGATION IN THE MARQUESAS ISLAND PLUME

At top trophic levels, the energy transfer rate is not constant, but is concentrated in intense, ephemeral foraging events. This situation offers an ideal application for adaptive sampling using aerial surveillance to locate these foraging events and direct a surface vessel to obtain more detailed observations. In the example presented, three foraging events were located using an aircraft equipped with oceanographic lidar supplemental visual observations. A chartered commercial fishing vessel equipped with 38 kHz acoustics, and nets was directed toward one of these events where high concentrations of copepods, euphausiids, walleye pollock (Theragra chalcogramma), Pacific herring (Clupea pallasi), shearmovers (Procellaridae), and humpback whales (Megaptera novaeangliae) were documented. (Abstract ID 9571)

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TOS/AGU/ASLO Abstract Book
Within the frame of the TARA expedition, we deployed a Bio-Argo float in the Marquesas plume to investigate the productivity of this “green spot” within the blue sub-equatorial Pacific waters. The float measured temperature, salinity, irradiance at three wavelengths, the backscattering (bbp) and attenuation (cp) coefficients as well as Chls and CDOM fluorescence. It was operated three times per day (sunrise, noon, sunset) every day for an initial period of 55 days and every five days thereafter. We present here the analysis of this highly resolved time series. From the diel cycle in bbp (converted into POC) and Chla we estimate rates of Gross Community Production. We show that these rates are linked to the thickness of the mixed layer suggesting a control by available radiation. The absence of a diel cycle in bbp suggests this quantity is essentially driven by the presence of non-living (detritus or suspended sediments) material. Finally the spatial and temporal dynamics of “erratic spikes” in the cp and Chla vertical profiles is analyzed with respect to export dynamics of the locally produced material. (Abstract ID 10245)

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A FRENCH OUTFREACH INITIATIVE INCLUDING OCEANOGRAPHIC AUTONOMOUS OBSERVATIONS

The OAO (Oceanographic Autonomous Observations) team operates automatic platforms such as gliders and profiling floats and is also strongly implicated in the technological development of their “new generation” in terms of scientific payloads. The acquired multi-sensor data, particularly focusing on marine biogeochemically-relevant data (e.g., oxygen, nitrate, chlorophyll-a, amount of light penetrating the Ocean) together with temperature and salinity, then serve within the wide fields of fundamental research and operational applications. Within this framework and making use of the exceptional characteristics of such autonomous platforms (e.g., multidisciplinary real-time data in high resolution, possibility for sub-regional to global perspectives), the OAO team also seeks to contribute the more and more towards educational and outreach activities. On a local, national and international basis, thus several activities are proposed and the development of attractive outreach approaches is undertaken (e.g. facilitator program). Aiming to broadly capture an interest in Ocean Sciences and to initiate or deepen the understanding of the Oceans and their functioning, these initiatives are meant as complementary actions with an integrative and whenever possible collaborative intention to efforts of existing and emerging networks. (Abstract ID 10290)

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WAVE EFFECTS AND STABLE BOUNDARY LAYERS ON AIR-SEA FLUXES

Many internal turbulence aspects of the ocean boundary layer can affect the sea surface temperature, thereby influencing the fluxes of latent heat, sensible heat, and upwelling long wave radiation. In this work we focus on the effects of turbulence created by wave breaking and Langmuir circulations on the sea surface temperature, and on the effects of a strongly stable ocean boundary layer. These varying aspects of the upper ocean are studied singly and in concert through the use of a second moment closure model that models the enhancement of turbulence kinetic energy from both wave breaking and Langmuir circulations. The effect on the surface fluxes of these variations in sea surface temperatures are shown for a range of conditions that are appropriate to the regimes in which they are occurring. (Abstract ID 12694)

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THE KURISHIO FRONT: ECOLOGICAL BARRIER OR BLENDER?

We performed a fine-scale survey of phytoplankton communities across the Kuroshio Extension in the North Pacific to examine the role of cross- and along-frontal dynamics in regulating the local community structure and diversity. Western Boundary Current fronts are the interface between subtropical and subpolar gyres supporting swift, along-frontal currents separating the waters of the gyres and their associated plankton populations. A cluster analysis of the observed pico- and micro-phytoplankton distributions reveals a sharp divide between clearly distinct phytoplankton communities either side of the front, suggesting an ecological barrier. However, a targeted molecular study of Ostreococcus shows that coastal and oceanic clades of this picophytoplankton genus co-occur at the front. We observe a slug of coastal water entrained into the stream, at the edges of which we see evidence of fine-scale mixing of the two Ostreococcus clades. Western Boundary Current fronts appear to be acting as both ecological barrier and blender, depending on the temporal and spatial scales of interest. (Abstract ID 9517)

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MULTIPLE TRACER CONSTRAINTS ON THE ANTHROPOGENIC CO2 UPTAKE BY THE OCEAN

Transient tracers such as CFCs and C-14 provide valuable information on the oceanic uptake of anthropogenic CO2. In a model framework, we examine the relationships between anthropogenic CO2 and the two tracers CFC-11 and C-14 on inventories computed over either isopycnal slabs or vertical columns. Due to different solubility characteristics, concentrations are normalized by accounting for the effects of CFC solubility and the Revelle factor, respectively. We find linear relationships on a basin-scale in the ETH runs of the NCAR CCSM-ocean model, that have proven to be robust by conducting the same analysis with simulation output of the Ocean Carbon Model Intercomparison Project (OCMIP). With new datasets from international synthesis programs having become available recently, we will apply these relationships to observational tracer data to estimate both the global anthropogenic CO2 inventory for the mid-1990 and the decadal change since that time. These results will be compared to the estimates from several other methods (ACT, TTD, eMLR, etc.). As a rather direct approach, with its distinct strength and weaknesses, it will serve as an additional independent constraint on the anthropogenic CO2 uptake by the ocean. (Abstract ID 11906)

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On the vertical structure of westward propagating anomalies in the north atlantic and their impact on the moc at 26.5’n from observations.

The Meridional Overturning Circulation (MOC) measured at 26.5°N in the North Atlantic exhibits a mean transport of 17.9 Sv and a standard deviation of 4.7 Sv from April 2004 to December 2010. The subannual variability of the geostrophic transport is believed to be partly caused by Rossby waves and eddies (Hirschi et al., 2007). This hypothesis is tested by studying westward propagating anomalies along the RAPID moorings, which may impact the western boundary dynamic height profile through isopycnal displacements. The characteristics (period and wavelength) of these anomalies are compared to the theoretical dispersion relation and observations of planetary waves from altimetry. Their vertical structure is evaluated at each mooring of varying longitudes through normal mode decomposition. Rossby wave propagation is estimated using coherence between modal amplitudes at different moorings. (Abstract ID 9466)

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SIMS ANALYSIS OF PRIMARY AND INFILLED AREAS WITHIN STYLASTER ERIBESCENS COLONIES

Hydrocorals, such as Stylaster eribescens, contain infilled canals and pores of secondary aragonite which may complicate their use as geochemical climate proxies. The small size (often <0.5 μm) of the infilled areas makes comparison of oxygen isotope values between primary and secondary skeleton difficult. Sections of Stylaster eribescens collected at the Charleston Bump (400-600m depth North Atlantic, NW Blake Plateau) were cast in 1 inch epoxy mounts, ground, and polished. Imaging via SEM was used to identify and characterize infilled areas. 8°O analysis was performed in situ from 1.2 micron spots using SIMS to directly compare the 8°O values of adjacent primary and secondary skeletal areas. Results show that infilled areas do contain 8°O values that differ from that of the surrounding primary skeleton. This will complicate the use of S. eribescens as geochemical climate proxies. (Abstract ID 12794)

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OPTICS AND COMPOSITION OF PARTICULATE MATTER IN HYPOXIC AREAS OF THE TEXAS/Louisiana SHELF

Particulate matter in hypoxic areas of the TVLA shelf have three major sources – river plumes, primary production, and resuspended sediments. The sources and processes controlling distribution and transport of these particles can be investigated through optical and in-situ sampling and analysis. Discrete samples for particulate matter (PM) and particulate organic carbon (POC) concentration were filtered for calibration of optical measurements interfaced with the CTD and flow-through systems during the June and August 2011 cruises of the Mechanisms Controlling Hypoxia program, which began measuring T, S, Oxygen, beam attenuation, Fl and PAR annually in 2004. Continuous measurements of surface beam attenuation and CDOM fluorescence (Wet Labs) plus T, S and Fl were made during 2011 using the ship's flow-through system along the entire cruise track from south of Galveston, Texas to east of the Mississippi outflow. Concentrations, gradients and ratios of optical and compositional values are being used to infer sources of particles and their relationship to, and influence on, areas of hypoxia. (Abstract ID 10649)

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RELATING TIDAL CYCLES OF STRATIFICATION, SHEAR, AND TURBULENCE TO ESTUARINE RESIDUAL FLOW

Tidal variability in estuaries commonly exceeds non-tidal residuals, yet is omitted from traditionally derived tidal-average momentum dynamics. Tidal correlation (TC) terms occur at lowest order and could cause substantial changes to the dynamics, strength, and even sense of residual flow. Relative phasing of tidal cycles in stratification, shear, and turbulence vary dramatically in space and time. Relative phasing control over TC terms and associated residual flow is examined using analytical models and an observational case study of Eastern Long Island Sound (LIS) near the estuary axis (moored CTD profiler records for stratification, and turbulent overturns using Thorpe-sorting and a ferry-mounted ADCP). Sensitivity to relative phases in the analytical model is underscored by the case study. In LIS near the bottom, stratification varies weakly and peak shear during flood apparently dominates turbulence characteristics. By contrast, in the upper water column tidal strain is active, with shear, stratification, and turbulent overturns all peaking during late ebb and slack after ebb; low Richardson numbers indicate shear drives enhanced turbulence during peak stratification, unlike in other systems where turbulence is suppressed by stronger ebb stratification. (Abstract ID 10314)

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ATMOSPHERIC CIRCULATIONS INDUCED BY A MID-LATITUDE SST FRONT: A GCM STUDY

The LMDZ AGCM is used with a resolution locally enhanced to 0.5° to analyze the impact of a sharp SST front in the North Atlantic: two perpetual-winter simulations are compared, one with climatological high-resolution SSTs, the other with an enhanced Gulf Stream front. The results corroborate the theory developed previously by the present team to explain the impact of oceanic fronts: the vertical velocity at the top of the atmospheric boundary layer has two components: mechanical (driven by the free-atmosphere vorticity) and thermal (driven by the Laplacian of the boundary-layer temperature). The latter is dominant in the tropics, while in mid-latitudes both play a role in determining the boundary-layer wind convergence. The strengthened SST front does generate the predicted stronger ascent above the warmer waters south of the front and stronger descent above the colder waters to the north. The simulated ascent over the warm anomalies is deeper and more intense than the descent and is accompanied by enhanced precipitation. The vertical shear of the along-front velocity is also modified by the stronger front, as is the cloudiness structure. (Abstract ID 12011)

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STOCHASTIC PLUME SIMULATIONS IN THE GULF OF MEXICO DURING THE DEEPWATER HORIZON OIL & GAS Gusher EVENT

During the Deep Water Horizon accident significant amounts of oil and gas were released from the ocean floor. Major issues in characterizing and predicting the extent of the affected areas were a poor knowledge of the amounts of oil reaching the surface and from the ocean floor. Major issues in characterizing and predicting the extent of the affected areas were a poor knowledge of the amounts of oil reaching the surface and from the ocean floor. (Abstract ID 10649)

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PLUME SIMULATIONS USING OCEAN MODEL ENSEMBLES FOR THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT

The Fukushima plant damage caused radioactive contamination of coastal waters. Major issues characterizing the extent of the affected waters were a poor knowledge of amounts released and the complex coastal dynamics of the region that are not deterministically captured by the prediction systems. To assess the areas that were most likely affected by the accident, while taking into account these limitations and uncertainty in model velocities, an ensemble of 32 runs of the Navy Coastal Ocean Model was configured over the region. Tracer particles have been released on each ensemble member, every hour since the accident time; their locations at each instant can be considered as mean positions of reference water volumes or radioactive amounts, and used to identify areas where signatures of water released from the plant could be found. Results were then compared and integrated with a direct diffusion-advection solution based on the available reports defining inputs of radiation over the coastal region. A stochastic plume was then determined using Risk Assessment Code analysis that associates a number from 1 to 5 to each grid point, determined by the likelihood of having an high radiation concentration and/or tracer particle within short ranges, hence defining high risk areas and those recommended for monitoring. Maps detailing the risk assessment will be discussed using available local observations to assess their consistency and relevance for planning surveys and oil recovery operations at sea. (Abstract ID 10570)

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POLEWARD THERMOHALINE CIRCULATION ON THE SOUTHEAST BERING SEA SHELF

To understand future effects of climate variation in the SE Bering Sea, we need to understand the response to present conditions. Previous investigations of the continental shelf have included closely spaced hydrographic (CTD) casts, but along isolated sections that were too far apart to draw detailed inferences about water properties and flow between sections. We present measurements from 3 summers (2008-2010) on a 37x37-km spaced grid of approximately 300 CTD casts covering most of the shelf during NOAA's bottom trawl surveys. This gives the first comprehensive 3-D view of the temperature, salinity and density fields including the
multi-layered nature and ecologically important Cold Pool (temperature < 2°C). Geostrophic velocity vectors from the gridded observations reveal the thermohaline circulation. Results from all 3 years show consistent poleward flow of warm water along the outer temperature front (above the 100-m isobath) from the Pribilof Islands, across the shelf, past St. Matthew Island and into Russian waters. Satellite-tracked drifter trajectories confirm this circulation. The observations come from 3 “cold” years; inferences about climate change await future “warm” year measurements. (Abstract ID 10574)

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THE AZORES MARINE PARK: DEEP-SEA FEATURES AND MULTI-PURPOSE MARINE PROTECTED AREAS

Portugal with its archipelagos has one of the largest European EEZ’s and expects to obtain jurisdiction over a major North Atlantic seabed area in case its extended continental shelf claim is accepted at the UN. Most of this seafloor corresponds to a diversity of deep-sea habitats. The promising economic opportunities of mineral resources, bioprospection for pharmaceutical and industrial applications increases the responsibility to the nation’s stakeholders. Based on OSPAR and IUCN Guidelines for the Management of MPAs, plans for deep-sea MPAs where produced for the vent fields Lucky Strike and Menez Gwen hydrothermal; and Dorn João de Castro and Sédio seamounts. In view of the extended shelf claim, the Azores Regional Government will be responsible for four additional deep-sea protected areas; Rainbow vent field, the Mid-Atlantic Ridge (box) North of Azores, the Altair and Antaimaur seamounts. In response to the multiple designs and management requirements of areas between the 12nm territorial sea limit (the EEZ) and the extended shelf claim boundary, the Azores Government created the Azores Marine Park. The process leading to its legal creation is reviewed and discussed. (Abstract ID 11699)

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INTERANNUAL VARIABILITY IN GLOBAL PHYTOPLANKTON PHENOLOGY

Large areas of the world’s oceans experience a significant seasonal cycle in phytoplankton biomass. The timing of the bloom affects ecosystem dynamics with implications for biogeochemical cycles and higher trophic levels. Phenological changes may additionally indicate climate change, as the physical processes that control timing alter in a warming world. However, to understand future phenological changes we must first determine variability in timing and what drives it. Here, phytoplankton phenology metrics such as bloom initiation and peak are calculated globally using satellite ocean colour data. The impact of gaps in the time-series is investigated using a global biogeochemical model that assimilates SeaWIFS data. We find that the missing data significantly alter estimations of bloom timing. This uncertainty is seen to vary spatially and between different methods of calculating the same metric. We choose the most reliable metric based on this analysis to explore the relationships between interannual variability in phenology and underlying physical drivers, such as mixed layer depth and climate oscillation indices. Relating phenology to indicators of ocean variability offers new insights on the mechanisms that control bloom dynamics. (Abstract ID 10187)


Ice-ocean interactions on inertial to monthly timescales are studied using winter 2009-2010 observations from the first ice-Tethered Profiler equipped with a velocity sensor. Ocean velocity spiraled clockwise and decayed with depth through the surface mixed layer. Directly-estimated turbulent momentum flux just below the ice-ocean interface was correlated with the ice-ocean velocity difference, allowing a drag coefficient to be estimated. The ice-ocean drag coefficient had larger values derived for straight ice-drift segments and certain ice-drift directions. The surface-layer turbulent kinetic energy dissipation rate also scaled with ice-ocean velocity shear. Inertial or tidal energy in the ice velocity and internal wave fields was observed throughout the record with elevated energy associated with increased stratification within the surface layer and a slightly thicker surface layer. The direct turbulent heat flux was primarily upward, and the direct turbulent salt flux had alternating sign due to brine rejection during ice formation and internal wave mixing and entrainment. Analyses of this and future ITPV data sets will advance understanding of ice-ocean interactions and their parameterizations in numerical models. (Abstract ID 10246)

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REMOTE OBSERVATIONAL OCEANOGRAPHY USING SHIPS OF EXPLORATION AND SATELLITE/INTERNET TELEPRESENCE SYSTEMS

Telescope technologies combined with high-bandwidth video/data streaming and online portals will bring vast quantities of information about the remote oceans to interested people worldwide. During the next 20 years, these technologies will empower scientists and educators to become deeply involved in observational oceanography in real time, facilitating the decision-making process and remote control of and interactivity with sensing systems and instrumentation on remote platforms. The Inner Space Center (ISC) at the University of Rhode Island Graduate School of Oceanography works directly with two ships of exploration, the NOAA Ship Okeanos Explorer and the R/V Nautilus. During the 2010 and 2011 field seasons, the ISC helped support multiple expeditions onboard these platforms by enabling teams of scientists, students, and educators to take part in the field program remotely, providing access to video and data streams and facilitating remote ship-to-shore telecommunications. These capabilities have been tested and protocols have been refined for remote operations with high success, but with expected operational and technological challenges associated with this new paradigm. By 2030 we expect this new paradigm to be established and mainstreamed on many remote ocean observing and exploration systems. (Abstract ID 12791)

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EXPLORING INNER SPACE – EDUCATIONAL KIOSKS AND COMMAND STATIONS FOR INTERACTING WITH OCEAN EXPLORATION CONTENT IN AQUARIUM SETTINGS

Through a partnership between the NOAA Office of Ocean Exploration and Research, the University of Rhode Island Inner Space Center (ISC) at the Graduate School of Oceanography, COSEE, and the Mystic Aquarium and South Carolina Aquarium, we have developed a proof-of-concept interactive system for engaging public audiences with ocean exploration content. Modeled after remote scientific exploration command consoles, the ISKiosk and command station enables aquarium visitors to connect with exciting programs in ocean exploration led by marine scientists. The scientists involved in the exploration programs are excellent resources to help develop and produce the educational content that will aim to improve ocean literacy. This program will expand and grow as more aquariums, science centers, and other
informal education facilities become equipped with the technologies to connect with the ISC. Opportunities exist for ocean scientists engaged in seagoing exploration to communicate their work through this program. (Abstract ID 12802)

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THE ROLE OF THE AMAZON RIVER PLUME IN STRUCTURING UPPER OCEAN STRATIFICATION, BIOCHEMISTRY, AND BIOLOGICAL COMMUNITIES IN THE WESTERN TROPICAL NORTH ATLANTIC

The Amazon River discharges into the equatorial Atlantic Ocean, forming a surface fresh plume layer that extends more than 2000km from the river mouth. Results from two cruises (spring 2010 and fall 2011) undertaken as part of the multidisciplinary ANACONDAS field campaign illustrate the dynamic nature of the plume and its role in modifying the upper ocean currents. Velocity fields show distinct vertical shear associated with the salinity stratification. Stair-step salinity structures sometimes occur beneath the prism plume layer. These may indicate fossil (older) plume water and they often harbor unique biochemical signatures and communities. Vertical salinity fronts with strong surface expression and suggestion of vertical velocities were observed in a semi-permanent eddy in the North Brazil Current retroreflection in fall. The fronts have a visual colored dissolved organic matter signature, and also tend to damp surface gravity waves and whiteness expression on the plume side, suggesting that salinity barrier layers may reduce air-sea exchange of dissolved gases. (Abstract ID 11946)

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EFFECTS OF FORAGING MODE AND TURBULENCE ON THE ENCOUNTER RATES OF THE LORATE CTENOPHORE ANOMENIOPSIS LEDYI

The lobate ctenophore, Anomniopsis leidy, is a voracious zooplankton predator which generates a laminar feeding current to encounter prey (i.e.; suspension foraging). However, it has been suggested that encounters with faster swimming prey, such as copepods, are primarily initiated by the prey inadvertently swimming into the ctenophore (i.e.; ambush foraging). Since the effects of turbulence vary depending on foraging mode it is important to understand how encounters are initiated for different types of prey. We used a simple empirical model to get a first order approximation of how foraging mode affects the encounter rates of A. leidy with prey. Further, we examined how different levels of turbulence may alter encounter rates. The importance of copepod initiated encounters varied for different copepod sizes and corresponding swimming speed. However, for copepods such as Centropages hamatus encounters initiated by the copepod were much greater than those by the feeding current. As expected, the relevance of turbulence varied depending on the encounter mechanism. Model results were compared to preliminary observations of encounters with prey. (Abstract ID 9963)

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LATERAL ADVECTION OF MOMENTUM AT THE SHOAL-CHANNEL INTERFACE IN A PARTIALLY-STRATIFIED ESTUARY

The contribution of non-linear advection terms to the tidally-averaged longitudinal momentum budget in a partially-stratified estuary has traditionally been assumed small compared to the tidally-averaged longitudinal baroclinic pressure gradient and vertical Reynolds stress divergence. However, recent studies have found non-linear advection terms contributing at leading order in various cases, therefore questioning the skills of traditional scalings of the estuarine circulation. In this talk we examine the lateral advection of momentum at the shoal-channel interface of a partially-stratified estuary using transect observations and data from moored instruments distributed across the interface in South San Francisco Bay. We find that lateral advection of momentum in the channel is strongest late in the ebb, when the lateral shear is the strongest and densest water from the shoal plunges down the slope toward the channel. As a result, the tidally-averaged lateral advection term acts to increase the residual circulation, favoring inflow at the bottom and outflow at the surface. Comparison with ADCP measurements of the tidally-averaged vertical Reynolds stress divergence also suggest that lateral advection contributes at leading order in this system. (Abstract ID 9989)

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IN SITU MEASUREMENTS OF SURFACE GRAVITY WAVES IN TYPHOON CONDITIONS

Wave data from four buoys is presented from the recent Impact of Typhoons on the Ocean in the Pacific (ITOP) experiment. Two Air-Sea Interaction Spar (AISI) buoys and two Extreme Air-Sea Interaction (EASI) buoys were moored in “Typhoon Alley” off coast of Taiwan for four months. The buoys measured waves from 4 tropical cyclones in which significant wave heights in excess of 10 meters were recorded. Preliminary findings using Heave-Pitch-Roll (HPR) analysis on the EASI buoys (Nomad type hull) shows promise for uncovering directional information. Comparisons/validations are performed among the 4 moored buoys as well as with drifting Minicat Wave Buoys, marine radar (WamM II), and altimeter satellite (JASON). (Abstract ID 10430)

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HMA: A META-DATABASE FOR GENOMES, METAGENOMES, AND PHENOTYPES FROM COLD ENVIRONMENTS

The recent flood of sequencing data has been a boon for the traditionally data-poor discipline of biology, but can also prove overwhelming. For microbial ecologists, it would be useful to access a database of phenotypic traits for cultured species of microorganisms, but there does not yet exist a comprehensive database linking genome, taxonomy, and phenotype from environmental isolates; neither are detailed metadata always submitted by sequencing facilities and investigators. For example, no queryable database exists to get a list of all known strains of Bacteria that reduce sulfate, or strains which grow at temperatures below 10°C. As an initial foray into a web-based database linking phenotype and genotype, I have created a database linking sequences and phenotypic data (which are often archived in disparate locations and formats) of cold-active microorganisms from all three Domains of Life. When available, I include sampling environment, location, temperature and growth range, depth, sequencing platform, amount of data, etc. Currently, the database includes 50 complete genomes sequences as well as 444 metagenomes, including a number of transcriptomes and viromes. Isolates and environmental samples, collected between 79°N and 77°S, come from many environments. The database—called “hima” after the Sanskrit word for snow or cold—will be updated into the future and further expanded to include analytical resources; it can be accessed at http://veric.org/work/hima/. (Abstract ID 12871)

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OBSERVATIONAL EVIDENCE OF AN INCREASE IN VERTICAL MIXING SOUTH OF THE POLAR FRONT IN THE SOUTHERN OCEAN USING OBSERVATIONS OF RADIIOCARBON AND SURFACE CO2.

Measurements of surface water pCO2 and 14C/12C of dissolved inorganic carbon (C-14) south of the polar front suggest that estimated increases in Southern Ocean winds may be driving an increase in vertical mixing of deep waters to the surface which has acted to decrease the Southern Ocean sink. The increase in vertical mixing is demonstrated by a (70±14 %) decrease in C-14 between 1973 and 2006 in the Drake Passage south of the Polar Front and a steeper meridional gradient of surface water C-14 across the polar front. Using a GC model we estimate that ~75% of the observed decrease in surface C-14 is due to the large decrease in atmospheric 14C/12C as result of nuclear bomb testing. The decrease in C-14 is synonymous with an increase in surface water CO2 south of the polar front region of the Southern Ocean which is significantly greater than that expected from the rise in atmospheric CO2 observed over the last 30 years. These observations are significant because they support the low resolution GCMs which show a decrease in CO2 uptake in the Southern Ocean due to upwelling of carbon rich deep waters south of the Polar Front. The potential biases of these data based estimates will be discussed. (Abstract ID 12385)
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MODELING THE OXYGEN ISOTOPE COMPOSITION OF PHOSPHATE IN AQUATIC ECOSYSTEMS

The oxygen isotope composition of phosphate (δ18Op) has emerged as an important tool for understanding rates and mechanisms of phosphate uptake and regeneration in the oceans. Microbial phosphate cycling leads to the rapid exchange of phosphate oxygen with water oxygen. Early culturing experiments suggested that phosphate remineralization would result in δ18Op values consistent with isotopic equilibrium. Indeed, measurements of δ18Op in the coastal ocean and deep ocean have indicated that phosphate cycling often leads to isotopic compositions near equilibrium. However, a wide range of experiments on a variety of phosphoprophylase enzymes suggest that remineralization can easily lead to large excursions from isotopic equilibrium. Here we assemble a generalized model that highlights the potential importance of pyrophosphatase and cell lysis for exerting significant control over δ18Op. We show how these results can inform our understanding of couplings between P and C cycles in the euphotic zone of a continental margin environment, the euphotic zone for open ocean oligotrophic environments, and the deep ocean. (Abstract ID 12842)

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MEAN AND SEASONAL TRANSPORT VARIABILITY IN THE SOUTHWEST ATLANTIC DERIVED FROM A TWO-WAY NESTING MODEL EXPERIMENT

The Southwest Atlantic Circulation (SWAC) is principally governed by the interaction of the Brazil Current and the Malvinas Current originating from the Antarctic Circumpolar Current (ACC). Previous studies have shown a deficiency in reproducing an acceptable position of the Brazil/Malvinas confluence, noticeable in coarse-resolution models. Facing the dilemma between the need to have a high-resolution model grid applied to the SWAC region and to resolve the large-scale ACC, our study uses ROMS ocean model at a 1/12°x1/12° resolution for the SWAC region embedded into a coarser-resolution (1/4°x1/4°) southern hemisphere grid. We find a strong agreement between the modeled and observed latitudinal position of the confluence at ~39°S. We present evidences that during austral summer (winter), the southward (northward) displacement of the confluence coincides with an intensification (weakening) of the Brazil Current, which is found to respond to a strengthening (weakening) of the wind stress curl in the SWAC below ~3°S. This study also highlights the asymmetry between Brazil and Malvinas currents transports, with a weakening of the Malvinas current during summer. Those hypotheses are supported by a passive tracer method. (Abstract ID 9622)

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OCEANIC TRANSPORT AND ITS ROLE ON THE SNOW BALL EARTH HYPOTHESIS

Balance models have been proposed to model the dynamics of the Earth’s climate at long time scales, primarily to discern the role played by changes in the Sun’s input on geologically-documented periods of climate change. Previous models capture the radiative balance, radiation changes, and the albedo effect. More recent models also include a dynamic for the ice sheets. We investigate the role played by oceanic transport on a balance model by coupling the ice sheet thermodynamics, radiation effects, changes in solar radiation, and the flow of a zonally-averaged ocean. We use this model to determine the importance and manner in which oceanic transport affects ice sheet coverage at climatic scales, as well as how ice melting and freezing affects the classic thermaline scenario for ocean overturning. (Abstract ID 9330)

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IS CALCIIFICATION IN THE SCLERACTINIAN CORAL PORITES RUS AND THE CRUSTOSE CORALLINE ALGA HYDROLITHON ONKODES CONTROLLED BY BICARBONATE OR CARBONATE IONS?

In the context of contemporary ocean acidification (OA), it is critically important to understand the mechanism(s) of calcification on tropical coral reefs, and how it responds to declining carbonate ion concentration ([CO3]2-). In order to evaluate the roles of [CO3]2- versus bicarbonate ion concentration ([HCO3]-), Porites rus and Hydrolithon onkodes were maintained for 2 weeks under a matrix of 9 treatments representing three [CO3]2- crossed with three [HCO3]-. Both [CO3]2- and [HCO3]- played a significant role in light and dark calcification of P. rus, whereas [HCO3]- mainly affected calcification in the light. Both [CO3]2- and [HCO3]- had a significant effect on the calcification of H. onkodes, but the strongest relationship was found with [CO3]2-. Therefore, calcification of both P. rus and H. onkodes appears to be dependent on more than one species of the DIC system, and is affected by the availability of both [CO3]2- and [HCO3]-. These results suggest that the decrease in [CO3]2- expected as a result of OA, and its associated effects on coral reef calcification, might then be mitigated by the ability to also use HCO3- to calcify. (Abstract ID 9456)

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The complete 1979-1986 and 1997-2010 NASA climatology, yearly and seasonal Level-3 Standard chlorophyll map sets were analysed using principal component analysis. The first component identifies the characteristic chlorophyll structure for the period under study, whereas the second outlines the major differences between the original maps. Higher components permit the identification of spatially and temporally local variations and anomalies. Water masses having seasonal averaged chlorophyll values up to 0.8 mg m-3 present a cyclic variation showing highest chlorophyll concentrations during the winter months and lowest values during summer months and the basin or the sensor under consideration. The Gulf of Mexico was temporally and spatially the most dynamic of the three basins under study. (Abstract ID 10349)

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HYDROCARBONS AS SUBSIDY ENERGY FOR MICROBIAL AND FOOD WEB PRODUCTION IN COASTAL GULF OF MEXICO WATERS

Deepwater Horizon was unprecedented in total loading of petroleum hydrocarbons and chemical dispersants released into a marine environment. To better understand source-sink dynamics of oil-derived carbon and surface spill impacts on microbial food web processes, we conducted mesocosm experiments, and field surveys under pre- and post-spill conditions, measuring a full suite of chemical and microbial metabolic parameters. 13C was used as a tracer of oil to resolve isotopic carbon depletion in dissolved inorganic pools. High initial spikes in microbial growth were observed in oil only treatments but cell numbers declined rapidly after 24h. Sustained, high-level production was also observed in dispersed oil treatments but growth was delayed by 48h. In the field, localized spikes but greatly reduced seasonal dissolved organic carbon, increased offshore microbial production, and carbon depletion were coincident with surface oil slicks, and demonstrated oil carbon was respired. In addition, total chlorophyll-a remained low compared to pre-spill years, and contained 100 times less carbon than surface oil. Collectively, these results suggest increased influence of the ‘microbial loop’ under oiled conditions with implications for trophic dynamics in the Gulf. (Abstract ID 11552)

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HYPOXIA IN A HISTORICAL PERSPECTIVE – INDICATORS OF CHANGE

The spatial extent and severity of hypoxia in the Baltic Sea is believed to have increased over the last century with discharges of nutrients, although there are few quantitative studies. Monitoring of oxygen beginning in ca. 1900 suggest that hypoxia was confined to the very deep parts of the Baltic, but the scarcity and heterogeneity of the data (in both vertical and horizontal space) complicate the assessment of hypoxic area and volume before ca. 1970 and confident analysis of non-climatological chlorophyll data based on the World Ocean Database.

The historical archives of in situ chlorophyll data from the National Oceanographic Data Center were used to analyze long-term patterns in the non-climatological distribution of chlorophyll at regional scales. We will show the distribution of “outliers” from mean climatological chlorophyll fields and analysis of patterns and trends at various regional and temporal scales. These analyses contribute to our understanding of climate variability and climate change impacts on marine ecosystems. The historical archives at the National Oceanographic Data Center (NODC) preserve historical ocean observations dating back to the early 1700’s to the present. These data have been used to create the much cited World Ocean Database and World Ocean Atlas (WOA) series of atlases of key ocean variables. We used the latest update of WOD and WOA for this analysis. This analysis continues the long history of NODC to provide baseline information for key variables and examine the deviations from the baseline. (Abstract ID 11164)

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ANALYSIS OF NON-CLIMATOLOGICAL CHLOROPHYLL DATA BASED ON THE WORLD OCEAN DATABASE

In a recent field investigation of the interactions between sediment and turbulence, three separate sensors used to collect information on suspended sediment load were co-located in the neashore. These included a multi-frequency acoustic backscatter sensor (ABS), a fiber optic backscatter sensor (FOBS) and a digital holographic camera. Each sensor has its own strengths with the FOBS nominally providing high frequency concentration measurements up to the water surface, the ABS providing multi-frequency responses with the potential for grain size estimation; and the holographic camera providing direct information on the sizes and shape and distribution of the local suspended sediment load as well as permitting segregation of the suspended material into sediments, organic matter and bubbles. Initial results indicate general consistency between the sensors on a mean basis but with clear instances of significant disagreement. We shall analyze the results to perform a cross-comparison of the sensors, examine the relationship between imdered size differentiation capabilities of the multi-frequency ABS sensor; and seek to determine the relationship between the size-distribution of the bed material and the suspended load. (Abstract ID 10686)

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at plume-dominated stations and in the plume-influenced depth interval (0-10 or 0-25 m)
crustacean larvae and coastal zooplankton were more prevalent. We discuss the potential
influence of the plume on transport of zooplankton development stages as well as plume
zooplankton on export. (Abstract ID 10821)

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Assessing data collection, spatial and temporal patterns in crowd source bathymetric data

Crowd Source Bathymetry (CSB) data may be collected by any type of vessels, a variety of sonar
systems, and for myriad reasons. Enlisting the resources of recreational boaters, pilot boats,
tug boats, cruise ships, as well as fully equipped survey ships in the “opportunistic” acquisition
of bathymetric data may potentially open data streams of current observations to navigators,
cartographers, scientists, and engineers. Using autonomously collected time, observation, and
position data from test vessels that operated without regard to bathymetric survey objectives,
we characterize the statistical representation of seafloor structure from these sources and
derive comparative differences with existing survey data. Potential types of data streams are
envisioned and simulated for comparative purposes. One strength of CSB data is the temporal
frequency in repeat observations, while spatial representation is less evenly distributed.

(Abstract ID 10941)

Ocean acidification, caused by increasing pCO2

Ocean Drilling Program (IODP) drillship JOIDES Resolution. In an effort to educate, inspire and

Public - these educators use the authentic, cutting-edge research being conducted on the ship

LIVE FROM THE OCEAN: AN OVERVIEW OF RECENT EXPERIENCES

Deep Earth Academy calls Onboard Education Officers on every expedition of the Integrated
Ocean Drilling Program (IODP) drillship JOIDES Resolution. In an effort to educate, inspire and
excite a wide variety of audiences — including teachers, students of all ages, and the museum-going
public — these educators use the authentic, cutting-edge research being conducted on the ship,

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to engage these audiences through live ship-to-shore video broadcasts, blog posts, photos and videos, related classroom activities, and social networking sites such as Facebook and Twitter. Over the course of more than three years, the technology and methodology used has evolved, as have best practices, feedback mechanisms, and support for educators and their participants. This session will share these lessons learned, statistics and feedback, and explore questions for achieving broader reach going forward. (Abstract ID 11149)

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ADRIATIC SEA DECISION SUPPORT SYSTEM (ADRI-DSS)
The Adriatic Sea Decision Support System (ADRI-DSS) consists of an on-line service built upon a set of integrated operational oceanography products. ADRI-DSS integrates the Adriatic Sea forecasting system (AES) products with coastal in-situ observations from the Regional Environment Protection Agency (ARPA-EMR) of Emilia-Romagna (Italy) to support ARPA-EMR activities of coastal monitoring. Specifically ADRI-DSS supports the daily action of ARPA-EMR integrating and providing different types of operational oceanography products (forecast, observations, simulations). ADRI-DSS integrates with the routinely observations that the user carry out on a weekly basis. The system has been designed through the interaction with ARPA-DAFNE and consists of an online portal containing simulation and forecast for the relevant north Adriatic region. Moreover the models products are compared with in-situ observations of temperature and salinity collected by the ARPA-DAFNE itself and different types of online data post-processing are available for the user. The final aim of ADRI-DSS is to integrate selected products from the AES with the in-situ observations to support the monitoring and marine environment status assessments of ARPA-DAFNE. (Abstract ID 11836)

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ISOLATION OF BLACK CARBON FROM MARINE DISSOLVED ORGANIC CARBON USING A REVISED SOLID PHASE EXTRACTION METHOD
The presence of black carbon (BC) in marine dissolved organic carbon (DOC) may be a key to understanding the old 14C age of DOC. Measurements of BC in DOC have been constrained by the ability to obtain representative samples of the bulk DOC pool itself, including both the high and low molecular weight fractions in which char and soot BC are present. Previous work by Ziolkowski and Druffel (2009) reported a low abundance of BC in the high molecular weight (HMW) DOC fraction. However, the HMW-DOC in their study represents only one fourth of the bulk DOC pool. Here, we report progress on a modification of a Solid Phase Extraction method (de Jesus, 2008) to extract bulk DOC. We then subject this extracted organic matter to acid hydrolysis using the Benzmere Polycarboxylic Acid method and isolate the derivatized BC markers using preparative capillary GC. With this method development, we have the ability to quantify and measure the 14C/12C ratio of BC in the bulk DOC pool to better understand BC cycling in the ocean and its possible importance as a carbon sink in the ocean. De Jesus, Roman (2008), Natural abundance radiocarbon studies of dissolved organic carbon (DOC) in the marine environment. Doctoral Thesis, U.C. San Diego, pp. 83 Ziolkowski, L. A., and E. R. M. Druffel (2009) reported a low abundance of BC in the bulk DOC pool to better understand BC cycling in the ocean and its possible importance as a carbon sink in the ocean. (Abstract ID 9696)

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AN INVESTIGATION OF SPATIAL AND TEMPORAL VARIABILITY OF SURFACE SEABED PROPERTIES AND ERODIBILITY ON THE WAIPAOA RIVER MARGIN, NEW ZEALAND
Margins with high sediment supply can produce thick sequences that contain detailed information on the controlling sedimentary processes. However, the stratigraphic record must be unraveled to understand the terrestrial and marine processes influencing sedimentation. As part of the multi-institutional MARGINS “Waipaoa Investigation of Seabed Energetics” project, time-series analysis of surficial seabed properties (e.g., erodibility measurements, x-ray radiography, and sedimentological and radiochemical data) are being used to evaluate temporal and spatial changes in strata formation and sediment dynamics on the Waipaoa River margin. Data indicate significant temporal-spatial variability in seabed properties reflecting a dynamic sedimentary environment, especially proximal to Poverty Bay. Stations located near the mouth of Poverty Bay are characterized by heterolithic deposits and often show greater erodibility in comparison to other sites (e.g. those in the mid-shelf depocenters) that have higher clay percentages. Temporal changes in physical sediment properties appear to be caused by short-term deposition and erosion of sediment which is controlled by fluvial supply and oceanographic conditions. Measurements of seabed properties (e.g., erodibility) will be incorporated into modeling efforts to predict sedimentation in this morphologically complex system. (Abstract ID 11727)

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IMPACT OF WINTER SST ANOMALIES ON EASTERN SEABOARD SUMMER SURFACE WIND VARIATIONS
The direction of summer winds plays a key role in a wide array of physical and biological processes. Using a 60-year time series of winds observed at nine stations along the US East Coast, we demonstrate how the large-scale variability in inter-annual summer wind direction is linked to climatological forcing. Using NCA/NCEP reanalysis data, we have documented that the prevalence of winds from the south along the majority of the Eastern Seaboard is related to sub-heating in the location and intensity of the Bermuda High. South winds are favored when the Bermuda High intensifies and builds northwest over New England. In contrast, during summers when the Bermuda High is weaker over New England, north winds become more common. The large-scale variability of the Bermuda High is linked to SST anomalies from the previous winter. We propose a mechanism by which cold winter SST anomalies intensify the Bermuda High during the following summer favoring winds from the south, while warm winter SST anomalies limit the northwest expansion of the summer Bermuda High reducing the occurrence of winds from the south. (Abstract ID 10405)

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AN AIR-SEA FLUX EXPERIMENT FOR 2030
In January 2011 the University of Rhode Island held a two day retreat for faculty and research scientists interested in where the field is going over the next 20 years. The retreat began with presentations detailing the current status and anticipated advances in genetics, nanotechnology, numerical modeling and robotics. Participants then outlined scientific problems that they expect will exist in 2030. This was followed by breakout sessions in which participants discussed experiments, based on anticipated technological advances, that might be undertaken in the 2030 time frame to address some of the identified problems. In this presentation we outline one of these experiments. The experiment was designed to quantify air-sea fluxes under high wind conditions following a wave train. We believe that not only will the processes involved remain poorly resolved in 2030 but also that they will become of increasing importance as the coupling and the spatial and temporal resolution of ocean and atmospheric models improves. The experiment outline is based on a suite of unmanned submersible and air assets designed to sample the ocean, the atmosphere and the interface between the two. (Abstract ID 12464)

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HALOBATES IN THE EASTERN TROPICAL PACIFIC 1967-2010: AN UPDATE ON DENSITY AND EVIDENCE FOR SEASONAL RANGE SHIFT
Five species of the marine insect Halobates are adapted to life on the open ocean. Four of these species live in the Eastern Tropical Pacific Ocean. The distribution and density of Halobates in the Eastern Tropical Pacific was investigated using a 10 year data set collected from the Sea Education Association’s sailing research vessel SV Robert C. Seamans. These data, now compared to the EASTROPAC Halobates dataset from 1967-68. Data for two species, Halobates sobrinus and Halobates micans, suggest rather than a change in distribution in the last 45 years, Halobates in the region shift their range seasonally. As many have suggested previously, sea surface temperatures appear to affect the range of Halobates. The surface current structure in the region also may help control distribution. The low co-occurrence in net tows suggests monospecific aggregations even when the ranges of two species overlap. Halobates density shows significant inter-annual variation though the causes remain unclear. (Abstract ID 11174)
FORAGING BEHAVIOR OF A WIDELY RANGING MESO-PELAGIC TOP PREDATOR, THE NORTHERN ELEPHANT SEAL.

The mesopelagic zone of the northeast Pacific Ocean is an important foraging habitat for many predators, yet few studies have addressed the factors driving basin-scale predator distributions or inter-annual variability in foraging and breeding success. We collected diving, tracking, foraging success, and natality data for a large number of adult female northern elephant seals over seven years. Mean foraging success varied by factor of two across years and was a significant predictor of natality. At sea, behavioral foraging metrics based on diving and tracking data suggest the boundary between the sub-arctic gyre and subtropical gyre contains a rich and persistent prey resource at mesopelagic depths, but a small proportion of seals were also successful north of the boundary in the sub-antarctic gyre and neighboring continental shelf breaks. Seal density distributions and temperature profiles show a strong association with the gyre-gyre boundary during both annual migrations, consistent with previous reports that the latitude of the gyre-gyre boundary is stable relative to dynamic surface features, such as the transition zone chlorophyll front. (Abstract ID 11759)

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MODIFICATIONS OF A SOUTH ATLANTIC OCEAN WARM-RING BY AIR-SEA INTERACTION

Two different models were used to investigate the modifications in the thermostat of a warm Agulhas ring by air-sea interaction in the South Atlantic Ocean: a one-dimensional mixed layer model (PFWP) and a realistic OGCM (ROMS), with surface forcing from NCEP climatological and synthetic data. The ring was sampled three time by the High Density XBT Transects (AX18), which shows that the 16°C thermostat reaches 220 meter depth in July 2000, and extends down to 310 meter depth in January 2010. The impact of the surface flux induced secondary circulation within the ring is investigated in the deepening of the thermostat and the formation of a subsurface velocity maximum. This effect is supported by geostrophic velocities calculated with temperature and salinity XBT section and absolute AVISO SSH. The synoptic-scale surface forcing is necessary for a good simulation of the ring thermal balance, since large heat fluxes out of warm-core rings can be expected during atmospheric fronts or storms. (Abstract ID 12295)

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FUTURE OCEAN USES IMPORTANT FOR COASTAL AND MARINE SPATIAL PLANNING

There is a need to conserve ocean ecosystems and use ocean space, requiring planning for multiple uses of compatible activities and development of strategies to promote, enhance, and optimize these uses. The Rhode Island Ocean Special Area Management Planning (OSAMP) process is an ecosystem-based planning framework with unique policy drivers. The OSAMP also informs implementation actions for future multiple uses of ocean space. The OSAMP reviewed possible future uses and conservation issues for Block Island and Rhode Island Sounds: mining, offshore LNG, short sea shipping, marine conservation, artificial reefs, aquaculture development, expansion of ecotourism and underwater cemeteries, and use as a research/education area. Principles and practices of ecological engineering, industrial ecology, life cycle assessments and material flow accounting, as well as social ecology and ecological economics will be important to the design, implementation, and evaluation of compatible, multiple uses of ocean space. There will also be a rapid turnover of ideas on the future uses of ocean space; thus, a participatory framework for the engagement of stakeholders must continue as new uses are explored so that all information can be shared systematically. (Abstract ID 9524)

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PHYSICAL PROCESSES DRIVING FINESCALE BIOLOGICAL PATCHINESS IN AN INNER SHELF, HIGH PRODUCTIVITY ENVIRONMENT: ACOUSTIC AND OPTICAL MEASUREMENTS

As part of an interdisciplinary effort to define lateral mixing in an inner shelf area previously studied for its development of plankton thin layers, we conducted finescale sampling using acoustics (Simrad 200 kHz and 710 kHz) and an undulating optical imaging system (ISIS) in...
the northeast Monterey Bay over a 12-d period. Acoustic observations revealed considerable spatio-temporal variability in the vertical extent of fine layering of the water column; some days were characterized by well-defined thin layers (ca. 1 m thick), while other days the water column was acoustically homogeneous (ranging from dense returns to very light returns). Optical observations of the water column revealed extremely dense phytoplankton aggregations (dominated by *Pseudo-nitzschia spp*), with extensive flocculation (ca. 1-2 cm diameter) concentrated at thin layers. Flocs were also abundant where strong acoustical returns occurred throughout the water column. Zooplankters (e.g. copepods, shrimp, etc.) were distinctly absent from most of these thin, subsurface layers, though concentrations of copepods were occasionally evident near the surface. Alteration of the water column was driven by lateral intrusion of offshore water and stirring of a non-bloom water mass. (Abstract ID 11092)

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OCEAN OBSERVATORIES INITIATIVE: CONSTRUCTION PROGRESS UPDATE
The National Science Foundation’s (NSF) Ocean Observatories Initiative (OOI) is implementing the construction and operation of an interactive, integrated ocean observing network. Construction funding for this research-driven, multi-scale network began in September, 2009. The OOI is constructing instrumented networks of multidisciplinary sensors on moorings, autonomous underwater vehicles, gliders, and seafloor platforms. During the past year, major advances occurred across the project. The OOI now has an implementing organization to develop education infrastructure. $880$ km of underwater cable was installed across the Juan de Fuca plate off the Oregon coast and a cable station at Pacific City, OR was established. Several at-sea tests of essential design elements for coastal and global moorings were conducted off the Oregon coast and south of New England. Considerable test data will be available in late 2011 and into 2012. Gliders are being purchased and tested for deployment in 2012, with data flowing by fall 2012. Over half the instrument types to be installed during construction have been identified. Workshops and webinars will occur on a regular basis. More information at http://www.oceanobservatories.org (Abstract ID 12086)

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INTERRUPTED TURBULENCE AND SEDIMENT SUSPENSION IN THE SURF ZONE AND IMPLICATIONS FOR ONSHORE SEDIMENT TRANSPORT
Wave breaking turbulence and sediment suspension in the surf zone are characterized by large intermittent events. We analyzed cross-shore observations of velocity and sediment concentration from a large-scale laboratory experiment (CROSSTEX) under erosive and accretive wave forcing to investigate the conditional probabilities between wave breaking turbulence and sediment suspension. Approximately 30–65% of the sediment suspension events were associated with turbulent events, implying that intermittent turbulent motion is one of the fundamental mechanisms for the initiation of sediment suspension in the surf zone. The uncorrelated sediment suspension events were associated with strong offshore currents, consistent with advection. One notable exception was at the bar trough in the accretive case, implying that additional mechanisms for the initiation of sediment suspension are important. For the accretive case, the large intermittent sediment suspension events contributed to a net onshore transport near the bar. We developed a time-dependent model of intermittent sediment suspension for both cases using an artificial neural network to explore the contribution of the slowly varying undertow, wave induced velocity, and turbulent kinetic energy on sediment suspension across the surf zone. (Abstract ID 11968)

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THE INFLUENCE OF NEARSHORE BARS ON INFRAGRAVITY ENERGY AT THE SHORELINE
Bathymetric features such as nearshore sandbars can alter local nearshore hydrodynamic processes such as the production of infragravity energy. These bathymetric features may act to reduce or increase the amount of infragravity energy that reaches the shoreline. To determine the influence of the bathymetric features on infragravity energy, the numerical nearshore processes model XBeach was used to simulate infragravity energy at the shoreline. Numerical simulations were completed for three types of bathymetric scenarios: continuous alongshore bar, 1-2 rip, and no-bar. An empirical parameterization for significant infragravity swash developed by Stockdon et al. (2006) was modified for barred beaches. Results show that the amount of infragravity energy in the form of swash is dependent on the bar height and depth, in addition to the offshore wave height and wavelength. Since infragravity swash influences beach erosion (Rovinskii et al. 2009, Ruggiero et al. 2006), results of this research may be used as part of an erosion vulnerability scale. Such information on erosion vulnerability is important for the design of coastal protection systems and the protection of coastal communities. (Abstract ID 9349)

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BIOLUMINESCENCE IN THE NEAR SEAFLOOR REGION OF THE DEEP SEA.
Bioluminescent activity has been reported to be very low in the absence of artificial stimulation. However, bioluminescent zooplankton, advected by currents, are stimulated to produce light as they impinge on overtopping features on the seafloor. The rate of bioluminescent flashes is dependent on the size of the overtopping feature, the current speed and the BL density. Low-light video imaging systems were used to quantify the density of bioluminescent zooplankton (BL) in the near seafloor region (0-400 m above bed). BL density was found to decrease exponentially with seafloor depth, by a factor of 4.2 per 1000 m in the Mediterranean Sea ($R^2=0.92, P<0.0001$) and by a factor of 3.5 in the Atlantic Ocean ($R^2=0.89, P<0.0001$). At equivalent depths, BL densities in the N Atlantic Ocean were consistently higher than those in the Mediterranean Sea, reflecting the lower productivity of the latter region. Novel predictions can be made of the visual environment of the deep-sea floor using high resolution bathymetric maps, current data and BL density depth trends. (Abstract ID 12580)

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THE 3-MINUTE SOLUTION: COMMUNICATING YOUR RESEARCH IN SHORT, EFFECTIVE VIDEOS
The fact that changes are occurring in the ocean provides both a unique opportunity and urgent need for ocean and coastal scientists to communicate their research to a broad audience. Some of these changes affect us in our daily lives - more intense hurricanes, drought, dead zones, depleted fisheries – making the connection to research more obvious. Connections to daily life mean more people are more concerned, yet that places additional pressure on ocean scientists to be able to communicate effectively. With the rise of YouTube and other online outlets, short videos have become a part of the daily information stream for students, educators, and citizens. Video has been used effectively in a variety of settings, and we will offer examples: online teaching, aquarium kiosks, live broadcasts from research cruises, educational websites, audio slideshows. But making an effective video is not as simple as turning on the camera. We will present the COSEE OCEAN template: how to produce an engaging video, featuring a scientist communicating their research clearly, that will capture the attention of a broad audience in under three minutes. (Abstract ID 10757)

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SOME LIKE IT HOT, SOME LIKE IT COLD: THERMAL FLEXIBILITY IN CORAL SYMBIOTS
The symbiosis between coral hosts and zooxanthellae forms the foundation of coral reef ecosystems. Translocation of photosynthates, including sugars, amino acids, and lipids, from symbiont to host signals coral health and may be responsible for light enhanced calcification. In shallow waters, photosynthetic symbiont production can exceed the requirements for symbiont to host signals coral health and may be responsible for light enhanced calcification. In deeper, lower light waters, algal symbiont photosynthesis slows and may provide lower levels of essential nutrients and energy to the host. Extreme temperatures can have devastating impacts on coral symbiosis by causing bleaching. We used high-resolution GC-MS metabolomics to compare metabolite signals in four clades of symbionts (A, B194, B224, and D). Symbiont production of metabolites varies with light and temperature. Thermally tolerant Clade D differentiates itself from other clades. Clade D produces high energy fatty acids, even in high light stress when Clade A and B184 greatly reduce fatty acid production. Clade B224 shows promise as a thermally and light tolerant symbiont. (Abstract ID 10826)

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NEXT-GEN PHYLOGEOGRAPHY
Phylogeography has emerged over the last two decades as an exciting and informative field that spans the chasm between population genetics and systematics. Population genetics has traditionally been interested in the processes of evolution, including estimated associated parameter values such as migration rates, genetic diversity, and measures of selection; systematics has focused on historical patterns of divergence and associated morphological,
temporal, and ecological changes correlated with such patterns. Phylogeography attempts to merge these perspectives and capitalizes on gene divergence patterns and their fit to predictions derived from different models in population genetics. The seminal work of Avise and colleagues ushered in this approach to merging concepts from these two fields to study speciation and population divergence. Over the past two decades, an impressive set of analytical tools have been developed with advances in both population genetics and phylogenetics that have had a significant impact in phylogeography. Recently, significant advances in DNA sequencing technologies have revolutionized the scale and scope of genetic data that can be used to study phylogeography and population genetics. Here I overview the methodologies, both molecular and analytical, for phylogeographic inferences and provide examples of applications of such methodologies to natural history studies. (Abstract ID 11611)

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RECONSTRUCTION OF MARINE FISHERIES CATCHES FOR TUVALU (1950-2009)
Tuvalu’s total marine fisheries catches within its EEZ were reconstructed for the years 1950 to 2009. This reconstruction accounts for officially un- and underreported catches of artisanal and subsistence fishery sectors as well as the baitfish used in the pole-and-line tuna fishery. FAO data were used in combination with data from fish markets, regional reports and consumption data. Total reconstructed catches were estimated to be 66,631 over the six decades, which is approximately 5 times larger than the amount reported by the FAO to Tuvalu’s behalf (12,241 t). Total catches increased from 83 t/year-1 in 1950 to 1,607 t/year-1 by 2009. The majority of total catches were from the subsistence sector (87%). Although the subsistence sector was the principal portion of the reconstructed catch, it was largely excluded from the reported data. This investigation reveals the need for an improvement in the accounting of marine fishes total catches were from the subsistence sector (87%). Although the subsistence sector was the principal portion of the reconstructed catch, it was largely excluded from the reported data. This investigation reveals the need for an improvement in the accounting of marine fishes.ubc.ca

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WATER COLUMN METHANE DYNAMICS IN RESPONSE TO THE DEEPWATER HORIZON HYDROCARBON SPILL
The Macondo Blowout injected as much as 500,000 tonnes of natural gas into the Gulf of Mexico water column. To determine the impacts and the fate of this massive injection of gas, we measured the methane concentration and the rates of aerobic methane oxidation during several expeditions following the BP oil spill from early May until December 2010. In situ dissolved methane concentrations were determined using headspace extraction and gas chromatography, and methane oxidation rates were determined using the tritiated methane radiotracer technique. Aerobic methane oxidation rates peaked within methane rich subsurface plumes in late May (58 nmol/L) but decreasing significantly by late June (less than 50 nmol/L) throughout the water column. The quantification of methanotrophic populations by quantitative PCR revealed an increase in the methanotrophs 16S rRNA gene copy number that corresponded to the observed patterns in increase of the methane oxidation rates. Quantification of the pmoA gene (encoding particular methane monooxygenase subunit A) over time, as well as laboratory experiments identifying environmental factors regulating the methanotrophic community, provided insight to the factors regulating methane cycling in Gulf of Mexico waters. (Abstract ID 12742)

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HOOKING UP: THE ROLE OF FLUID STIRRING AND CHEMOTAXIS IN EXTERNAL FERTILIZATION STRATEGIES
Many benthic invertebrates reproduce via an external fertilization strategy called broadcast spawning. Males and females release sperm and egg at separate locations, and subsequent fertilization relies on structured fluid stirring (at large scales) and chemically mediated sperm taxis (at small scales) to bring gametes into contact. Past studies by our group show the role of fluid stirring on bringing initially distant gametes into close proximity. However, these same studies show that, due to the weakly diffusive nature of egg and sperm, actual coalescence of gametes by stirring and mixing alone is limited. This suggests that sperm chemotaxis is critical for efficient fertilization. We present a set of analytical, numerical, and laboratory experiments that demonstrate how physical processes cause gametes to aggregate. We then demonstrate how sperm taxis acts as a "directed diffusion" at small scales that greatly enhances the resulting fertilization rate. The goal is to show the effect of complex flows on the resulting distribution of attractant plume exuded by eggs, and how sperm taxis parameters like swimming speed and attractant sensitivity impact the resulting fertilization success rate. (Abstract ID 12301)

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FORMATION AND EROSION OF THE SEASONAL THERMOCLINE IN THE KUROSHIO EXTENSION RECIRCULATION GYRE
Data from the Kuroshio Extension Observatory (KEO) surface mooring are used to analyze the balance of processes affecting the upper ocean heat content and surface mixed layer temperature variations in the recirculation gyre (RG) south of the Kuroshio Extension (KE). Cold and dry air blowing across the KE and its warm RG during winter cause very large heat fluxes out of the ocean that erode the seasonal thermocline in the RG. Some of this heat loss is replenished through horizontal heat advection. Enhanced diffusive mixing at the base of the mixed layer tends to transfer heat downward, potentially eroding and even modifying subtropical mode water. Diffusivity at the base of the mixed layer, estimated from the residual of the mixed layer temperature balance, has values of $3-5\times10^{-4} m^2/ s$ during the summer and values a couple of orders of magnitude larger during winter. The enhanced diffusivities appear to be due to large inertial shear generated by wind events associated with winter storms and summer tropical cyclones. (Abstract ID 10084)

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CARBONATE MINERAL SUPPRESSION AND OCEAN ACIDIFICATION IN THE EASTERN BERING SEA
Increasing CO$_2$ concentrations in the atmosphere and ocean have induced an anthropogenic acidification phenomenon, particularly in high latitude seas, commonly resulting in suppression of carbonate mineral saturation states. On the Eastern Bering Sea shelf, several natural mechanisms of carbonate mineral saturation state suppression have been observed, including the upwelling of low pH deep water onto the shelf; the influx of low pH river water to the coastal margin; and a highly productive biological pump, which seasonally lowers pH in bottom waters and increases atmospheric CO$_2$ absorption in surface waters particularly over the middle shelf. The anomalous occurrence of coccolithophore blooms in recent years may also contribute to carbonate mineral suppression in the region by lowering surface ocean alkalinity and reducing buffering capacity. Here we use $^{818}O$ tracer data to distinguish the impact of these blooms on carbonate mineral saturation states in the Eastern Bering Sea. Despite the presence of these various naturally occurring mechanisms of carbonate mineral suppression, we show
that it is ultimately the addition of anthropogenic CO₂ that results in seasonal undersaturations of carbonate minerals to this system. (Abstract ID 9529)

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INVESTIGATING THE TEMPORAL VARIABILITY OF SUSPENDED PARTICLE POPULATIONS IN A SHALLOW SHELF SEA

The majority of the energy associated with tidal activity is dissipated within shelf seas, though they occupy a relatively small area when compared to the expanse of the open ocean. The dynamics of suspended particulate matter (SPM) in a shallow shelf sea environment are explored across a spring-neap-spring cycle during the onset of seasonal stratification. A vertical microstructure profiler was used to measure several turbulence parameters, whilst near-simultaneously a subsurface holographic imaging system recorded the number and type of SPM (inorganic flocs, phyto and zooplankton). The response of SPM to the changeable physical domain has been observed, highlighting the degree to which temporal variability in SPM populations exist through resuspension events and interaction with the complex, vertically sheared flow regime. Analysis of the size and distribution of specific groups of SPM across the tidal cycle is made possible with the application of bespoke particle identification and enumeration software. Advection of small-scale lateral gradients in SPM populations is assessed through use of the biogeochemical models of the General Ocean Turbulence Model (GOTM). (Abstract ID 9717)

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RETROSPECTIVE ACCESS TO OPERATIONAL US. OCEAN MODEL PRODUCTS THROUGH THE OCEANOMADS SYSTEM

OceanOMADS is an archive and access system for operational ocean model output, associated with the National Oceanic and Atmospheric Administration (NOAA) National Operational Model Archive and Distribution System (NOMADS). The project is collaborative and distributive: three principal partners each contribute in ways that reflect their individual strengths and missions. The NOAA National Weather Service provides real-time access to NOAA and Navy operational model products via the National Centers for Environmental Prediction. A research and development component is provided through the Ecosystem Data Assembly Center at the Northern Gulf Institute, a NOAA Cooperative Institute. Finally, long-term preservation and retrospective access are provided by NOAA’s National Coastal Data Development Center (NCCDC), a division of the National Oceanographic Data Center. This presentation focuses on the data catalog and services that comprise NCCDC’s OceanOMADS (http://www.nodc.noaa.gov/ocean-nomads/), as well as plans for its future development. The current data collection includes several years’ worth of daily operational model runs from NOAA and Navy, as well as NOAA’s recent 30-yr reanalysis. We give examples of data services provided, including basic visualization, spatial and temporal subsetting, and timeseries aggregation. (Abstract ID 11986)

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NEAR-BOTTOM OCEAN CURRENT PROFILES IN THE NORTHERN GULF OF MEXICO

Federally-mandated ocean current profiles from oil and gas platforms in the northern Gulf of Mexico provided important information for the tracking of surface and deep oil from the Deepwater Horizon incident. These current profiles, which extend from the surface to approximately 1000 meters depth and from the bottom upward in deeper locations, are available from NOAA’s National Data Buoy Center. Although the data were collected in order to enhance safety and redesign of the offshore platforms, the data, collected at sub-hour intervals, provided a unique data set for supporting the Deepwater Horizon response. The data set is also appropriate for investigating the oceanography of the northern Gulf of Mexico. Analyses of the deepwater data show wind-generated inertial currents traveling throughout the water column and impacted by bottom friction. Weak tropical storms and major hurricanes (Katrina, Rita, and Wilma) generate above-background currents at three locations with depths ranging from 1100 to 1300 to 1950 meters. Time series analyses of a near 5-year record of near-bottom currents indicate the presence of topographic Rossby waves near 27.3N. (Abstract ID 11919)

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THE OCEAN OBSERVATORIES INITIATIVE EDUCATION AND PUBLIC ENGAGEMENT: DELIVERING REAL TIME DATA FOR TRANSFORMATIVE LEARNING IN THE UNDERGRADUATE CLASSROOM

The Ocean Observatories Initiative (OOI) will reshape the way ocean science is conducted. Recent advances in the delivery of web-based education, and use of visualization technology and data visualization tools in educational contexts, have led to the development of on-line platforms for instruction that engages students in active scientific inquiry by collecting and analyzing data of real world phenomena. The OOI Education and Public Engagement (EPE) Implementing Organization will leverage these technologies for ocean education. As the OOI develops and deploys transformative tools necessary to understand the changing oceans, it will also enable the effective translation of results into understandable information usable by educators and potential workforce participants. To this end EPE will construct a series of software tools and a web-based social network to support engagement of a wide range of education users and free choice learners. These tools will enable them to enhance their undergraduate education and engage the free choice learners using real-time and streaming data provided by the OOI. (Abstract ID 10528)

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POSSIBLE CLIMATE CHANGE IMPACTS ON SUPPLY OF MICRONUTRIENT IRON TO THE GULF OF ALASKA

It is well documented that glaciers near the Gulf of Alaska (GoA) have been rapidly losing mass, yet the impacts on the ocean are not well understood. One possible impact is altered transport of iron, an essential micronutrient that limits productivity in much of the GoA, since glacial flour is a source of iron to the ocean in rivers as well as dust. Yet there are very few iron data from this part of the ocean, hence iron sources are poorly quantified. Here we will present recent work from the coastal GoA, including iron and nitrate profiles, as well as surface-water concentrations, from cruises spanning a transect from the mouth of the Copper River to beyond the continental shelf. We will discuss sources of iron from the coastal ocean (rivers, sediment resuspension) as well as various mechanisms by which this iron can be transported beyond the continental shelf, to deeper, iron-limited waters (currents, eddies, dust). We will share thoughts on how some of these processes might change in response to melting glaciers and climate change, and possible impacts on productivity. (Abstract ID 11798)

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THE MICROBIAL COMMUNITY ASSOCIATED WITH A RED TIDE FORMING DIATOM, APPICATION OF COMBINATORIAL LABELING FLUORESCENCE IN SITU HYBRIDIZATION

We studied the processes of colonization and dynamics of microbial communities attached to a red tide forming diatom in a natural bloom and in culture. To visualize the co-occurrence of different prokaryote groups we applied 3 different, clade-specific probes to a red tide forming dinoflagellate in a natural bloom and in culture. To visualize the processes of colonization and dynamics of microbial communities attached to a red tide forming diatom in a natural bloom and in culture. To visualize the co-occurrence of different prokaryote groups we applied 3 different, clade-specific probes to a red tide forming dinoflagellate in a natural bloom and in culture. To visualize the processes of colonization and dynamics of microbial communities attached to a red tide forming diatom in a natural bloom and in culture. To visualize the co-occurrence of different prokaryote groups we applied 3 different, clade-specific probes to a red tide forming dinoflagellate in a natural bloom and in culture. To visualize the processes of colonization and dynamics of microbial communities attached to a red tide forming diatom in a natural bloom and in culture. To visualize the co-occurrence of different prokaryote groups we applied 3 different, clade-specific probes to a red tide forming dinoflagellate in a natural bloom and in culture. To visualize the processes of colonization and dynamics of microbial communities attached to a red tide forming diatom in a natural bloom and in culture. To visualize the co-occurrence of different prokaryote groups we applied 3 different, clade-specific probes to a red tide forming diatom in a natural bloom and in culture. To visualize the processes of colonization and dynamics of microbial communities attached to a red tide forming diatom in a natural bloom and in culture. (Abstract ID 12735)

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RELATIVE GROWTH RATE OF THE INVASIVE SEAWEED GRACILLARIA VERMICULOPHYLLA AND ITS ASSOCIATION WITH THE POLYCHAETE DIOPTERA CUPREA

The red invasive seaweed Gracilaria vermiculophylla invaded United States estuaries approximately 15 years ago. In southeastern US estuaries, much of the G. vermiculophylla population is glued by the opportunid polychaete Diopatra cuprea to its emergent tubes as
and subtidal zone on a South Carolina mudflat (Charleston Harbor) and assayed the decoration
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not explain oxygen depletion below 5 m (P=0.98). Oxygen demand from sediments enriched
below 5 m declined nearly 50% between 2001 and 2004, remaining low through 2011. The
in the upper 8 m was best explained by N loading (P = 0.047), somewhat influenced by salinity
Here we present vertical profiles of total dissolved (<0.2 μm) Fe and dissolved Fe(II) measured
where oxidation rates are diminished. Fe(II) concentrations spanned a range from
and relative bioavailability of dissolved Fe pools in surface waters are only poorly understood.
Identifying the major sources, sinks and the bioavailability of Fe in the Arctic Ocean is required
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The REDOX SPECIATION OF DISSOLVED IRON IN SEA WATER OF THE ARCTIC
OCEAN: OBSERVATIONS FROM THE ARCTIC GEOTRACES-IPI EXPEDITION IN THE
BEAUFORT SEA
Identifying the major sources, sinks and the bioavailability of Fe in the Arctic Ocean is required
to understand the structure and productivity of the marine ecosystem. The chemical speciation
and relative bioavailability of dissolved Fe pools in surface waters are only poorly understood.
Here we present vertical profiles of total dissolved (<0.2 μm) Fe and dissolved Fe(II) measured in the
Beaufort Sea and in the vicinity of the Canadian continental shelf in the Arctic Ocean.
Filtered seawater samples were collected for shipboard analyses at various depths at six stations
during the Canadian GEOTRACES-IPI Arctic Expedition during August and September
2009. Measurements of Fe(II) were made using a portable luminol chemiluminescence
flow-injection analysis (CL-FIA) system while total dissolved Fe was determined using
Chlorophyll a choice,
Gracilaria vermiculophylla
vs. the co-occurring Diopatra tubes in Charleston mudflats is due to
RGR is higher in the subtidal zone
Ulva lactuca
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The sea-water from Gulf of Trieste has a low pCO2 due to a high pCO2 consuming activity, which is
related to high salinity. By reducing the pCO2 level in the Basin, the pCO2 consuming activity
increases and the higher pCO2 level is reached. The decreases in pCO2 levels are due to the
increase of primary production and heterotrophy. This increase is related to the decrease of
suspended particulate matter (SPM) and algae. This decrease is due to the increase of salinity
and temperature. The decrease in pCO2 levels is not related to the increase of pCO2 consumption
by carbonate compensation or the increase of pCO2 exchange. The decrease in pCO2 levels
is related to the increase of primary production and heterotrophy. This increase is related
to the decrease of SPM and algae. This decrease is due to the increase of salinity
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Gracilaria vermiculophylla is a choice, Gracilaria vermiculophylla on

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N-LOADING, CHLOROPHYLL AND PERSISTENT HYPOXIA IN THE CHESAPEAKE BAY
We studied early summer chlorophyll and oxygen concentrations in the main stem of the
Chesapeake Bay from 2001 to 2011. Mean chlorophyll values ranged from 8.6 μg/l in 2002, to
40.1 μg/l in 2003 and averaged 19.5 μg/l (SD = 10.3). Stepwise regression revealed chlorophyll in the upper 8 m was best explained by N loading (P = 0.047), somewhat influenced by salinity
(P = 0.084), and unaffected by either temperature (P = 0.436) or year (P = 0.746). Oxygen levels below 5 m declined nearly 50% between 2001 and 2004, remaining low through 2011. The
decline fit a model of hyperbolic decay (F=(a)(b)/(x+b)), R2 = 0.90, P < 0.0001. N loading did not
explain oxygen depletion below 5 m (P=0.98). Oxygen demand from sediments enriched by
benthic respiration may explain the trends of contemporary N loading. Overall, the last decade,
surface oxygen levels (above 8 m) correlated positively with chlorophyll concentrations (R2 =
0.78, P = 0.0007), reflecting the importance of photosynthetic contributions to the oxygen budget in the photic zone. (Abstract ID 9424)
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The REDOX SPECIATION OF DISSOLVED IRON IN SEA WATER OF THE ARCTIC
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A 15-year time series of microbiogeochemical ecophysiological measurements involving
sediment, nutrients, plankton, productivity, and benthic community components straddles
several major ecosystem perturbations. One of these, in a benthic kensia bivalve muscle, led to rapid oligotrophication of a 58,000 km2 basin and collapse of its commercial and now even sport fisheries. Biomass diversion from plankton to benthos was also evident in lower total and particulate (biomass) phosphorus offshore. Research education and citizen science activities have provided many measurements of community structure as length-frequency relations that are easy to measure accurately by novices. Since the beginning of the invasion, less prolific datasets for morphometry-composition relations (morphometry: wet weight, dry weight, elemental composition as a function of length) have been developed. Consistent biogeochemical composition was found among inhabitants of disparate benthic character (rocky, sandy, silty, clay) and over the full range of ecological competition (from pioneers to
total dominance) during the first 10 years of establishment. This expands the value of a million length measurements to estimation of basin-scale food web alteration. How many quaggas does it take to make a walleye? (Abstract ID 10893)
before being passed to the CESM coupler. Results will be presented from a 100 year simulation of the nRCM, with the ROMS domain covering the north-east Pacific. Comparisons with a standard CESM run reveal significance of maintaining two-way coupling for regional downscaling in that the nRCM provides statistically significant reductions of the warm SST bias offshore of the California/Oregon coast which induces changes in the atmospheric boundary layer and far field (up-scaling) effects in the tropical Pacific and north Atlantic oceans. (Abstract ID 11931)

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TOWARD A UNIFIED AIR-SEA INTERFACE FOR FULLY COUPLED ATMOSPHERE-WAVE-OCEAN MODELS AND TROPICAL CYCLONES PREDICTION
One of the most challenging issues in understanding and modeling of tropical cyclones is the representation of fully coupled air-sea interactive processes in numerical models. The study aims to develop a unified air-sea interface for fully coupled atmosphere-wave-ocean models, which is physically based and flexible to use for development of new physical parameterizations of wind-wave and wave-current coupling in high-wind conditions. It takes advantage of the recent advancement in the applications of the Earth System Modeling Framework (ESMF) in a multi-model system that includes the Weather Research and Forecasting (WRF) model, the Hybrid Coordinate Ocean Model (HYCOM), and the University of Miami Wave Model (UMWW). The main objective of this study is to better understand the momentum transfer across the air-sea interface in tropical cyclones. Coupled atmosphere-wave-ocean model experiments of Hurricane Ike (2008) are used to examine the effects of air-sea coupling on hurricane structure and intensity change. (Abstract ID 12883)

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OBSERVATIONAL STUDY OF THE FLUX AND WATER MASS VARIABILITY THROUGH DAVIS STRAIT
An ongoing observational program to quantify volume, freshwater and heat exchange between the Arctic and North Atlantic Oceans through Davis Strait has been operational since September 2006. The year-round program consists of velocity, temperature and salinity measurements from 15 moorings spanning the full width of the Strait. Over the shallow Baffin Island and West Greenland shelves, novel moored instrumentation provides temperature and salinity near the ice-ocean interface. Autonomous gliders improve the spatial resolution (average profile separation = 4 km) of the array and have captured the first high-resolution wintertime sections across the Strait. No clear trends are observed in the 2006-2010 net fluxes. However, more recent data (2008-2010) suggest an increase in Arctic freshwater discharge through Davis Strait, consistent with decreasing freshwater inventory within the Beaufort gyre. Interannual flux variability is large and mean (+ standard deviation) volume, freshwater and heat fluxes are -1.4 ± 0.2 Sv, -89 ± 16 mSv and 23 ± 4 TW, respectively. Net volume and freshwater transports through Davis Strait are similar in magnitude to those estimated for Fram Strait, the other major Arctic gateway. (Abstract ID 11794)

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BRACHIOPODS RECORDING SEAWATER TEMPERATURE – A MATTER OF MATURATION?
The stable, low-magnesium shells of brachiopods and their long geological record means that they are an attractive source of past seawater temperature data. Indeed, these attractive features have been exploited by employing brachiopods in a wide range of palaeo-environmental studies. With brachiopods, as with all biological proxy systems, caution is required in order to separate out biological and kinetic influence from environmental data. This paper considers the recording of seawater temperature in modern brachiopods in known water conditions in the context of biomineralisation. Consideration is given to the kinetics of shell formation, biological control on crystallography as well as shell structure, perforations and maturation of brachiopods in order to tease these factors apart and identify a robust strategy for extracting seawater temperature data. (Abstract ID 11186)

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NON LINEAR INTERNAL TIDES, SOLITARY WAVES AND TURBULENT MIXING IN THE CONTINENTAL SHELF OF SOUTH BRITTANY
In July 2010 the PerZong campaign was set up in South Brittany (Bay of Biscay) in order to assess the impact of strong internal tides, solitary waves and associated turbulent mixing on the phytoplankton distribution on the continental shelf. High frequency measurements of CTD and currents were performed at two locations (65 m depth and 25 m depth), in addition turbulent dissipation and vertical eddy diffusivity were estimated using microstructure measurements. During spring tide semi diurnal internal tides evolved into nonlinear fronts and solitary waves at both locations. At the deepest location a large vertical mode 2 response was associated with nonlinear fronts resulting in a splitting of the pycnocline and large overturns. These frontal structure were followed by train of high frequency waves with a few minutes period. At the shallowest mooring vertical mode 1 was dominant and frontal structure and solitary waves seem to result from a more classical steepening process as described in the KDV framework. At both location nonlinear waves were associated with large values of dissipation ($epsilon=10^{-6} W/kg$) within the pycnocline suggesting a strong impact on mixing. (Abstract ID 11476)

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HYDRODYNAMIC ROUGHNESS AND BED STRESS OVER CORAL REEFS
The highly irregular and spatially variable roughness characteristic of coral reefs results in high dissipation rates and associated high drag for waves and currents. Several field studies have been carried out over coral reefs in a variety of locations around the tropical Pacific with the objective of examining the relationship between physical bed roughness and the hydrodynamic response for reef environments. The beds at each site are characterized by highly inhomoogeneous roughness. Physical roughness is surveyed over large areas using AUV based altimeter observations. Boundary layer turbulence is measured at each study site using a bottom mounted vertical spar with three ADVs while velocity profiles are measured using a nearby ADCP. Bed stress associated with the steady flow is estimated from the ADV data using the inertial dissipation method and from the ADCP data using logarithmic fits to the mean profiles. Here we summarize the results of the data analysis and present estimates of bed stress and hydrodynamic roughness scale from the multiple study sites. These results are then related to AUV-based measurements of physical roughness. (Abstract ID 12263)

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INTERIOR VERSUS BOUNDARY MIXING FOR THE EROSION OF A COLD INTERMEDIATE LAYER IN A SUBARCTIC ESTUARY
The relative importance of interior versus boundary mixing is examined for the cold intermediate layer (CIL) in the St. Lawrence Estuary. CIL erosion rates were calculated using 18 years of historical weekly temperature profiles. Per month, the CIL thickness decreases by 11 m, its core temperature warms by 0.2 degrees and its heat content increases by 0.6 MJ/ m$^3$. These erosion rates are remarkably well reproduced with a 1D vertical diffusivity model with a mean turbulent diffusivity inferred from around 1000 turbulence profiles collected during summer 2009 and 2010. These measurements were collected within the interior and
near lateral boundaries, where the CIL intersects the sloping bottom. The analysis suggests that interior mixing alone accounts for about 70% of the diffusivity required to reproduce the erosion rates with the 1D diffusion model, with the remainder being attributed to boundary mixing. We conclude that while boundary mixing may be significant it does not seem to dominate CIL erosion. (Abstract ID 11240)

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A NEW MECHANISM FOR OCEAN ATMOSPHERE COUPLING IN MIDLATITUDES

The role of moist convection in "transferring" upward surface ocean conditions throughout the troposphere is studied using reanalysis data for the extratropical Northern and Southern Hemispheres in winter. It is found that conditions for the development of a convective air column from the sea surface to the tropopause are met frequently over all major western boundary currents and their extension in the ocean interior (sometimes for as much as 50% of the time). These frequent occurrences are shown to be jointly controlled by oceanic advection of warm waters and, on the atmospheric side, the downward displacement of the tropopause associated with synoptic weather systems. Based on these results, it is proposed that the oceans can influence the atmosphere directly through convection in midlatitudes, as is commonly thought to occur in the Tropics. Analysis of the Richardson number Ri found at low levels suggests that moist symmetric instability (0 < Ri ≤ 1) is a key process involved in linking surface ocean temperatures to atmospheric lapse rates, in addition to standard upright convection. These low Ri processes are not currently parameterized in climate models, which raises the possibility that the extratropical oceanic influence on climate might be underestimated in the current generation of models. (Abstract ID 11428)

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The effect of natural ocean surfactants on bubble fragmentation and coalescence

The plumes of bubbles generated by breaking waves in the ocean are thought to influence marine aerosol production, air-sea gas transfer, and both the optical and acoustical properties of the upper ocean. One of the major uncertainties in the current understanding of these bubbles plumes is the effect of natural surfactants. These chemicals are produced by marine life and will accumulate on surfaces, including the surfaces of bubbles, changing the surface physical properties. It is thought that the presence of surfactants may change bubble plumes significantly, by altering bubble formation processes and by slowing bubble dissolution. However, there is not currently enough information to predict these changes or their importance. This study is a step towards understanding the effects of natural surfactants on ocean bubble plumes, and the consequences for gas exchange and aerosol production. In the future, it may be possible to use observations of ocean bubbles to measure some of the properties of the natural surfactants present. Using very clean apparatus, individual bubbles of different sizes were either fragmented or smashed together by turbulence in the presence of different surfactants. Fragmentation is known to be the main mechanism generating new large bubbles underneath breaking waves, so studying the effects of surfactant on this process should provide insight into the generation of natural bubble plumes. Using the results of these experiments, the effects of those surfactants on an entire bubble plume are predicted. The next stage of this study, not presented here, will be to test those predictions in wave tanks and the open ocean. (Abstract ID 9942)

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LONG-TERM OXYGEN CHANGES IN THE EQUATORIAL EASTERN PACIFIC

Observations indicate increasing oxygen minimum zones (OMZs) in the tropical Pacific over recent decades. A comparison of repeated hydrographic sections in the eastern tropical Pacific at 110°W and 86°W demonstrates that enhanced oxygen is related to stronger eastward flow at some locations, but not at others. Oxygen generally decreases below the surface layer in the tropics at the 110°W and 86°W sections. Historical data are quite sparse for constructing oxygen time series, but floats with oxygen sensors prove to be good tools to fill measurement gaps in later portions of these time series. In the future, floats with oxygen sensors might play an important role in allowing construction of nearly continuous time series in regions with sparse or infrequent ship-based hydrographic surveys. In the eastward flow region just south of the equator, a time-series constructed from historical and float data reveals oxygen decreasing from 200–700 m depth at up to 1.9 µmol kg−1 over the last 34 years. Oscillations on shorter time scales, e.g. an El Nino signal in the upper 350 m, are superimposed upon this trend. (Abstract ID 9680)

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STORM SURGE MODELING IN THE CHESAPEAKE BAY DUE TO THE PROBABLE MAXIMUM HURRICANE

The characteristics of the Probable Maximum Hurricane (PMH) were developed for a critical hurricane track affecting the Chesapeake Bay. The Probable Maximum Storm Surge (PMSS) due to the PMH was modeled using the industry standard software, and results were compared to results using an empirical method. The characteristics of the PMH, including wind speed, forward speed, and central pressure were developed using guidance from the National Oceanic and Atmospheric Administration (NOAA). The track and parameters of the PMH were used as inputs into the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) software developed by NOAA. Antecedent water conditions were also evaluated. Together with the storm surge height predicted by SLOSH, a PMSS height was determined. The PMSS at the location of interest was also calculated using an empirical method. This method was developed by the United States Army Corps of Engineers (USACE) specifically for the Chesapeake Bay. The peak PMSS water surface elevation modeled by the SLOSH software was 13.1 ft above the antecedent water level. This was significantly lower than the PMSS elevation predicted by the empirical method. (Abstract ID 10466)

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INFLUENCE OF KEY PARAMETERS ON PROCESSES ASSOCIATED WITH THE OXYGEN MINIMUM ZONE IN THE UPWELLING OFF NAMIBIA USING A 3-D MODEL

As regions of high primary production being often associated to Oxygen Minimum Zones (OMZs), Eastern Boundary Upwelling Systems (EBUS) represent regions of interest for the oceanic nitrogen and oxygen cycles. Indeed, losses of nitrogen (denitrification and anammox processes and nitrous oxide (N2O) emissions to the atmosphere) take place in oxygen depleted environments like EBUS, and decrease the role of nitrogen source of these regions. In the present study, a 3-D coupled physical/biogeochemical (ROMS/BIOS/BUS) model, already validated in the Namibian sub-system of the Benguela Upwelling System, is used. The nitrogen transfer has been investigated in the Namibian upwelling system using this coupled model, especially between 22°S and 24°S where the OMZ is well developed (< 0.5 mlO2/l). In this study, we performed a sensitivity analysis of the values of parameters associated with specific processes of the OMZs (denitrification/nitrification, nitrous oxide fluxes, anammox process, O2/N2O fluxes at the water-sediment interface) on nitrogen transfers in this system in order to know the most sensitive key parameters. For example, the anamnose rates between 0.01 and 0.45 d−1 are associated with nitrogen loss between 0.02 and 0.27 mmolN/m2 d−1 off Namibia. (Abstract ID 12943)

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LINKAGE BETWEEN MARSH-DERIVED DISSOLVED ORGANIC CARBON (DOC) AND ECOSYSTEMS IN A NEARBY BAY AND THE COASTAL OCEAN.

We examined the contribution of DOC from a coastal marsh in Louisiana to the adjacent bay and coastal ocean in the northern Gulf of Mexico. Tidal flooding and relaxation cycles transported marsh-derived DOC into nearby open waters. The open water near the marsh edge was net heterotrophic on 97% of our study days. Twenty km offshore, bay water was net heterotrophic on 61% of the days studied but less strongly so than at the marsh edge. Concentrations of DOC at the marsh edge were, on average, twice as high as concentrations in the bay. Water temperature appeared to be the predominant source of variability in Net Ecosystem Metabolism on a seasonal time scale but variability of both respiration and primary production was high on shorter time scales associated with wind and light (cloudiness). Further transport out of the bay into the coastal ocean is indicated by a separate, previously published.
The concept of Redfield Ratios, or the ocean's nutrient stoichiometry has been fundamental to understanding the ocean biogeochemistry, reflecting the balance of elements between organisms and the chemical environment and thereby modulating to a large extent the metabolic status of an ecosystem as well as the ecosystem structure. This presentation will provide two case studies, one in the western South China Sea (WSCS) under the influence of meso-scale eddies and another in the northern South China Sea (NSCS) under the influence of both river plume and coastal upwelling. In responding to development of meso-scale eddies in the WSCS, we observed highly variable DIN (total inorganic nitrogen):DIP (reactive soluble phosphorus) molar ratios in the seawater fluctuating up to 44 in the upper 100 m water column. In the coastal upwelling zone and deep chlorophyll maximum layer of the NSCS, the DIN:DIP consumption ratio was 16.2±2.9, which is the classic Redfield ratio. In contrast, soluble phosphorus) molar ratios in the seawater fluctuating up to 44 in the upper 100 m water column. In the coastal upwelling zone and deep chlorophyll maximum layer of the NSCS, the DIN:DIP consumption ratio was 16.2±2.9, which is the classic Redfield ratio. In contrast, the river plume this ratio was 48±9.9. Possible mechanisms controlling the difference in nutrient consumption ratios in different physical and biogeochemical settings will be reasoned. (Abstract ID 10296)

The enhanced biological productivity in vicinity of islands is long known as Island Mass Effect (IME). IME is associated with flow perturbations by islands, and corresponding upwelling and vertical mixing supply nutrient rich deep water to the nutrient depleted surface euphotic layer and result in phytoplankton blooms. There have been numerous studies on IME and island wakes; however, due to the complexities of the wake dynamics, quantitative understandings of the vertical water exchange associated with oceanic islands and resulting IME are still lacking. Previously, we estimated upwelling speed of 0.01 m/s from the surface divergence observed by ADCP survey in a vicinity of a small island (D=5 km) in the Kuroshio current with horizontal flow speed of 0.1 m/s. In this study we investigate the upwelling associated with island wakes by using idealistic model experiments and theoretical analysis to explain how small islands induce strong upwelling in strong geostrophic currents. (Abstract ID 11498)

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ecosystem restoration, and to monitor impacts of the 2010 oil spill. In support of the MOCNESS plankton collection tows for detailed characterization of plankton populations above and near these reefs, two Spray gliders operated by HBOI in collaboration with Bluefin Robotics were deployed over a period of several months to provide large scale distribution of phytoplankton concentrations and remainant hydrocarbon presence above these reefs and the surrounding waters. Results from these glider deployments are presented including a description of transect planning and sampling strategies necessary to support cruise objectives. (Abstract ID 12862)

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PLANKTON DYNAMICS FOLLOWING THE BP OIL SPILL

Human activity has impacted the Gulf of Mexico ecosystem for decades. The 2010 Deepwater Horizon Oil spill, however, was unprecedented for the volume of oil released, contamination by dispersant, and the oceanic depths over which this occurred. In addition to surface plumes of oil, subsurface plumes were documented to the southwest and northeast of the wellhead. Here we report the results of eight cruises to investigate plankton dynamics in the NE Gulf of Mexico, a region impacted by oil, and four cruises to the west shelf, a region relatively unimpacted by oil. Phytoplankton were collected for biomass, community composition, and assessed for photosynthetic inhibition. Zooplankton abundance and distribution was assessed using bongo tows and the SIPPER imaging system. Phytoplankton showed a reduced photosynthetic capacity in near-surface waters during August compared to following months. During May, zooplankton concentrations were reduced and detrital particles enhanced at stations closest to the wellhead. Maximum detritus concentrations occurred during August, within a month of capping the wellhead. Oiled detritus could have contributed to the flux of oil to the seafloor. (Abstract ID 12630)

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THE OCEAN CARBON AND BIOGEOCHEMISTRY PROGRAM: BUILDING A COMMUNITY FROM THE BOTTOM UP

The Ocean Carbon and Biogeochemistry (OCB) Program and its Scientific Steering Committee (SSC) were created by NSF, NASA, and NOAA in 2006 to promote, plan, and coordinate collaborative, multidisciplinary research opportunities on marine biogeochemical cycling and ecosystem processes within the U.S. and with international partners. OCB focuses on the ocean’s role as a component of the global Earth system, bringing together research in biology, chemistry, and physics to advance our understanding of marine ecosystems and biogeochemical cycling. The OCB model is based on a community-driven set of research priorities and bottom-up implementation measures. The OCB Project Office, based at the Woods Hole Oceanographic Institution, plays multiple support roles, including coordination of scientific opportunities within the OCB community and with other U.S. and international programs; communication via websites, newsletters, and email lists; organization of workshops and activities; scientific and logistical support of its SSC and subcommittees; and development and dissemination of education and outreach materials. Here we provide an overview of OCB, including programmatic structure and current scientific foci, and report on key outcomes and challenges of recent activities. (Abstract ID 12890)

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DEVELOPING SHELF-WIDE ESTIMATES OF BOTTOM STRESS FOR THE U.S. EAST COAST AND GULF OF MEXICO USING THE SWAN NUMERICAL WAVE MODEL

Ocean waves induce orbital motion that at shallow enough water depths results in a shear stress on the sea floor. Bottom wave stress depends on the strength and variability of local and regional wind forcing; wind wave and swell formation and propagation; and depth. Previous work has shown regional relationships between bottom stress and surface sediment texture in the Middle Atlantic Bight. Here we present wave stress data for the entire U.S. Atlantic and Gulf of Mexico continental shelf for the period April 2010-April 2011 on a 5-km grid calculated using the Simulating Waves Nearshore (SWAN) numerical wave model. Modeled bottom wave stress is validated against values calculated from ocean buoy wave spectra. Stress estimates are cross-correlated with wind stress forcing to determine where the waves that dominate regional stress generation are formed. Bottom stress depends strongly on spectral shape and the energy in longer periods, and model results are sensitive to directional resolution and seabed boundary conditions even at distances of hundreds of kilometers. (Abstract ID 10262)

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VARIABILITY OF THE ATLANTIC MERIDIONAL OVERTURNING CIRCULATION IN CCSM4

Atlantic meridional overturning circulation (AMOC) variability is documented in the Community Climate System Model version 4 (CCSM4) pre-industrial control simulation. AMOC shows a broad spectrum of low frequency variability covering the 50-200 year range, contrasting sharply with the multi-decadal variability seen in the 20th century resolution CCSM3 present-day control simulation. Furthermore, the amplitude of variability is much reduced in CCSM4 compared to that of CCSM3. Parameterized eddy fluxes play a crucial role in the creation of salinity anomalies that dominate density anomalies in the Labrador Sea and influence AMOC. High Nordic Sea densities do not necessarily lead to increased overflow transports, because the overflow physics is governed by source and interior region density differences. Increased overflow transports do not lead to a higher AMOC, either. This has important implications for decadal prediction studies. Although the results suggest only weak direct impacts of the North Atlantic Oscillation (NAO) on AMOC variability, we speculate that NAO plays a role through setting the surface flux anomalies in the Labrador Sea and affecting the subpolar gyre circulation strength. (Abstract ID 9662)

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ASSESSMENT OF SST ANALYSES IN SUPPORT OF OCEAN FORECASTING AT THE NOAA OCEAN PREDICTION CENTER

Forecasters at the NOAA Ocean Prediction Center (OPC) have several SST analyses available within their operational workstations including the NOAA Real Time Global SST (RTG_SST), the new RTG_SST with AMSR-E (NOMAA Optimum Interpolation Daily SST (OISST), the NOAA/ NESDIS Blended GOES SST, and the in-house 3-day composite GOES SST. The new RTG_SST incorporates observations from AMSR-E (Advanced Microwave Scanning Radiometer) along with AVHRR (Advanced Very High Resolution Radiometer) retrievals. Inclusion of information from these instruments gives forecasters an improved and timely awareness of ocean thermal features such as fronts and eddies during the winter storm season. This paper will compare the various SST analyses available to OPC forecasters and provide statistics of the comparisons. Examples of the use of SST to improve weather prediction over the Atlantic and Pacific will be given. (Abstract ID 10315)

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CIRCULATION DYNAMICS OF THE CENTRAL EASTERN BERING SEA SHELF

We present analyses of a moored current meter array deployed between July 2008 and July 2010 on the eastern central Bering Sea shelf, a shallow shelf influenced by strong tidal forcing, strong (weak) winds in winter (summer), seasonal sea ice and strong summer stratification. Subtidal, vertically-integrated equations of motion show that the cross-shelf balance is geostrophic to first order. In the along-shelf direction, the pressure gradient and Coriolis terms also dominate, but local accelerations, wind stress and bottom friction account for up to 40% of the typical momentum balance, with the wind stress alone representing 5-20%, depending on the season and local water depth. Additionally, the wind stress contributes to the sea surface slope through Ekman divergence, and the resultant changes in sea surface topography significantly affect the flow, both in magnitude and direction. The varying coastline orientation induces along-shore current variations that complicate the flow field required to maintain mass continuity. Low frequency flows (< ¼ cpd) are coherent over distances exceeding 200 km, allowing us to compute shelf fluxing rates that vary seasonally and inter-annually. (Abstract ID 12355)

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HIGH-FREQUENCY VERTICAL VELOCITIES IN THE DEEP OCEAN
Based on realistic numerical simulations of the primitive equations, we present two ways of generating strong high-frequency vertical velocities in the deep ocean. The first mechanism involves forcing by the wind. Interactions between the resulting inertial oscillations and mesoscale eddies generate strong vertical velocities both in subsurface and in depth, with values of the order of 100 m/s. The second mechanism does not require wind forcing, but a strongly turbulent, surface-intensified balanced motion. In this context, spontaneous emission of inertia-gravity waves takes place, that is mainly seen on the vertical velocity in depth where it reaches values of 10 m/s, of the same order as the balanced velocity. In both cases, the deep vertical velocity appears to be an excellent filter through which one can understand the physics of otherwise surface-intensified phenomenons. (Abstract ID 12555)

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A GENE-BASED INDICATOR OF ION LIMITATION IN THE DIATOM THALASSIOSIRA OCEANICA

Diatoms are abundant primary producers and key players in marine nutrient cycling. In several oceanic regions, diatoms are iron limited due to low atmospheric inputs. Under these conditions, many phytoplankton replace ferredoxin, an iron-rich photosynthetic electron transport protein, with the iron-free protein flavodoxin. Thalassiosira oceanica, a diatom isolated in the open ocean, has three flavodoxin genes. We determined the expression profiles of all flavodoxin copies and ferredoxin in laboratory cultures of T. oceanica grown in iron limiting conditions under continuous and cycling light. Quantitative RNA expression analysis confirmed that one of the T. oceanica flavodoxin copies was sensitive to iron; its expression was induced 1000- or 3000-fold in iron limited cells depending on light conditions. The expression of the two other flavodoxin copies and ferredoxin did not change significantly under the experimental conditions. We are analyzing the expression of flavodoxin in field samples collected from Northeast Pacific ocean where we have previously identified T. oceanica in diatom populations to determine whether flavodoxin expression can be used as a field-based indicator of Fe status in wild T. oceanica populations. (Abstract ID 9863)

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LEARNING PROBABILISTIC ORGANISM ABUNDANCE MODELS THROUGH INTELLIGENT WATER-SAMPLE ACQUISITION BY AUVs

Marine scientists are developing models that predict organism abundance (e.g. Pseudo-nitzschia) from environmental parameters that can be measured in-situ (e.g. temperature, salinity, etc). Learning such models requires molecular and morphological analysis of physically acquired water samples, along with concurrent measurements of environmental parameters. Water samples are usually collected manually from piers and ships, resulting in sampling bias that can impact model skill. To address this issue, we are developing adaptive sampling algorithms for AUVs equipped with water collection systems that can be triggered by onboard automation software. We exploit current methods in statistical machine learning to learn a non-parametric probabilistic model that allows us to predict organism abundance at unobserved geographic locations in a region of interest, using measurements of environmental parameters gathered during a pilot AUV survey. The uncertainty in the predicted organism abundance is used to compute a sampling policy that the AUV can use for future water-sample collection. We present results of our analysis on historical data gathered in Monterey Bay, and demonstrate the utility of our approach in using latest AUV technologies to learn organism abundance models. (Abstract ID 12514)

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THE EVOLUTION OF PATCH OF THE NORTH ATLANTIC BLOOM

An array of four Seagliders surveying around a drifting Lagrangian float, supplemented by ship observations and occasional ocean color images was used to map thestraining and blooming of a patch of salty water advected from the North Atlantic Current into the Iceocean Basin. Optical sensors measured chlorophyll and POC; ship based imaging and flood cytommetry measured the community composition. Increased light and shallowing mixed layers caused a diatom bloom, terminated by salticule exhausting and with efficient export. However, the timing and intensity of the bloom varied by up to 3 weeks due to water mass and eddy variations resulting in a patchy bloom. Mapping revealed a detailed space-time picture for one such water mass; its initial blooming is suppressed by deep mixed layers; eddy stirring then fragments it into successively smaller filaments; one such 10 km x 20 km patch of high chlorophyll and POC blooms for about a week and disappears when its salticule became exhausted. These observations demonstrate combinations of autonomous and shipboard platforms and sensors can be used to make detailed mechanistic observations of biogeochemical processes. (Abstract ID 9576)

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RADIATION BALANCE INFORMATION LEVELS FROM THE FUKUSHIMA DAICHI NUCLEAR DISASTER IN THE ALEUTIAN ISLANDS AND WESTERN COASTAL REGIONS OF ALASKA

Air parcels from the Fukushima Daichi nuclear disaster crossed over the Aleutian Islands and other regions of Alaska within days of the accident. U.S. Environmental Protection Agency RadNet stations located in Alaska detected radionuclides in the air samples. However, outside of air sampling no other environmental sampling was done at that time. In the summer of 2011, during the Anchsirk Island Underground Nuclear Test Site environmental assessment, the Alaska Department of Environmental Conservation and the University of Fairbanks (UAF) School of Fisheries and Ocean Science collected terrestrial and marine samples. These samples and others are being analyzed for Cesium 134 and 137 and other radionuclides at UAF and Lawrence Livermore National Laboratory (LLNL). Results of this work will provide information on the magnitude of the Fukushima fallout release in western Alaska coastal regions providing input into biological uptake models, and help test predictive models of atmospheric fallout deposition. (Abstract ID 12789)

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SUPPORTING GULF OF MEXICO ECOSYSTEM RESTORATION: ISSUES AND CHALLENGES IDENTIFIED BY THE GULF COAST ECOSYSTEM RESTORATION TASK FORCE SCIENCE TEAM

The Gulf Coast Ecosystem Restoration Task Force (GCERTF) was established by Executive Order 13554 to develop a holistic, science-based Ecosystem Restoration Strategy for the Gulf of Mexico (GoM). As part of this effort, a Science Coordination Team (SCT) was formed to provide scientific input to the development of the Strategy. The SCT consisted of over seventy scientists from the state and federal GCERTF Member agencies. Starting with the ecosystem restoration goals described in “America’s Gulf Coast: A Long-term Recovery Plan after the Deepwater Horizon Oil Spill,” the SCT described current conditions in the Gulf, from inland watersheds to the offshore waters. Using this information, the team identified scientific gaps in understanding and high-level activities, with associated performance indicators, necessary to accomplish the goals of GCERTF. The team also identified the monitoring, modeling, and research essential to support restoration actions. The overall scientific assessment reveals that, Gulf-wide, the ecosystem continues to suffer from extensive degradation, and that integrated, science-based restoration initiatives, backed by a robust adaptive management framework, are necessary to develop a healthy, resilient, and sustainable GoM ecosystem. (Abstract ID 11365)

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ZONAL JETS AND ENERGY CASCADES IN THE BAROCLINIC DOUBLE GYRE PROBLEM

We consider the baroclinic double gyre problem over a range of forcing and dissipation parameters. Zonal jet-like features appear over a wide range of parameters, and are clearly evident both in time-averaged and in instantaneous fields. Energy fluxes associated with various terms (beta, nonlinear, forcing, etc) are also described in detail. In the weakly nonlinear regime, the jets are seen to propagate meridionally. The barotropic mode shows a “double cascade”. That is, over a range of wavenumbers the inverse cascade associated with the barotropic nonlinear self-interaction term is nearly compensated for by an enhanced forward energy cascade associated with the beta term. This is markedly different from quasigeostrophic beta-plane turbulence in a doubly periodic setting, where the barotropic mode exhibits an
inverse cascade from near the Rossby radius to a scale related to the Rhines scale. Here, there is no net cascade. Instead, there is a cycling of barotropic energy with nonlinear effects driving it upscale, and the beta term bringing it back. (Abstract ID 11558)

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DYNAMICS OF A MAJOR OUTLET GLACIER FJORD SYSTEM: CIRCULATION AND VARIABILITY IN SERMILIK FJORD, SE GREENLAND

Recent evidence points to the ocean as a trigger for the increased mass loss from the Greenland Ice Sheet. This hypothesis is supported by observations showing that relatively warm, submeltwater waters are present in Greenland's major glacial fjords, which act as conduits between the subpolar ocean and the ice sheet. However, the dynamics that control the circulation within these fjords is not well understood. The presence of stratification, absence of sill, and the deep, narrow geometry of the fjords complicate the use of classic fjord theory. Here, we present observations from Sermilik Fjord, in southeast Greenland, and identify the main modes of variability in velocity and hydrography from shipboard and moored instrumentation. We show that the fjord circulation is controlled via changes in the coastal current at the mouth of the fjord, but that internal modes of variability inside the fjord might play a significant role in mixing. We discuss the implications of this variability and how this modifies the fjords' dynamics. (Abstract ID 10066)

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OCEAN NETWORKS CANADA OBSERVATORY: BRINGING THE MYSTERIOUS DEEP-SEA TO SHORE-BASED AUDIENCES THROUGH SOCIAL MEDIA, REAL-TIME DATA AND EDUCATION

Ocean Networks Canada Observatory (ONC), comprised of VENUS and NEPTUNE Canada underwater cabled networks, supports transformative science in coastal and deep sea ecosystems. The networks collect data in four interest areas: ocean health, energy resources; natural hazards; and marine conservation, and stream it online in real-time. This data allows researchers to begin to understand how the ocean works to sustain life on Earth. ONC uses education and communication as its primary strategies to engage its main audiences, the public, students, educators and scientists, with this important research. ONC utilizes social media outlets and an active website, specializing in live video streaming with its “SeaTube” tool, to successfully peak its audiences’ interests. For example, ONC’s online “Pig” video, which investigated underwater decomposition rates, went viral after a surprising shower of shrimp ripped the “victim” to shreds. ONC would like to explore Live Video Conferencing between school classes and researchers aboard NEPTUNE Canada and VENUS cruises. ONC also wishes to involve users with Digital Fishers, a crowd sourcing tool, and other like tools to allow them to contribute directly to ocean science. (Abstract ID 11530)

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TOWARDS UNDERSTANDING PARTICLE SIZE DISTRIBUTIONS DERIVED FROM LASER DIFFRACTION

The use of laser diffraction is common practice for the determination of an in-situ particle size distribution. This method is adopted by the LISST-100 range of instruments (Sequua Scientific Inc.) and relies on Mie Theory; or an alternative algorithm, to infer a particle size and concentration from a measure of scattered light. However, these predictions have a number of restrictions, for example, Mie Theory assumes spherical particles of a known refractive index, and tested alternative algorithms do not cover the full range of particle sizes or shapes found within the marine environment. To assess the performance of the laser diffraction technique when measuring natural suspensions, we have simultaneously deployed a LISST-100X with a high-resolution holographic camera at a range of coastal environments around the UK, when measuring natural suspensions, we have simultaneously deployed a LISST-100X with a high-resolution holographic camera at a range of coastal environments around the UK, along with observations from specially constructed laboratory instrumentation. We observe substantial differences between the number distributions inferred by the instruments. To understand the causes of the differences observed, we present a novel approach for the multi-scale representation of particle size and assess the response of the LISST-100 to particles larger than the instrument range size. (Abstract ID 9691)

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LUCKY PERSPECTIVE IMAGER FOR THE COASTAL OCEAN (HICO): OVERVIEW AND COASTAL OCEAN APPLICATIONS

The Hyperspectral Imager for the Coastal Ocean (HICO) is the first spaceborne imaging spectrometer designed to sample the coastal ocean. HICO samples selected coastal regions at 95 m with full spectral coverage (87 channels covering 400 to 900 nm) and a high signal-to-noise ratio to resolve the complexity of the coastal ocean. HICO has been operating on the International Space Station since October 2009 and collected over 4000 scenes. Here we give a brief overview of HICO and the validation of coastal ocean products. We give examples of HICO data applications including, shallow ocean environments, river plumes and harmful algal blooms. (Abstract ID 10049)

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FRESHWATER Inputs AND COASTAL PRODUCTIVITY IN THE PACIFIC NORTHWEST

The coastal ocean plays a key role in global biogeochemical cycles. In the Pacific Northwest, the coastal waters are strongly influenced by freshwater inputs from the Strait of Juan de Fuca (fed by the Fraser and Puget Sound rivers) and the Columbia River. These rivers act as a conduit for land-derived nutrients and as a facilitator for entraining ocean-derived nutrients into the coastal euphotic zone. We present results from a four-box (NPFD) model of planktonic nutrient cycling coupled to a high-resolution circulation model of the Washington and Oregon coasts. Comparison of model results to physical and biological data from two recently completed observational studies indicates that the model is successfully reproducing nutrient and phytoplankton fields in the coastal Pacific Northwest. We examine a suite of numerical simulations of year 2005, comparing a base case with realistic bathymetry and forcing to three special cases: 1. with no Columbia River flow, 2. with no Fraser or Puget Sound river flow, and 3. with no Salish Sea, to examine the role of freshwater input and estuarine exchange on regional patterns of phytoplankton biomass and productivity. (Abstract ID 12793)

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LOCAL OCEANIC THERMAL RESPONSE TO ATMOSPHERIC FORCING: THE GULF STREAM REGION

The dominance of the Gulf Stream (GS) in the local heat balance is observed in an hourly 14-month record of unprecedented surface mooring measurements from November 2005 to January 2007. Instrumentation on the buoy provided a high quality record of air-sea exchanges of momentum, heat, and freshwater flux; and oceanographic sensors recorded the upper ocean variability in the upper 600 m. The mooring was at times south of the GS and at other times north of the GS. Our intent is to isolate the local oceanic response to the atmosphere from the advective variability of the GS. A one-dimensional heat budget analysis indicates that the impact of atmospheric forcing on the heat budget is one order of magnitude larger than that associated with atmospheric forcing when south of the GS and on the same order of magnitude as the atmospheric forcing when north of the GS. Through an EOF analysis, the impact of GS and atmospheric forcing are decomposed, allowing the local linear local oceanic thermal response to be isolated. This linear air-sea interaction is particularly prominent during the periods of active cold air outbreaks and sustained heating. Case studies of the summer and winter oceanic response to atmospheric forcing in the GS region. (Abstract ID 11333)

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INVESTIGATING THE ROLE OF BAROCLINIC FLOWS IN TIDAL CHANNEL MORPHOLOGY AND SEDIMENT TRANSPORT

A dense array of Acoustic Doppler Profilers and Conductivity-Temperature gauges were used to measure flow near the curved edge of a shallow (<1 m low tide, >3 m high tide) tidal channel in the Skagit River tidal flats. A simple sediment transport formula [Meyer-Peter and Muller (1948)] applied to measured near-bed velocities predicts peaks of seaward sediment transport as the tidal flats are drained late in ebb tide. During this time, a transition was observed from strongly depth-dependent flow towards more depth-uniform flow. We examine the causes of this transition, and its consequences for sediment transport. We investigate the possible influences of channel curvature and stratification on the observed flow. (Abstract ID 10035)
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THE OFFSHORE NORTHEASTERN CHUKCHI SEA: A COMPLEX HIGH-LATITUDE ECOSYSTEM

In 2008–2010, we conducted an interdisciplinary ecological study (Chukchi Sea Environmental Studies Program; funded by ConocoPhillips, Shell, and Statoil) in and near three proposed exploratory oil and gas prospects in the offshore northeastern Chukchi Sea during the open-water season. Some aspects of this ecosystem function as a classical pelagic–benthic dichotomy, whereas others suggest unusual ecosystem-level attributes. The Klondike study area functions as a pelagic system, whereas the Burger study area is primarily a benthic system; the Statoil study area has both pelagic and benthic attributes. Klondike has lower benthic abundance and biomass and more oceanic zooplankton, fishes, zooplankton-feeding seabirds, and pelagic-feeding seals than does Burger, which has benthic communities with high abundance and biomass, primarily neritic zooplankton, and more benthic-feeding marine mammals than Klondike. Statoil has characteristics of both ecosystems. Various water masses impinge onto all study areas seasonally and interannually, and patterns of sea-ice retreat vary interannually, leading to pelagic blooms in some years but within-ice production in others. These variations affect some of this pelagic–benthic dichotomy, and some aspects of this ecosystem suggest unusual structure. (Abstract ID 9593)

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MARINE ECOSYSTEMS IN A HIGH-CO2 WORLD: BALANCING BETWEEN SINCERE SCIENTIFIC CONCERN AND OVERSTATEMENT THAT MAY INCITE CLIMATE SCEPTICISM

Invading anthropogenic CO2 into the oceans has long been known to cause shifts in ocean chemistry. Projected doubling of dissolved CO2 in surface waters is accompanied by ~15% increase of major bicarbonate (HCO3−) and ~50% decrease of carbonate (CO3−). These shifts in the seawater buffer decrease the minor hydroxide (OH−). Time series measurements confirm this. Eventually this shift arrives at the deep seafloor where enhanced dissolution of fossil CaCO3 deposits is long recognized due to carbonate undersaturation. Conceivable but not proven is that this dissolution will be enhanced by the resulting increase in pH of the water. In the long run, increased contribution of subtropical waters in the Iceland Basin and to the large increase of the winter convection, to an increased contribution of subtropical waters in the Iceland Basin and to the large increase of the

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oriGin, formation and variability of the sUbPolar mode wAter observed over the reyKjanes ridGes

Using a 1/4 global simulation and a Lagrangian tool, we investigate the origin, formation and variability of the Reykjanes Ridge Mode Water (RMW) over 1966–2004. The source waters of the RMW originate from the Labrador Current and the Gulf Stream and are advected to the Reykjanes Ridge by the branches of the North-Atlantic Current. The RMW acquires its properties in winter in the Iceland Basin when its source waters enter the mixed layer. The variability of the SPMW is driven by two mechanisms. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters. On a decadal time scale, changes in the intensity of the winter convection condition the properties of the subpolar waters...
PACIOOS – “BUILD IT AND THEY WILL USE IT”

PACIOOS, last and biggest of the eleven IOOS Regional Associations, has been operational since 2008. Various water quality components including AUVs, buoys, nearshore sensors, and a seabed observatory have been deployed and have collected millions of data points at intervals ranging from seconds to hours, providing unprecedented coverage of the coastal ocean at an estimated cost of ~$370/day. This network not only provides cost benefits over ships but enables both science and public reaction. PACIOOS assets provide 24-hour near real-time coverage of the coastal ocean in weather that might preclude vessel operations or satellite observations. In this presentation we will illustrate data that have been recorded by PACIOOS assets, challenges in operating and maintaining the system, as well as describe the potential science and the agency and public benefits these data enable. The near-real time data from PACIOOS describes extant and recent past coastal conditions and the 24/7 coverage allows impacts of storms, spills and wave events on the coastal ocean to be quickly identified and appropriate action to be taken to be defended the health of Hawaiians residents and visitors. (Abstract ID 9666)

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BASIN-WIDE SYNCHRONOUS FORMATION AND REDOX-CONTROLLED PRESERVATION OF MEDITERRANEAN SAPROPELS 1

Preservation-related deposition of Mediterranean sapropels are associated with humid climate conditions. The last of such humid periods occurred from 10 to 5 ky ago, simultaneously with the sustained wet period in the cirmadian Mediterranean area. The end of this period coincides with a high MnO₂ peak in all 30 studied cores and concurs with an abrupt re-ventilation event at 5.7 ky 14C. As a consequence of increased fresh water (monsoon) input during that humid period, the most recent saprope 1 formed synchronously between 9.8 and 5.7 ky 14C BP at all water depths greater than a few 100m. Surface waters had a reduced salinity and concomitantly the deep (< 1.8 km) eastern Mediterranean Sea was devoid of oxygen during 4,000 years of formation (De Lange et al., 2008). This has resulted in a differential basin-wide preservation associated to water depth, as a result of different ventilation/climate-related redox conditions above and below 1.8 km. Climate-induced stratification of the ocean may thus contribute to enhanced preservation of organic matter, i.e. to formation of sapropels (and potentially black shales). De Lange e.a., 2008. Nature Geo 1, 600-601. (Abstract ID 11315)

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SUBMARINE CANYONS AS HOTSPOT OF BENTHIC BIODIVERSITY: EFFECTS OF LOCAL VS. LANDSCAPE HABITAT HETEROGENEITY.

The mapping of biodiversity on continental margins (CM) on landscape scales relevant to marine spatial planning and conservation is increasingly important. Submarine canyons are widespread topographic features on continental and island margins that enhance benthic biomass across oceanic provinces, latitude or primary production regimes. However, it remains unclear whether canyons enhance faunal biodiversity on landscape scales relevant to marine protected area design. Furthermore, it is not known which physical attributes and heterogeneity metrics can provide good surrogates for large-scale mapping of canyon benthic biodiversity. We employ multivariate multiple regression models to evaluate sediment and topographic heterogeneity, canyon-curvature profiles, and overall water mass variability as potential drivers of macrobenthic community structure and species richness in 6 canyons of the Hawaiian archipelago. We find that variables related to habitat heterogeneity at medium (0.13 km²) and large (15-33 km²) spatial scales such as slope, backscatter reflectivity and canyon curvature profiles, often explain a greater proportion of variation in benthic biomss. Sample depth and distance from shore are also important, implicating food supply as a major predictor of canyon biodiversity. (Abstract ID 12677)

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SESSION OVERVIEW: ADVANCES IN COASTAL OCEAN MODELING, ANALYSIS, AND PREDICTION

This overview will summarize the major topics addressed in this session, and will connect coastal ocean modelling research with ongoing ocean prediction activities within GODAE OceanView (GOV). Downscaling and extending predictability in coastal and shelf seas are two of the objectives of the GOV initiative through its international Coastal Ocean and Shelf Seas Task Team (COSS-TT). The main goal of the COSS-TT is to work towards the provision of a sound scientific basis for sustainable multidisciplinary downscaling and forecasting activities in the world coastal oceans. The main objective of this session is to provide a forum for multi-scale hydrodynamic modeling and observational studies that aim toward scientific validation, prediction and operational applications of numerical models in coastal and shelf seas, leading to new understanding of multiscale, interdisciplinary nonlinear ocean processes. Applications of nested models, such as the influence of physical processes on ecosystem dynamics and interdisciplinary coastal predictions are also addressed. The session promotes the discussion of methodologies that lead to reliable coastal forecasts (such as data assimilation, error analysis, influence of nesting, resolution and forcing), Observing System Simulation Experiments and the impact of sustainable, integrated modeling and observational networks that connect local, regional and global scales. (Abstract ID 9901)
the distribution of prey resources. Off Sri Lanka, the physical processes are complicated by a monsoonal regime with seasonally reversing currents and changing salinities. Using archived model results, satellite imagery and field data we attempt to understand the influence of oceanic processes on blue whale distribution in this area. During early 2011, whale sightings were consistently further offshore than in previous years. Results suggest that this is due to the anomalously high rainfall and associated freshwater input to the ocean, which may have displaced the krill aggregations on which the blue whales feed. The more saline offshore waters where whales were observed feeding are likely more favourable for krill aggregations. Here we show the influence of the freshwater output from the Bay of Bengal and local rivers on local physical processes and explain changes in whale distribution between 2011 and previous years. (Abstract ID 10867)

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MODEL CALCULATIONS OF BUBBLE FRAGMENTATION IN BREAKING WAVES AND COMPARISON WITH LABORATORY DATA

During active breaking, whitecaps entrain dense plumes of bubbles in the near-surface ocean layer, ranging in size from 10% of micrometers to 10% of millimeters. Depending on their size, these bubbles persist in the water column from seconds to minutes and impact interface processes, such as air-sea gas transfer and primary marine aerosol production. Despite their importance, relatively little is known about the initial size distribution of these bubbles and its dependence on environmental factors, such as wind speed, the wave spectrum and surfactants. Bubble creation processes in breaking waves are known to be scale-dependent, with the large end of spectrum driven by fluid turbulence and bubble fragmentation. A physical model for bubble fragmentation in whitecaps is presented and compared with the distributions of bubbles observed in laboratory seawater waves. The role of surface tension in shaping the distribution will be discussed. (Abstract ID 12532)

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THE BERING SEA ECOSYSTEM WORKSHOP - A MODEL FOR TRANSFORMING ECOSYSTEM SCIENCE INTO EDUCATIONAL RESOURCES

The North Pacific Research Board (NPRB) and partners COSEE-AK, ACOOS, ARCSS, and MBARI brought together teachers and scientists for professional development and the sharing of outcomes of the Bering Sea Project, a landmark integrated ecosystem study, in October 2011. Using the ecosystem study hypotheses as a guide, and with a focus on the use of data in the classroom, educators and researchers presented and learned from each other. Teachers and informal educators attended workshops and presented their projects and discussions. The model also gained insights into how to communicate with educators and students. Educational resources generated during the workshop were posted as a comprehensive Bering Sea Ecosystem Collection hosted through ARCUS' PolarTREC Learning Resources database at http://www.polartrec.org/collections/bering-sea-ecosystem.

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INTRUSION OF ANTARCTIC MELT WATER AND ITS EFFECT ON UPPER OCEAN VARIABILITY IN THE SOUTHERN INDIAN OCEAN

The effect of intrusion of melt water on upper surface of the Indian sector of the Southern Ocean along the latitudinal section from 59S to 55S in the months of January and February for three years 1992, 2003 and 2007 have been studied using CTD, PEL and ARGO profiles. The temperature and salinity sections show an intrusion of cold water between depths 50m and 150m. Northward Ekman transport is seen in this region. The extent of intrusion is found to have a strong positive relation to the maximum ice edge in this sector: The presence of the Kerguelen plateau also affects the upper ocean behavior: The study of geostrophic velocity shows the presence of two- and cyclonic eddies between 58S to 57S and a cyclonic eddy at 57 S in 1992 and 2003. Whereas in 2007 the anticyclonic eddies almost disappear and the cyclonic eddies appear at around 56S, which may be due to more freshwater input due to sea ice melting. Thicker barrier layer is extended towards north in 2007 compared to other two years. This may be due to larger equator ward sea ice extent in 2007 compared to other years. (Abstract ID 9599)

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AQUARIUS/SAC-D SATELLITE MISSION – US AND ARGENTINA WORKING TOGETHER TO UNDERSTAND OUR OCEANS

AquaSAC-D is a collaboration between NASA and Argentina’s space agency, Comisión Nacional de Actividades Espaciales (CONAE). On June 10 2011, the Argentine-built spacecraft, Satélite de Aplicaciones Científicas (SAC-D), carried several CONAE-sponsored science sensors into space, including those that measure sea ice concentration and sea surface temperature. The primary payload, NASA’s Aquarius instrument, began mapping global sea surface salinity in late August 2011 and has detected large-scale salinity distribution features clearly and with sharp contrast. Ocean-related data from AquaSAC-D are complementary, as are the US and Argentine approaches to education and public outreach (EPO) for this satellite mission. In the months leading up to the launch, close communication was vitally important, including international collaboration to develop key messages, create EPO products, coordinate media opportunities, and facilitate the broader impacts of the mission’s scientific goals. With new ocean data being collected, EPO staff in both countries are helping various communities to use Aquarius/SAC-D observations to better understand the interactions between global ocean circulation, the water cycle and Earth’s climate. In addition, more focused EPO activities address socio-economic applications such as fisheries management. (Abstract ID 9497)

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USING LINEAR MIXED-EFFECTS (LME) MODELS TO DISTINGUISH BASELINE AND TROPHIC 15N ENRICHMENT: ENSO EFFECTS ON ZOOPLANKTON IN THE CALIFORNIA CURRENT

Applications of Compound-Specific Isotopic Analysis of amino acids (CSIA-AA) to ecological questions typically use one pair of AAs - phenylalanine and glutamic acid – to distinguish between baseline and trophic 15N enrichment. We developed a linear mixed-effect (LME) model that utilizes all AAs for such assessments. Data are clustered into three levels that reflect the hierarchical covariance, with fixed effects investigated for AA and treatment levels. We used this approach to test the hypothesis of baseline versus trophic 15N enrichment for two dominant planktonic crustaceans (Calanus pacificus and Clausocalanus pacificus) from the California Current Ecosystem during and after the 1998 ENSO. Using the traditional approach, phenylalanine, while visibly enriched in 15N during 1998 for all groups, was not statistically
different between years for C. pacificus females. The differences in δ15N values of glutamic acid and phenylalanine, a proxy for trophic enrichment, were not statistically different between years for C. pacificus. (Abstract ID 11766)

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A COMPARISON OF TOPOGRAPHY-CATALYZED DIAPYCNAL MIXING PARAMETERIZATIONS TO OBSERVATIONS

Flow-topography interactions energize the internal wave field, often leading to enhanced turbulence and diapycnal mixing. Numerous observational studies reflect this, inferring enhanced mixing over rough topography and weak mixing elsewhere. OGCM studies using spatially varying mixing parameterizations clearly demonstrate the sensitivity of the ocean circulation to the heterogeneity of mixing. A few heterogeneous diapycnal mixing parameterizations using topographic roughness as a proxy for enhanced mixing are now in use. These remain rudimentary and have been subject to little validation. We here compare the tidal mixing parameterization by St. Laurent and co-authors and the Roughness Diffusivity Model (RDM) by DeCloeht and Luther to each other and observations ranging from microstructure surveys to basin-scale hydrographic inverse estimates. The parameterizations yield similar basin-averaged diffusivities but have dramatically different spatial distributions leading to different circulations in OGCMs. Both parameterizations are conservative compared to inverse estimates in mid-latitude basins and significantly underestimate diffusivities in the Northern Indian and Southern Oceans, suggesting that mixing processes other than the breaking of topography-catalyzed internal waves play an important role in setting the global spatial distribution of diapycnal mixing. (Abstract ID 12475)

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SCHEDULING SENSORS FOR BIO-GEO-CHEMICAL PROFILING FLOATS

Teledyne Webb Research Apex floats are being used for bio-geo-chemical profiling measurements, using a Saphanti/WETlabs bio-optical sensor system. This requires different sets of sensors, as well as different sampling modes, to be used between different pressure ranges and at different times during the day. In addition, float behavior (such as ascent rate) must be controlled, depending on the pressure range. These requirements have been met using a novel approach to describing how the sensors and profiles behave. For example, sensors are grouped into sets, with properties such as data verbosity levels, and whether active-optic or radiometry-related measurements are to be included. Profiles are then divided into pressure ranges, with each sensor set being programmed separately within each pressure range. Finally, profiles can be updated remotely (via the Iridium satellite system), which is important when ocean properties to be measured change due to season or float location. This approach has been successfully tested using two floats, in three deployments near the BOUSSOLE site, France, in collaboration with the University of Maine. (Abstract ID 11465)

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MARITIME SECURITY SUMMER RESEARCH: DIVERSITY INITIATIVES

The Center for Secure and Resilient Maritime Commerce (CSR), a Department of Homeland Security National Center of Excellence, aims to increase student interest and knowledge of the maritime domain, the marine transportation system and the sensor technologies used to secure our nation's ports, coastal borders, and remote and extreme islands, through a unique 8-week intensive STEM-based summer research program. The Summer Research Institute (SRI) engages a diverse group of undergraduate students from MSI, HBCU and other U.S. universities, in hands-on, multi-disciplinary research in collaboration with CSR researchers from Stevens Institute of Technology, Rutgers University, University of Puerto Rico, University of Miami, Monmouth University and MIT. The SRI has already been a stepping-stone for many students to pursue advanced academic study in maritime systems and career opportunities within the maritime homeland security domain. In the second year of the program, the number of minority participants increased through targeted recruitment and close partnerships with MSI and HBCU institutions. We will describe our strategy and our continued efforts to expand our outreach to under-represented populations. (Abstract ID 12102)

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INORGANIC CARBON AND CALCIUM CARBONATE SATURATION STATES: CALCULATION FROM IN SITU PH AND PCO2 DATA

The oceans' uptake of anthropogenic CO2 is clearly to our benefit and understanding the processes that control the uptake is vitally important. There are also negative consequences to consider. Although the ocean inorganic carbon reservoir is huge, it has been measurably altered by the penetration of anthropogenic CO2 from the atmosphere resulting in acidification of the surface ocean. More inorganic carbon data in space and time will help improve predictive models and estimate the effects of acidification, e.g. on calcium carbonate saturation states. Here we discuss the pros and cons of using the only commercially-available inorganic carbon measurement systems, pH and pCO2, for quantifying the marine inorganic carbon system. Data from a number of coastal studies show that CaCO3 saturation can be accurately quantified and that the combined pH and pCO2 data are valuable for measurement quality control. However, errors in calculated dissolved inorganic carbon and total alkalinity can be large, due to temporal and spatial mismatches between data sets and the inherent error in the pH and pCO2 combination. (Abstract ID 11554)

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ARCTIC OCEAN BOUNDARY CURRENTS IN THE ARCTIC CAP NOWCAST/FORECAST SYSTEM

The boundary currents of the Arctic Ocean are investigated using the Arctic Cap Nowcast/Forecast System (ACNFS). The ACNFS in the Arctic Ocean model being utilized by the Naval Oceanographic Office. It is a fully two-way coupled ocean-ice model utilizing the Hybrid Coordinate Ocean Model (HYCOM), coupled to the Los Alamos sea ice model (CICE). It is forced using the Fleet Numerical Meteorology and Oceanography Center's Navy Operational Global Atmospheric Prediction System (NOGAPS) atmospheric fields and assimilates remote sensing and in situ data. Examples of the validation, and an initial investigation of the boundary currents that are found in the model are presented. Given the general lack of data in the Arctic, in particular with respect to current measurements, the suitability of the model to investigate boundary currents is discussed. The use of operational models to investigate the ocean and the difficulties associated with it are also discussed. (Abstract ID 10415)

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THE POPULATION ECOLOGY OF NON-INDIGENOUS ASCIDIANS ON THE SOUTH COAST OF NEWFOUNDLAND

We have recently discovered two non-indigenous ascidians, Botryllus schlosseri and Botrydiiodes violaceus, in several harbours on the south coast of Newfoundland. As neither species has been detected on the east or northeast coasts of the island, it appears that they are at the northern boundary of their range and limited by low temperature and a short productive season. Since both of these species are pests of aquaculture operations elsewhere, we designed an interdisciplinary research program focused on factors predicting invasion fitness and future spread. Our results are intended to inform zonal closure and mitigation decisions of government. The seasonal life cycle of B. schlosseri is being determined in Arnold’s Cove, including somatic growth and the rates and timing of asexual and sexual reproduction decisions of government. The seasonal life cycle of B. schlosseri is being determined in Arnold's Cove, including somatic growth and the rates and timing of asexual and sexual reproduction decisions of government. The seasonal life cycle of B. schlosseri is being determined in Arnold's Cove, including somatic growth and the rates and timing of asexual and sexual reproduction decisions of government. (Lowen oral presentation) and larval recruitment (companion Ma poster). Since mitigation is more effective if applied early in an invasion, TaqMan assays are being developed with the aim of being sufficiently sensitive to detect a single egg or larva (companion Applin poster). Gene sequence information will also be used to infer source populations of the Newfoundland invaders. (Abstract ID 10305)

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ORGANIC/INORGANIC NUTRIENT CONTROL OF N2 FIXATION IN THE EASTERN TROPICAL SOUTH PACIFIC

N2 fixation has generally been studied in oligotrophic areas depleted in N, as N2 fixers are thought not to be competitive in N rich areas, or do not fix N2, which is a costly process in terms
of Fe quota and energy. In the Eastern Tropical South Pacific, incubation-based N2 fixation rates were measured both in surface and subsurface waters. Samples were collected along 10° & 20°S from nitrate-rich upwelling waters to highly oligotrophic conditions at 100°W, with euphotic zone nutrient amendment experiments (trace-metal clean conditions). These experiments indicate that nitrogen fixation was iron limited along 10°S, except in nearer-shore regions, where rates were limited by organic carbon availability. In the nutrient-replete subsurface, nitrogen fixation rates were highest in the core of the oxygen minimum zone (OMZ), and were significantly stimulated by additions of organic carbon at some stations. Volume-integrated rates of nitrogen fixation were higher in the OMZ, compared to the euphotic zone, in spite of ~10µM nitrate. These results will be discussed in the context of molecular analyses conducted targeting a marker gene for nitrogen fixation, nifH. (Abstract ID 10961)

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DESIGNING THE ENTERPRISE ARCHITECTURE OF THE GREAT LAKES OBSERVING SYSTEM

The NOAA Great Lakes Environmental Research Laboratory (GLERL) and its partners (Great Lakes Observing System (GLOS), EPA-Great Lakes National Program Office and the United States Geological Survey) have recently developed the near-term design of a comprehensive observing enterprise that will serve as the next generation of the Great Lakes Observing System. An observing system enterprise begins with a detailed catalog of user needs within the Great Lakes, and proposes observations, sensing systems, and management and information structures that will best support those user needs. The enterprise will comprise: an array of data collecting systems, including satellites, aircraft, fixed platforms and buoys, drifters and floats, automated underwater vehicles, towed sensor arrays, and ships; telemetry; a data management and communications (DMAC) system, which stores and organizes the data for use in developing products and services; and the products (such as models) that support the user needs. This presentation describes the development of the design, focusing on the unique aspects of an observing system that functions at multiple scales (whole-basin, lake and regional) in the Great Lakes, and summarizes plans for implementation. (Abstract ID 12204)

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UNDERSTANDING THE PLANETARY LIFE SUPPORT SYSTEM: NEXT-GENERATION SCIENCE IN THE OCEAN BASINS

Driven by solar and internal geothermal energy, the complex processes interacting within the global ocean constitute our planetary life-support system. New approaches to understanding this “oceanic modulator” are arising from submarine cabled networks, such as the one now under construction by the NSF Ocean Observatories Initiative, that provide electrical power and bandwidth to distributed sensors. Oceanographers are poised to benefit from a host of emerging technologies external to the ocean sciences, such as robotics, telecommunications, biotechnology, cloud computing, in situ chemical and genomic sensors, extraction of novel biochemical materials, digital imaging, nanotechnology, serious gaming, new visualization technologies, computational simulations and data assimilation, and seismo-acoustic tomography. More powerful than any one of these emerging technologies is the convergence of the ensemble. As rapidly evolving capabilities are integrated into sophisticated, remote, interactive operations throughout the ocean basins for decades, a new era of a human telepresence throughout our once “inaccessible” global ocean will be realized. Such capabilities are required to meet the immense environmental and societal challenges in the coming decades that can only be addressed through optimally informed international collaboration. (Abstract ID 12562)

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INTER-ANNUAL ANALYSIS OF SURFACE TEMPERATURE, CHLOROPHYLL-A AND INHERENT OPTICAL PROPERTIES FROM SATELLITE OBSERVATIONS IN THE SW OF BUENOS AIRES (ARGENTINA)

The inner shelf of the southwest of Buenos Aires Province (Argentina) is a very complex natural system. It combines an heterogeneous bathymetry, the presence of an estuary and outflows of rivers, and a important input of energy produced by the tide and wind. A global study of diverse satellite products was made in order to obtain a dynamic regionalization of the study area. In addition the seasonal and inter-annual behavior of the sea surface temperature (sst), chlorophyll-a (chl-a) and inherent optical properties (IOPs) were analyzed and related to the hydrographic and climatological characteristics of the area. Nine years data of Moderate Resolution Imaging (MODIS) were processed in order to get the set product. In situ data obtained from oceanographic campaigns were used to validate the results on the set. Weakly and monthly composities of ten years of Sea Viewing Wide Field of View Sensor (SeaWiFS) were made in order to determine different regions based on Ocean Color derived chl-a and IOPs. Finally, the inter-annual and seasonal trends of the parameters were obtained with the Census X-11 method. (Abstract ID 11886)

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IT’S COMPLICATED: VARYING TOPOGRAPHY AND THE ABYSSAL BOTTOM BOUNDARY LAYER

Physical oceanographers know the total amount of abyssal mixing and upwelling required to balance the deep-water formation, but we are still working to understand the mechanisms and locations—how and where it happens. From observational studies, we know that areas of rough topography are important and the hundreds of mid-ocean ridge canyons have particularly energetic mixing. Inspired by these observations, we studied diffusive boundary layers over varying topography using theoretical and numerical techniques. These boundary layers share many important properties with observed flows in abyssal canyons, like strong up-slope currents and acceleration near topographic sills. They also have a previously unidentified capacity to accelerate into non-linear overflows for a variety of oceanographically relevant shapes and sizes of topography. They also can force exchange of large volumes of fluid between the relatively unstratified boundary layer and the stratified far-field fluid, altering the stratification far from the boundary. In conclusion, these boundary layer processes may be a previously neglected source of a dynamically important amount of abyssal upwelling, profoundly affecting predictions of the basin-scale circulation. (Abstract ID 10714)

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PREDATOR:PREY SIZE RELATIONSHIPS IN PELAGIC ECOSYSTEMS: TESTING THE 10:1 HYPOTHESIS WITH MESOZOOPLANKTON FROM THREE REGIONS

Size-based theories of energy flow in pelagic marine ecosystems, as well as numerous conceptual models, assume that predators and prey are linked, on average, by a body length ratio of 10:1. We tested this hypothesis using bulk N and Compound-Specific Isotope Analyses (CSIA) on zooplankton in the 2 to 5 mm size range collected from three biogeochemical systems: the California Current Ecosystem (CCE), the Costa Rica Dome (CRD) and the subtropical North Pacific (Stn. ALOHA). Bulk δ15N values reflect substantial regional differences in the dominant N cycling processes, which vary from N2 fixation (Stn. ALOHA) to denitrification (CRD). However, the slopes of bulk δ15N versus size suggest that a 10-fold size difference corresponds to ~1/4 of a trophic level, implying a mean predator:prey size ratio in natural systems ~100:1. CSA corrects for source N differences among regions and size classes, but does not markedly alter this conclusion. CSA assessments of trophic position versus size strongly overlap for the three regions. If these results are generalizable, energy transfer to higher trophic levels of ocean systems may be substantially more efficient than previously considered. (Abstract ID 11985)

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WHERE HAVE ALL THE OYSTERS GONE: NATURAL AND ANTHROPOGENICALLY CAUSES FOR DRASTIC OYSTER REEF LOSSES IN GULF OF MEXICO ESTUARIES

In light of 85% loss global loss in oyster reefs, we consider examples from the Gulf of Mexico. Naples and Dollar Bays are small, connected bays in south Florida. Dollar Bay is a natural system with mangrove shorelines and a sandy bottom. Naples Bay, similar to Dollar Bay prior to 1940, is nearly completely bulkheaded, with extensive canals, has filled with +50 cm of sand and power line towers. Oyster reefs first started developing in Copano Bay (Texas) 6 ka, when sea level rise slowed and reefs began forming on fluvial terraces. By ~4.5 ka, 54% of the bay bottom contained oyster reef and shell. With additional sea level rise, the bay filled with mud, reducing reef distribution by 64%. (Abstract ID 10276)

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IOPs. Finally, the inter-annual and seasonal trend of the parameters were obtained with the Census X-11 method. (Abstract ID 11886)
100-day timescales is being established based on sediment inventories of 234Th. Radiochemical constants over the four remaining stations. The relative mass flux reaching the seabed on change is being developed.

Benthic ecological processes along this transect exhibiting contrasting ice conditions, insight into the response of this important high-latitude environment to current and future climate change is being developed. By determining trends in biogeochemical tracers along the N/S transect as well as to document possible hiatuses in deposit feeding on the Antarctic Continental Shelf) established 5 stations along a 600 km N/S transect on the West Antarctic Peninsula Shelf. By determining trends in biogeochemical tracers and on 250 years by including an additional core from the same colony. (Abstract ID 10067)

We investigate nonenvironmental variability within and among coral colonies and evaluate the errors associated with sampling, chronology, and temperature reconstruction using cross-dated coral Sr/Ca records from five coral cores recovered from three Porites lutea colonies in New Caledonia (22°28.8′S, 166°27.9′E). Our results reveal that it is necessary to select sampling paths with corallites extending parallel to the slab surface along the apex of the corallite fan to achieve reproducible results. Cross-dated and optimally sampled coral Sr/Ca variations are coherent on subannual to centennial time scales and are reproducible for more than three centuries within analytical precision or 0.28°C. Chronology error for a multicentury reconstruction based on a single core varies between 2.5 to 3.8 years century^-1 compared to our multicore chronology. We find the monthly anomaly reconstruction error (1σ) for a single core is 0.95°C and 0.59°C for five intra- and intercolony cores. For interannual variability, the error is reduced by ~33% by including an additional colony, whereas the chronology error is reduced for reconstructions >250 years by including an additional core from the same colony. (Abstract ID 10067)

We describe and assess the accuracy and precision of a new methodology for estimating the temperature and salinity of water during the annual cycle at Mississippi Canyon 118. The carbonate-hydrate mound is the site of the Gulf of Mexico Hydrates Research Consortium’s seafloor observatory to investigate and monitor hydrographic, geophysical, geological, geochemical and biological processes of the hydrocarbon system, northern Gulf of Mexico. Seafloor morphology and geology have been characterized integrating high resolution swath bathymetry, acoustic imagery, seafloor video and multiple resolution seismic data with sediment, water column, and pore-water samples collected over a long period of observations (2002-2011). Outcropping hydrates, fluid-migration features and seafloor communities identified and described from numerous types of imagery have been mapped. These maps have been combined over time on the bathymetry/fault maps to produce a biotypes-seep map from which we have identified and differentiated types of seeps. Community complexity is used as a proxy for seep duration/age while specific community components are believed to reflect composition of seep fluids. Although preliminary, this approach represents a novel classification system for seafloor hydrocarbon seeps. (Abstract ID 9968)

Recent ocean observations demonstrate a general trend of warming of the Labrador Sea over the past two decades. The processes which contributed to the change of the Labrador Sea are related in a complex way to the recent variations in the large scale atmospheric circulation and response of the ocean to these variations. In this study we use an eddy-resolving ocean general circulation model of the Labrador Sea to simulate the ocean variability in the past 30 years. The variations in the deep and intermediate water masses formation, intensity of the mean circulation and energetics of mesoscale eddies are assessed. The model results show a strong interannual variability in the formation rate of the Labrador-Sea Water (LSW) during the studied period. There was a trend of decay of the volume of the newly formed LSW during all years of the past decade, with exception of 2008. This decay is concurrent with an increase of the inflow of Inirriging Water in the Eastern Labrador Sea. The energetics of the mesoscale processes during the past decade is studied and the dominant processes in the eddy energetics and their relation to the large scale circulation variability are discussed. (Abstract ID 12596)

The VENUS cabled network in the Strait of Georgia has been observing environmental variables continuously since 2008 in the Strait of Georgia off the mouths of the Fraser River in British Columbia, Canada, a high traffic area with ferries, container, oil and coal terminals, the main shipping lane between the Pacific Ocean and Vancouver Harbour, and an active salmon fishery. We are currently adding profiling gliders, ocean and met sensor packages on three main shipping routes of BC ferries, and a CODAR high frequency radar system that will monitor surface currents and waves. We plan to implement a high resolution assimilating ocean circulation model to provide operational ocean and environmental forecasts on time scales from hours to weeks, including an early warning system using NEPTUNE Canada observations from offshore for intrusions of low oxygen, low pH waters that have been implicated in mass mortality of cultured scallop larvae in the northern Strait. The challenge will be to develop an integrated representation of these disparate observations and to determine which observations, when assimilated, will improve the forecasts. (Abstract ID 10523)
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METHANE BUBBLE PLUMES AT HYDRATE RIDGE: MULTIBEAM IMAGING OF TEMPORAL AND SPATIAL VARIABILITY AS PART OF THE OCEAN OBSERVATORIES INITIATIVE

Southern Hydrate Ridge (SHR) will be connected to the Internet in 2013 with a myriad of seafloor sensors connected to the terrestrial grid by high power and bandwidth cables, as part of NSF’s Ocean Observatories Initiative (OOI). SHR is a type-location for methane studies hosting both methane hydrate and methane gas. In 2011, as part of the OOI effort, we used the R/V Thompsons EM 302 multibeam sonar to image the rise height and shape of several bubble plumes at Hydrate Ridge. The rise-height was observed to exceed the top of the local methane hydrate stability field in several of the images, indicating bubble transport and methane entrainment into the shallow water column. These observations were supported by hydrocarbon analyses of samples collected adjacent to the plumes showing methane concentrations in excess of background levels, coincident with the base of the pycnocline. OOI sensors installed in 2013 that include an upward-looking ADCP, mass spectrometer and seismometers will provide real-time data to examine linkages among oceanographic and tectonic events and methane plume formation with data available 24/7/365. (Abstract ID 11879)

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EPISODIC CROSS-SHELF TRANSPORT IN THE NORTHERN GULF OF MEXICO

The biogeochemical connectivity between the Northern Gulf of Mexico shelf and waters offshore is subject to complex flow fields and is not well characterized. Here, remotely sensed observations are used to provide insight to both the mechanisms and the resultant ecological impact of a short-temporal large-scale cross-shelf transport event in the Northern Gulf of Mexico (NGOM). The satellite data reveal a filament of high chlorophyll coastal waters, seen as elevated ocean color, extending along the advective path of an eddy positioned near the continental shelf of the NGOM. A comparison of CDOM and fluorescence fields obtained from the MOCNESS sensor aboard NASA’s Aqua satellite quantified the mechanisms leading to the high chlorophyll signal associated with the transport may have varied significantly from previously studied cross-shelf transports in the region. Surface CHL observations showed that the ecological importance of the transport varied significantly with distance from the shelf. Finally, the impact of the event on primary productivity was explored as a means to describe the role of episodic events on the regional carbon budget. (Abstract ID 12706)

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DECAD-SCALE OCEAN MODEL SIMULATIONS IN THE GULF OF MEXICO REVEAL INCREASING TRENDS IN OCEAN HEAT CONTENT AND SEASONAL TEMPERATURE EXTREMES

The Navy Coastal Ocean Model (NCOM) is configured at 4km horizontal resolution with a 40-layer z/v vertical structure to conduct 30+ year reanalysis simulations in the Gulf of Mexico (GOM). This NCOM-GOM model is forced by NASA’s Modern Era Retrospective-analysis for Research and Applications (MERRA) atmospheric fluxes, available from 1979 to near-present, and by boundary conditions prescribed from Global NCOM. The objective of these quasi-ideal experiments is to examine and quantify oceanic temperature variability in the Gulf, from statistically significant calculations of sea surface temperature, upper ocean heat content, air-sea heat energy exchange, and other important quantities pertinent to climate change and adaptation. Comparative analyses, versus IPCC A1B results and several observational data collections across the Gulf – including recent Flower Garden Banks Marine Sanctuary field observations (summer 2011), demonstrate robust model skill and reveal enhanced seasonal cycles of ocean temperature along with increasing trends in oceanic heat content. (Abstract ID 11897)

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HIGH RESOLUTION ESTIMATE OF SURFACE POTENTIAL VORTICITY FLUXES IN THE REGION OF THE SEPARATED GULF STREAM

Air sea interaction is a key phenomenon that acts to modify the properties of a water mass (and especially its potential vorticity, PV). More precisely, two mechanisms are acting to modify the PV of a water mass: on the one hand, mechanical forcing due to the wind is acting in a region of strong density gradients. On the other hand, heat and freshwater fluxes contribute to modify the PV. In the Atlantic, these fluxes are maximum in the Gulf Stream area. In order to better estimate the rate of formation of mode water, we use a high resolution regional model that we run with successive downscaling. This oceanic model is forced by a slab atmosphere in order to estimate correctly the air-sea fluxes. Since this model resolves meso- and submeso-scale, we are able to map the relative magnitude of the two effects in the presence of eddies. We verify these results using the observations performed in the CLIMODE framework. (Abstract ID 10758)

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EFFECTS OF OCEAN ACIDIFICATION ON LARVAL DEVELOPMENT IN ALASKAN CRABS

The goal of this study is to measure the effects of ocean acidification on larval development in Tanner crabs, Chionoecetes bairdi, and Dungeness crabs, Metacarcinus magister, in Alaska. A climate-driven challenge to marine populations is the expected decrease of up to 0.4 pH units in high-latitude waters of North America in the next century. Such a decrease could prove to be detrimental to crabs by causing increased mortality and abnormal development in early life stages. In coastal Alaska, several Tanner and Dungeness crab populations that once supported commercial or sport fisheries have experienced severe stock declines, and recovery might be impeded by additional challenges such as ocean acidification. Here, it is hypothesized that increasing acidity will cause decreased survival, morphometric deformities and decreased calcification rates in larval Tanner and Dungeness crabs. Larvae from females captured in Kachemak Bay, Alaska were raised in flow-through seawater tanks of three different pH levels representing a range expected for the next two centuries in the North Pacific. Larvae were monitored for survival, morphometrics and calcification rate of the exoskeleton during the first zoal stage. (Abstract ID 9393)

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NUTRIENT RATIOS AS A TRACER AND DRIVER OF OCEAN BIOGEOCHEMISTRY

Microbial life in the ocean contains immense taxonomic and physiological diversity; yet its collective activity yields global cycles of the major biolimiting elements N and P that are tightly linked. Moreover, the availability of N and P in seawater is closely matched to the metabolic demands of “average” plankton, as plankton composition and the oceanic nutrient reservoirs were mutually influenced. These simple observations have broad implications for the function of nutrient cycles within the Earth system, which can operate either as a biological homeostat that buffers ocean fertility against large changes or as an amplifier of climate perturbations, by alleviating or exacerbating the nutrient limitation of biological productivity and ocean C storage. A mechanistic understanding of these observations and their underlying dynamics must draw upon diverse fields, from physiogy and evolution to physical oceanography and paleoceanography, and must account for processes spanning a wide range of spatial and temporal scales. I will summarize the state of this understanding from the perspective of the nutrient distributions themselves and their changes over time, highlighting the role of physical and biological averaging processes that allow geochemical constancy to emerge from rich biological diversity. (Abstract ID 10286)

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WHAT WE HAVE LEARNED: CONNECTING SCIENTISTS WITH STUDENTS THROUGH THE USE OF COMMUNICATIONS TECHNOLOGY

Scientists at Scripps Institution of Oceanography have worked with a group of middle school teachers to teach students about developing new drugs through marine natural products research and the clinical drug discovery process. The participating San Diego Unified School District 7th grade life science teachers routinely teach a unit on drug discovery, and in collaboration with the Center for Ocean Sciences Education Excellence California (COSEE CA), enrich the instruction by providing students the opportunity to communicate face-to-face with marine scientists through an interactive videoconference. Using SKYPE to connect the lab to the classroom, the scientists discuss their work and answer questions about their lifestyle and their path to being a researcher. In addition, the students experience a lab tour and learn about the various jobs people do at the lab. The teacher/researcher team has refined this program over the last three years based on ongoing formative assessment. In this presentation, we will...
discuss what we have learned about developing this type of program and how we plan to implement it more broadly. (Abstract ID 12850)

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THE ROLES OF COASTAL GLIDERS IN THE OCEAN OBSERVATORIES INITIATIVE

The NSF-funded Ocean Observatories Initiative (OOI) will make use of ocean gliders for a variety of roles on its coastal and global scale nodes. Within OOI, gliders will be used to make repeated transects to resolve mesoscale variability on seasonal and climatological time scales, for adaptive sampling and process studies, and even to relay data from subsurface moorings via acoustic modem. For coastal scale nodes, gliders will carry a multidisciplinary suite including CTD, chlorophyll fluorescence, optical backscatter, DO2, PAR, and ADCP water velocity sensors. Coastal gliders will maintain a continuous presence on both the re-locatable Pioneer array (initially over the New England/New Jersey shelf and slope) and the permanent Endurance array of the Oregon and Washington coasts. We plan to begin operational deployment of gliders on the coastal scale OOI arrays in May 2012. The science payload and operational strategies place strenuous requirements on the OOI glider design. The three month mission and heavy science payload stretch the battery capacity of available glider platforms. Biofiltering mitigation is also a necessity for these missions. OOI is now testing the Teledyne Webb Slocomb G2 configured to fulfill these requirements. In this talk, we will describe the roles of coastal gliders in OOI, report on the testing progress and update the plans for operational deployments in the coastal scale arrays of OOI. (Abstract ID 12666)

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DENTRIFICATION RATES AND CARBON FLUXES IN OXYGEN DEFICIENT ZONES

Denitrification in the main three pelagic oxygen deficient zones (ODZ) of the world’s oceans is thought to account for approximately 30% (60-90 Tg/y) of the combined nitrogen loss from the ocean. However, current estimates are based either on stoichiometric calculations or instantaneous discrete rate measurements and there remains considerable range and uncertainty in the existing numbers. We used published and unpublished sediment-trap carbon-flux numbers to calculate denitrification rates. Trap-flux derived denitrification rates were highest in the eastern tropical South Pacific, 27 nM/d, and lowest in the eastern tropical North Pacific, 5.2 nM/d. The rate for the Arabian Sea was 7.6 nM/d. When rates were fit to a “Martin-type curve” the attenuation coefficient, alpha, was significantly smaller than that generally considered representative for the global ocean (~0.3/m rather than ~0.8/m). Given a mean combined nitrogen deficit of about 7 uM for each ODZ, sediment-trap derived rates suggest water mass replacement times on order 1 to 8 years for ODZ waters. (Abstract ID 12405)

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DYNAMICALLY- AND OBSERVATIONALLY-CONSTRAINED ESTIMATES OF WATER-MASS DISTRIBUTIONS AND AGES IN THE GLOBAL OCEAN

We develop a global data-constrained ocean circulation model to infer the distribution of water masses and their ages in the ocean. The model is constrained by temperature, salinity, radionuclides, and CFC distributions in the ocean, as well as independent estimates of sea-surface height and heat and freshwater fluxes. We find that the ocean is ventilated primarily by water masses forming in the Southern Ocean, which make up more than 50% of the ocean’s volume. We also find that more than 60% of interior ocean waters make first contact with the atmosphere in the Southern Ocean, further emphasizing the central role played by the Southern Ocean in the regulation of the Earth’s climate. The mean age of deep waters is greater than 1000 years throughout most of the Indian and Pacific Oceans, reaching a maximum of 1400-1500 years in the mid-depth North Pacific. The mean time for deep waters to be re-exposed at the surface through most of the Indian and Pacific Oceans, reaching a maximum of 1400-1500 years in the deep North Pacific. These findings have important implications for the oceanic uptake of heat and greenhouse gases. (Abstract ID 10921)

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ACTIVE AND PASSIVE ACOUSTIC SYSTEMS ON A CABLED OCEAN OBSERVATORY

Cabled observatories are particularly good platforms for supporting both active and passive acoustic observing systems. The continuous power and virtually unlimited bandwidth lends itself naturally to the demands of acoustic technology. The VENUS coastal network, active since 2006 in the coastal waters of British Columbia, has been using a variety of both active and passive systems to probe and monitor the environment. In particular, several well-established active technologies generating rich data records have been deployed, including Acoustic Doppler Current Proﬁlers (ADCP), Acoustic Doppler Velocimeters (ADV), and high-frequency inverted echo-sounders (Zooplankton Acoustic Proﬁlers, ZAP). Passive sounds have been monitored with multi-element hydrophone arrays. Multiple active and passive acoustic systems can interfere with each other, so a variety of synchronizing, sampling, and spatial separation strategies have been employed. With meagin communications, these systems have default conﬁgurations that collect hundreds of megabytes to gigabytes of data per day. The presentation will discuss some of the challenges, solutions, and results associated with acoustic systems on a cabled observatory. Upcoming deployments include the addition of DIDSON acoustic imaging technology. (Abstract ID 10564)

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REMOTELY FORCED SUB-THERMOCLINE VARIABILITY AT LOW FREQUENCY IN THE SOUTH-EASTERN PACIFIC

The eastern boundary current systems are connected to the equatorial variability at a variety of time scales through the equatorial Kelvin wave that can propagate along the coast or can reflect as Rossby wave (ER). At low frequency, linear theory predicts that Kelvin wave reﬂects as Rossby waves at almost all latitudes. Here we present an analysis of the subthermocline interannual variability in the eastern South Paciﬁc as simulated by models of various complexity; from linear to eddy-resolving models. The focus is on the energy flux associated with extra-tropical ER and their connection with equatorial Kelvin waves. The WKB theory is used to interpret the simulated subsurface variability. The analysis reveals vertical propagation of energy associated to seasonal and interannual timescales suggesting that a significant share of the mechanical energy of the wind stress along the equator is transmitted to the deep ocean at higher latitudes. A particular focus is put in the vertical energy flux associated to the EL Niño variability, differentiating the two types of EL Niño, namely the conventional EL Niño and the Central Paciﬁc EL Niño. (Abstract ID 12007)

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CALCIIFICATION RATES UNDER DIFFERENT CO2 LEVELS FOR THREE BERMUDIAN CORALS MEASURED IN SITU AND IN AQUARIUM

Rising levels of atmospheric CO2 in ocean surface water are causing increasingly unfavorable conditions for calcification of coral reef communities and potentially trending towards net dissolution of calcium carbonate reef substrate. This study tracked the growth rates of three common Bermudian corals, Diploria strigosa, D. labyrinthiformis and Porites astreoides under present and IPCC projected CO2 levels, both in flow-through aquaria, and in situ measurements on the Bermuda coral reef platform. Aquaria specimen were incubated for 10 days at IPCC projected pCO2 levels for 2100, and measured for growth using the buoyant weight method normalized for surface area and initial mass. In situ measurements were conducted at two extreme ends of a naturally occurring carbonate ion concentration gradient on the reef platform, with growth tracked quarterly via buoyant weight. Six months of in situ growth data indicate a faster rate of coral growth in study sites with higher carbonate ion concentration. In contrast, the aquaria study found no significant change in the growth rate of D. strigosa subjected to CO2 levels modeling surface seawater for the year 2100. (Abstract ID 10124)

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VERTICAL VELOCITY OF THE DEEP SEA HYDROTHERMAL PLUME OF DANTE AND ITS INTERACTION WITH TIDAL FLOWS

The acoustic scintillation method has been used to study the vigorous hydrothermal plume of Dante within the Main Endeavour vent field (MENV) at the Endeavour segment of the Juan de Fuca Ridge. Forty-day time series of vertical velocity and temperature fluctuations were obtained across the rising plume at 20 m above the Dante edifice in an environment where the flow is dominated by strong (5 cm/s) semi-diurnal tidal currents and a northerly mean residual current (3 cm/s). These measurements provide a window on deep-sea hydrothermal plume dynamics in strong oscillatory cross flows. Plume models that take into account ambient stratification and time-dependent background flows, in conjunction with these measurements, yield insights into entrainment, plume bending, rise height, and, inferentially, mound heat flux. In particular, an integral plume model with an entrainment velocity that is a function of both the plume axial
velocity and the ambient tidal flow perpendicular to the plume axis indicates that increased entrainment occurs during strong cross flows causing the plume to cool, rise more slowly and bend. Results from a separate three-dimensional numerical model show the plume bending with the tidal cycle and having rise heights that vary from ~75 to approximately 250 m for an estimated mound heat flux of 40 MW and a discharge salinity anomaly of ~5 psu. (Abstract ID 12847)

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THE EMERGENCE OF STRIATIONS IN THE NORTH PACIFIC CIRCULATION

Recent observation suggest that the mean ocean circulation is characterized by zonal striations in the velocity field resembling the alternation of jet-like features. In this study the generating dynamics of these striations are explored numerically with a set of high-resolution (~10km) long-term (100 year) simulations of the North Pacific. The simulation set are conducted with decreasing level of complexity towards more idealized configuration that allow retaining the essential dynamics and forcing necessary for the striations to develop in the long-term mean. For each model simulation we diagnose the spin-up dynamics of the ocean model and how the onset of the striations, and their location, is sensitive to topography, coastal geometry and different strength of the forcing – which modulates the gyre scale circulation and the degree of non-linearity of the flow field. Results indicate that striations develop from the eastern boundary and migrate in the ocean interior following linear and non-linear beta dynamics. However their appearance in the long-term mean is determined by topographic features along the eastern boundary and the ocean interior that localize in space the vorticity anomalies generating the beta-plumes. (Abstract ID 10837)

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THE EFFECTS OF VIOLACEIN-PRODUCING BACTERIA ON MICROZooplankton GRAZING AND PHYtoplankTON GROWTH

Microzooplankton are grazers that are less than 200 μm. They are important in regulating population levels of bacteria and other microorganisms in the ocean. Also they have an important role in the microbial loop transforming dissolved organic carbon and they are an important food source. There are some genera of aquatic bacteria that produce violacein pigment as a chemical defense. It is a highly toxic pigment that has been shown to kill freshwater microzooplankton. We experimentally investigated how violacein-producing bacteria (VPB) affect microzooplankton grazing and phytoplankton growth in estuarine plankton communities. Our results suggest that the addition of VPB to estuarine microplankton communities affects algal growth instead of inhibiting microzooplankton grazing. For VPB to have an effect in the natural environment, in estuaries it has to be at concentration range of ~10^3 ml^-1. In estuaries and coastal seas, estimates of total bacterial abundance range from ~1 x 10^6 ml^-1 to ~2 x 10^7 ml^-1. So, for there to be an effect at least ~10% of bacteria would have to be VPB. VPB could have a negative impact on phytoplankton communities but there could also be a positive impact, the control of blooms the Chesapeake Bay and its tributaries. (Abstract ID 9669)

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BACTERIAL COMMUNITY METABOLIC AND PHYLOGENETIC PROFILES FROM THREE NORTH FLORIDA FRESHWATER LAKES

Molecular and cultivation dependent tools were used to compare the metabolic and phylogenetic profiles of bacterial communities in the Lakes Munson, Bradford and Moore in Tallahassee, Florida. With minimal information regarding bacterial diversity between lakes but there could also be a positive impact, the control of blooms the Chesapeake Bay and its tributaries. (Abstract ID 9669)

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AN EXAMINATION OF OCEANIC PROCESSES CONTRIBUTING TO THE SST ANOMALIES IN THE NORTH ATLANTIC OCEAN

A one-dimensional mixed layer model is combined with satellite fields to determine the processes responsible for SST anomalies in the North Atlantic Ocean. The model is forced at the surface with heat, momentum and freshwater fluxes. We modify the 1-d model to include geostrophic and Ekman advection of temperature and salinity advection down to 150m. Climatological and time-varying forcing terms are applied in different combinations to estimate their effects. We focus on the many contributions to SST at six locations in the North Atlantic Ocean including the Gulf Stream and its recirculation gyre, the Northwest Corner; the North Atlantic Current, the Labrador Current and the Azores Current. We see a fragile balance between the advection of temperature and of salinity, particularly in the subpolar gyre, where the water column is easily destabilized. Climatological depth dependent corrections to the advection of both temperature and salinity are needed to stabilize the column and can be surprisingly large compared to the advection terms themselves. Adding salinity advection resulted in more reasonable mixed layer depths and SST than temperature advection alone. (Abstract ID 10674)

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ABYSSAL WARMING IN THE NORTIC SEAS

Since Greenland Sea Deep Water (GSDW) is the coldest of the three local Deep Waters, Meincke & Rudels (1995) concluded that the sustained warming in the deep Greenland Sea from the early 1970s to the present was due to a progressive shift from vertical exchange (with the cool surface layers) to horizontal exchange (with the relatively warm Arctic Ocean Deep Water (AODW) through Fram Strait), and the accompanying changes in salinity and oxygen were consistent with that view. Dickson & Osterhus (2007) later explained the parallel warming of Norwegian Sea Deep Water at 2000m beneath OWS M as being due to the spread of this warming GSWD through the Jan Mayen Channel (all 2000m). Here we follow the warming signal northwards from OWS M through the Lofoten Basin to Fram Strait, where we conclude that it may explain the steady rise in temperature observed close to the seabed over the last ten years in the deepest part of the watercolumn (2500m) of the HAUSGARTEN-site. Since sea-floor temperature is a known control on the dissociation of gas hydrates from sediments in this area, it is important to develop an understanding of the cause of such a sustained warming trend. If our conclusion is correct, the observed warming there may be the recent expression of a longer trend involving changes in the exchange of deep waters between three ocean basins (Eurasian, Greenland and Norwegian) over a period of 4 decades. And at OWS M and Fram Strait, the deep warming continues. (Abstract ID 9933)

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BUILDING AN OCEAN LEARNING NETWORK: FOSTERING COLLABORATIONS WITH THE INFORMAL SCIENCE COMMUNITY

COSEE Florida is a partnership between the Smithsonian Marine Station at Fort Pierce, Indian River State College, Florida Institute of Technology, and Ocean Research & Conservation Association. As a part of the national network of Centers for Ocean Sciences Education Excellence (COSEE), whose mission is "to spark and nurture collaborations among research scientists and educators to advance ocean discovery and make known the vital role of the ocean in our lives", one of the primary initiatives of COSEE Florida is to create an active, statewide Ocean Learning Network through which ocean scientists can broadly disseminate their research in meaningful ways, thereby meeting broader impact requirements. Although in operation for just over 12 months, COSEE Florida has successfully fostered a number of mutually beneficial relationships outside its core group of partner organizations, resulting in opportunities for scientists to engage in educational outreach. This presentation will highlight the collaborations between ocean scientists and informal science facilities, as well as discuss some of the strategies employed to achieve them. (Abstract ID 12124)

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GULF OF MEXICO BLOWOUT SCENARIOS USING A COUPLED CIRCULATION-OIL TRANSPORT/DISPERSION MODEL

A Gulf circulation (DeCAST) and oil transport (Shinsho) model is run in ensemble mode, using specified wind and eastern Caribbean Sea inflow over several centuries in a set of scenarios, including different initial conditions, oil and dispersion characteristics. Decades-to-centuries Gulf residence time and pyrolytic thinness, together, imply quasi-laminar cross-pyrolytic mixing, so water mass profiles near and above it are largely controlled by eastern Caribbean Sea conditions. Model deviations from Gulf climatology are used to improve Caribbean inflow. During year 356 a warm eddy forms at the northern tip of a tongue of Loop Current water along the Florida shelf slope, moves westward, merges with a new LC extension, entrains new LC water and intensifies, then separates and migrates westward gracing the Gulf northern shelf-break. Such scenario, although rare, is a potential threat to oil rigs and to rapidly spread entrained oil. (Abstract ID 12144)

**TRANSPORT/DISPERSION MODEL GULF OF MEXICO BLOWOUT SCENARIOS USING A COUPLED CIRCULATION-OIL TOS/AGU/ASLO 2012 Ocean Sciences Meeting**

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**THE CLIVAR AND CARBON HYDROGRAPHIC DATA OFFICE**

The CLIVAR and Carbon Hydrographic Data Office (CCHDO) at the UCDP Scripps Institution of Oceanography is the official data center for the International CLIVAR/CO2 Repeat Hydrography Program. The CCHDO's primary mission is to distribute CTD and hydrographic data sets of the highest possible quality, accompanied by data histories and extensive documentation, to the user community. These data products of WOCE, CLIVAR, IOCCP and other oceanographic research programs. CTD, hydrographic, ocean carbon, and tracer data files are collected from data originators, principal investigators and national data centers. The CCHDO staff check and correct each file for content, format and consistency and assemble them with relevant metadata. Data files are produced in three widely-used formats. Custom formats and projects may be provided by arrangement. New public data files and updates are made available immediately in as-received condition. Additionally, ocean carbon data, quality controlled by CDIAC, are merged into the bottle data files at the CCHDO. The CCHDO also provides its public holdings, to NODC/WDC-A for archive and further distribution. (Abstract ID 12212)

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**EXPANDING GOOPS TO INFORM ECOSYSTEM BASED APPROACHES (EBAS) TO MANAGING HUMAN USES OF MARINE ECOSYSTEM GOODS AND SERVICES AND ADAPTING TO CLIMATE CHANGE**

While considerable progress has been made implementing those elements of the Global Ocean Observing System (GOOS) and Global Climate Observing Systems (GCOS) that require geophysical observations and models of the ocean-climate system (emphasizing improved predictions of natural hazards and climate change), implementation of those elements requiring observations and models of biogeochemical and ecological states has been slow. Developing the capacity for sustained provision of these data and information as an integral part of GOOS is the focus of a report of the IOC Panel for Integrated Coastal Observations (PCIC). The report focuses on expanding GOOs to provide data and information needed for rapid detection and timely anticipation of the effects of major drivers of change on key marine ecosystem states and impacts of changes in states. The goal is to expand GOOs to inform EBAs for managing human uses of ecosystem goods and services and adapting to climate change. Essential chemical, biological and biophysical variables are identified and a plan for expanding the Global Ocean Observing System (GOOS) to include essential biogeochemical and ecological observations and models is described. (Abstract ID 9746)

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**THE EFFECTS OF UPWELLING-FAVORABLE WIND FORCING ON THE EVOLUTION OF STRATIFICATION AND OXYGEN CONCENTRATION OF THE NORTHERN GULF OF MEXICO IN SUMMER 2011**

Two six-day surveys of the Texas-Louisiana Shelf were conducted in June and August 2011 to estimate the spatial distribution and time evolution of the hypoxic zone of the northern Gulf of Mexico. In June, elevated freshwater volume from Mississippi River flooding was observed across the shelf from Texas to east of the Mississippi River delta. Objectively analyzed fields of dissolved oxygen concentrations show patchy hypoxic (DO less than 2 mg/L) conditions from Galveston Bay, Texas to the Mississippi River delta covered an area of 8450 sq-km. Predominately upwelling-favorable winds influenced oceanic conditions in mid-July leading to widespread normoxic and oligotrophic oceanic waters with little vertical or horizontal variability of multiple parameters on the western continental shelf and highly stratified conditions on the eastern shelf. By August, observations show hypoxia was confined to the stratified eastern shelf and covered 8770 sq-km. A newly developed operational physical circulation numerical model of the southwestern Gulf of Mexico, which includes parameterized oxygen demand, shows good agreement with the observed temperature, salinity, velocity, and oxygen oceanic fields. (Abstract ID 11382)

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**DO THICKER HOST TISSUES REDUCE SYMBIOT STRESS IN CINNADARIAN-ALGAL SYMBIOSIS?**

Both host and symbiont influence the stress susceptibility of cnidarian-algal holobions, and many studies suggest a significant role of the host. Thicker host tissues have long been speculated to provide increased symbiont photoprotection, but this hypothesis has not been tested. We compared the photophysiology of the chlorophyte Elliptochloris marina living in symbiosis with two closely related, sympatric sea anemones, Anthopleura elegantissima and A. xanthogrammica. After three months of acclimation in experimental tanks, maximum and effective quantum yield of photosystem II was consistently higher in A. xanthogrammica symbionts. Maximum relative electron transport rates were also higher in A. xanthogrammica symbionts when inside intact tissues, but not directly following extraction of symbionts from host tissues, indicating host-specific differences in the internal light environment. Tissues of A. xanthogrammica were thicker and attenuated more light than those of A. elegantissima, but we found no differences in tissue pigmentation, confirming the role of tissue thickness. The ecological implications of tissue thickness in moderating symbiont stress are highlighted by previously established host-dependent zonation and biogeography patterns of A. marina. (Abstract ID 11694)

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**SENSITIVITY OF EQUATORIAL ATLANTIC VARIABILITY TO MEAN STATE BIASES**

Analysis of observed sea surface height, sea surface temperature, and heat flux and reanalysis wind stress and upper ocean temperature show that the Equatorial Atlantic Zonal Mode (ZM) obeys similar physics to the El Nino Southern Oscillation (ENSO): positive Bjerknes and delayed negative feedbacks. This implies the ZM may be predictable on seasonal timescales, but models demonstrate no prediction skill in this region. In this study using different configurations of Kiel Climate Model (KCM), we show that a reasonable simulation of the ZM depends on realistic representation of the mean-state, i.e., surface easterlies along the equator, upward sloping thermocline to the east, with an SST cold tongue in the east. We further attribute the differences among the simulations to the individual components of the positive Bjerknes and delayed negative feedbacks. Our findings indicate that seasonal predictions will have no skill in the Equatorial Atlantic while the coupled models exhibit large mean state errors. (Abstract ID 12961)

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**THE UBIRUITY OF DISSOLVED BLACK CARBON IN FRESHWATER ENVIRONMENTS.**

Black carbon (BC) is ubiquitous in the environment, including in the deep ocean. As such, it is of importance in the global carbon cycle, but little is known about the processes controlling its transport and fate in marine environments, particularly in its dissolved form. It has been proposed that dissolved BC enters the ocean environment via fluvial transport to become a significant component of marine dissolved organic carbon (DOC). However, the flux of dissolved BC to the ocean has not been constrained, and no information regarding the BC content in terrestrial DOC on a globally relevant scale has been reported. Here we present a database of dissolved BC based on the BP/CA methodology from about 300 freshwater samples,
range from headwater streams to large rivers, to wetlands, covering a wide range of climatic regions worldwide. Our data show that dissolved BC is ubiquitous in freshwater environments representing about 10% of the terrestrial DOC, and its environmental dynamics seem closely coupled to those of bulk DOC. Consequently, the estimated dissolved BC flux to the ocean is 25 Mt/yr. (Abstract ID 12251)

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THE THERMO-CARBON PUMP: MILLENNIUM-SCALE STABILIZATION OF MARINE DISSOLVED ORGANIC MATTER THROUGH THERMOGENESIS

The global pool of thermogenic dissolved organic matter (thDOM or “black carbon”) in the ocean exceeds one petamole (10^15 mole) carbon. The objective of this study was to provide estimates on the global turnover of thDOM. An extensive data set was obtained for the Southern Ocean where several water masses of different origins and ventilation ages join. For global validation, the major deep water masses of the Atlantic and Pacific Oceans were included in this study. We found that the global annual removal of deep-ocean thDOM is approx. 30 gigamoles (10^9 mole C) per year. Assuming a steady-state, this removal rate results in an average age of thDOM in the deep ocean of approx. 35,000 years, being the most refractory component of DOM identified on the molecular level to date. In the deep ocean, thDOM is a conservative property of seawater, and removal of thDOM was only observed at the sea surface. Thermogenesis is the first identified mechanism responsible for millennium-scale stabilization of marine DOM. This process therefore plays a major role in the global carbon cycle. (Abstract ID 9485)

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MESOSCALER QUASI-ZONAL ALIGNMENTS IN SST SPATIAL CORRELATION ELLIPSES, ITS LINK TO OCEAN STRATIFICATION AND NON-LINEAR AIR-SEA COUPLING

Evidence is continuing to emerge that the mesoscale variability of the ocean does not average out to zero over extended periods, revealing persistent structural patterns that play a yet understudied role in ocean circulation and air-sea interactions. Our analysis exploits derived objective analysis products for the southeast Indian Ocean from AVHRR sea surface temperature and QuikSCAT scatterometry as well as a state of the art BLUEReanalysis (BRAN). This study reveals quasi-zonal alignments of 2-3 meridional width, in the orientation of spatial correlation ellipses of surface ocean state properties from BRAN. Further analyses shows that the above mentioned surface mesoscale spatial properties are influenced by the mean zonal-jet-like features - otherwise known as ‘ocean striations’ - of the southeast Indian Ocean. A two-dimensional spatial filtering method using Hanning window of 4° half-width reveals underlying signatures of quasi-zonal bandings in the mean SSTs from BRAN and AVHRR. Structural imprints of mesoscale SST are also evident in spatial anomalies of wind-stress satellite observations. Unlike previous studies of mesoscale air-sea coupling, the relationship in this region appears to be non-linear. (Abstract ID 10848)

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MODIFIED HALOCLINE WATER OVER THE LAPTEV SEA CONTINENTAL MARGIN

A series of transects carried out in 2002-2009 across the Laptev Sea continental margin show consistent cross-slope differences of the lower halocline water (LHW). Over the slope the LHW core is on average warmer and saltier by 0.39°C and 0.26 psu, respectively, relative to the off-slope LHW. Historical hydrographic data (1990s-2010) also show a distinct cross-slope difference of the LHW over the Laptev Sea continental margins. Over the slope, the LHW is on average warmer and saltier by 0.2°C and 0.5 psu, respectively, relative to the off-slope LHW. Our results suggest that an important part of the heat and salt lost from the underlying Atlantic water (AW) is gained by the overlying LHW over the continental slope area. This implies the role of enhanced vertical mixing over the sloping topography, which contributes to the difference between the on- and off-slope LHW properties. The LHW temperature time series constructed from the on-slope historical records are related to the AW boundary current transporting warm water from the North Atlantic. In contrast, the on-slope LHW salinity is linked to the sea ice and wind forcing over the potential upstream source region in the Barents and northern Kara seas, as also indicated by hydrodynamic model results. (Abstract ID 9506)

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A NUTRIENT PARADOX: CLIMATE INDUCED DECLINE IN SILICATE BUT NO APPARENT IMPLICATIONS FOR PHYTOPLANKTON PRODUCTIVITY

Macro-nutrient availability in continental shelf waters of the western Tasman Sea has changed over the last 30 y (increasing nitratesilicate), likely due to decreasing riverine inputs and the increasing southwards intrusion of the Eastern Australian Current (EAC), the western boundary current of the South Pacific gyre. With diatoms assumed to drive primary productivity, nutrient enrichment experiments were performed to test whether resident phytoplankton were silicate-limited. Experiments were conducted in austral spring using 3-day
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problematic for sustaining phytoplankton productivity in the region, but suggests complexity in fulvic acid. The relatively low abundance of diatoms indicates silicate limitation may not be limiting nutrient—nitrogen appears to be the dominant macronutrient driving carbon fixation, dissolved iron concentration, primary productivity, and humic-like substances were measured. Biomass and productivity responses in different water masses showed that silicate is not the limiting nutrient—nitrogen appears to be the dominant macronutrient driving carbon fixation, with potential co-limitation by iron and stimulation of productivity by terrestrial organic matter (fulvic acid). The relatively low abundance of diatoms indicates silicate limitation may not be problematic for sustaining phytoplankton productivity in the region, but suggests complexity in predicting the response of lower trophic levels to future change. (Abstract ID 11118)

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THE ROLE OF ACC EDDIES AND WINDS IN ACROSS-SHELF WARM DEEP WATER TRANSPORT IN THE AMUNDSEN SEA

The Amundsen Sea region is undergoing Antarctic ice sheet loss through erosion by warm deep waters flowing southward in across-shelf canyons to and beneath the West Antarctic Ice Sheet. In this area the east-flowing ACC, controlled by the bathymetry, veers southeastward near 210 E and exhibits a double-jet structure between 210 and 235 E and -57 to -52 N. These jets break into energetic, strongly barotropic eddies, many of which travel towards the Amundsen shelf break. The eddy pathways are influenced by bottom topography, winds, and the mean flow in which they’re embedded. The Ocean Surface Current Analyses Real-time product (OSCAR) is a global dataset of surface currents analytically calculated from satellite sensed SSH, winds, and SST. We assess the forcing of onshore warm deep water fluxes by the ACC by comparing OSCAR currents with observed barolonic and barotropic current structures derived using ADCE temperature, and salinity data from a year-long moored time series near the mouth of the westernmost canyon on the Amundsen shelf. (Abstract ID 10803)

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TROPICAL ATLANTIC CLIMATE FOR A COARSE AND A HIGH RESOLUTION COUPLED CLIMATE MODEL

Using two fully coupled ocean-atmosphere models (GFDDL-CM2.1: our IPCC-A1B model and basis of GFDDL’s experimental seasonal to decadal forecast system, and CM2.5: a new high-resolution global climate model based on CM2.1), the tropical Atlantic basins in the mean state, the seasonal cycle, and the interannual variations were investigated. Many aspects of the simulation are significantly improved in CM2.5 relative to CM2.1—yet others persist. CM2.5 successively reproduces the annual mean and the seasonal cycle of the rainfall over the Sahel and the northern South America, a subsurface dome of the thermocline in the northeastern tropical Atlantic (known as the Guinea Dome), and the seasonal phase-locking of the interannual variations of the northern tropical Atlantic. This marked improvement is mainly due to a significant reduction in some of the biases in the seasonal meridional circulation of the Intertropical Convergence Zone (ITCZ). Also, the idealized climate change response of the northern tropical Atlantic has been explored, using outputs from present-day Control and carbon dioxide doubling (2 times CO2) experiments with GFDDL-CM2.5. We find that the interannual variations show a significant response to CO2 doubling: the seasonal peak of the interannual variations of the SST over the northern tropical Atlantic moves from boreal spring to early boreal summer, at which time it is about 25% stronger than in the Control run. (Abstract ID 9355)

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DETERMINING FACTORS THAT INFLUENCE MOLECULAR QUANTIFICATION OF THE HARMFUL RAPHIDOPHYTE HETEROSIGMA AKASHIWO USING A SANDWICH HYBRIDIZATION ASSAY (SHA)

Molecular techniques for detecting and quantifying harmful algal bloom (HAB) species have become central to research and monitoring to expedite sample processing. One example, sandwich hybridization assay (SHA), directly detects organisms using large subunit rRNA-targeted oligonucleotides. Assay results can be used to approximate cell density. However, it occurs globally, produces ichthyotoxic blooms and SHA has previously been validated for it. This study is part of a broader NOAA-MERHAB award wherein SHA results are directly compared to another commonly used molecular approach, quantitative PCR (qPCR). This program entails a rigorous methods comparison of SHA and qPCR using criteria such as cost, accuracy, sample throughput, range/limit of detection, speed and others for HAB research and monitoring. (Abstract ID 11268)

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RECENT ADVANCES AND CHALLENGES IN USING ADAPTIVE SAMPLING TO QUANTIFY PROCESS AND TEST OCEANOGRAPHIC HYPOTHESIS

There has been a growing recognition over the last 20 years that the biological, biogeochemical, and optical dynamics of marine systems are frequently dominated by episodic events or by processes that are spatially concentrated in regions of strong gradients such as those observed in chemoclines, thin layers and fronts. Although much of the progress in this area has been dominated by the use of adaptive sampling to guide the collection of discrete samples from ships for laboratory analysis, recent advances in sensors, deployment systems and near-real time data analysis has opened the door for the autonomous collection and analysis of these samples in situ. Herein, we will first use autonomous profiler data collected during a storm experiment to illustrate the need for new in situ adaptive sampling approaches for quantifying critical processes and testing hypothesis. We will then consider how these challenges might be overcome by incorporating some of the advanced sensors illustrated in other talks in this session into ocean observing systems and then using them to adaptively sample structures and processes at the critical time and space scales needed to test hypotheses. (Abstract ID 12328)

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SOURCES AND TRANSPORT OF ZINC AND CADMIUM AND THEIR COMPLEXING LIGANDS IN THE ATLANTIC AND PACIFIC OCEANS: DIFFERENTIAL LIGAND DECAV IN SPECIFIC WATER MASSES

The complexation and chemical speciation of Zn and Cd have been determined in the water column of the Western North Pacific and the Equatorial South Atlantic using anodic stripping voltammetry. A novel mathematical interpretation tool (“Titration Data Interpreter”) enabled precise, non-biased ligand parameter optimization, after which the speciation of Zn and Cd was calculated. The results obtained in these oceanic regions indicate marginal seas and other point sources provide both metals and strong ligands from a combination of riverine, terrestrial, marine and anthropogenic source material. Further, ligands decay with time as they are transported along water masses in both Atlantic and Pacific Oceans, suggesting a relationship to ligands produced in water formation regions and estuaries. A consortium of decaying and non-decaying ligands complexes these two metals, affecting their chemical speciation in surface, intermediate and deep waters, resulting in potentially limiting concentrations of bioavailable Zn and Cd in some water masses, both at depth and where some of them upwelled. (Abstract ID 10940)

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HEAT AND FRESHWATER TRANSPORTS BY EDDY MOVEMENTS

Oceanic mesoscale eddies contribute important horizontal heat and salt transports on the global scale. Transport is area-integrated flux across a vertical section, and eddy flux is the time-averaged product of temperature or salinity (T/S) and velocity anomalies with respect to their time means. These statistical covariances can arise from a variety of dynamical processes, and this presentation proposes that the eddy heat and salt transports are mainly due to individual eddy movements. T/S anomalies inside individual eddies (with respect to the ambient water) occur due to geostrophic uplift and depression of the background pycnocline vertical profiles associated with cyclonic and anticyclonic eddies, respectively. Satellite altimeter-measured sea surface height anomaly (SSH) data is used to identify and track individual eddies, and vertical profiles from co-located Argo floats are used to calculate T/S anomalies. The estimated meridional heat transport by eddy movement movement is similar in magnitude and spatial structure to previous eddy covariance estimates from models and the eddy heat and salt transports both are a sizable fraction of the total transports. The importance of eddy transports, in particular by eddy movement, supports the need for an eddy-resolving oceanic model in climate simulation. (Abstract ID 10910)
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HOW WELL DO CLIMATE MODELS REPRODUCE NORTH ATLANTIC SUBTROPICAL MIDDLE WATER?

Formation and the subsequent evolution of the Subtropical Middle Water (STMW) involve various dynamic and thermodynamic processes. Proper representation of mode water processes in climate models is important in order to predict future climate change. The North Atlantic STMW, referred to as Eighteen Degree Water (EDW), in three coupled models (GFDL CDA, CM2.1, and NCAR CCSM3.0) are analyzed to evaluate how well EDW processes are simulated, and to examine whether data assimilation improves or degrades model's response to forcing. In comparison with estimates from observations, the data assimilating model (CDA) gives a better representation of the formation rate, the spatial distribution of EDW, and its thickness, with the largest EDW variability along the Gulf Stream path. However, CDA does not capture the observed relationship between EDW volume and the EDW seasonal destruction. Observations show a robust anti-correlation between the upper ocean heat content and air-sea heat flux, with upper ocean heat content leading air-sea heat flux by a few months. This anti-correlation is well captured by CM2.1 and CCSM3.0, but not by CDA. Only CM2.1 captures the observed anti-correlation between the upper ocean heat and EDW volume. This suggests that data assimilation degrades the model's thermodynamic response to forcing. Unlike the observed dominant southward movement of the EDW, the EDW in CM2.1 and CCSM3.0 moves eastward after formation in the excessively wide jet stream in the models. (Abstract ID 10225)

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UPPER-LOWER LAYER COUPLING IN LOOP CURRENT EDDIES EKMAN AND FRANKLIN

Arrays of moored current meters and bottom mounted pressure equipped inverted echo sounders (PIES) centered near 28°N, 87°W were deployed in April 2009. Data were recovered via mooring rotation or telemetry in July and November 2010. Two Loop Current Eddies form during the 15-month observational period: Eddy Ekman in summer 2009 and Eddy Franklin in summer 2010. Lower-layer flows are not visually coherent with upper-layer Loop Current flows, and the principal axes of the standard deviation ellipses and the mean vectors are not, in general, aligned with those of the surface layer. In both detachment events, a marked increase in lower-layer eddy kinetic energy occurs coincident with the development of a large-scale meander along the northern and eastern parts of the Loop Current front. Lower-layer eddies develop in a pattern reminiscent of developing baroclinic instabilities. These growing and southward propagating meanders along the west Florida slope appear to be the major mechanism that causes these eddies to initially detach. (Abstract ID 9699)

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APPLICATION OF PROTEOMICS TO ASSESS THE SYNERGISTIC EFFECTS OF ELEVATED TEMPERATURE AND OCEAN ACIDIFICATION ON TEMPERATE MARINE CALCIFYING ORGANISMS

All living organisms respond to environmental changes through changes in the expression of multiple genes and proteins. Ongoing environmental changes, in particular decreasing ocean pH (ocean acidification or OA, as a result of increasing seawater pCO2) and increasing surface seawater temperature, represent additional environmental stimuli which may induce expression changes in marine organisms. The red coralline algae Lithothamnion glaciaceum, is a marine biogenic calcite which is likely to be structurally very sensitive to the changing climate. Therefore, any OA or temperature induced changes at the molecular level may have an unprecedented impact on marine ecosystems. Here we examined the algae proteome under control conditions (seawater pH 8.0) at either 16°C or 12°C and analysed quantitative expression changes of distinct proteins known to be involved in biomineralisation, in response to acidified conditions (pH 7.7) at the two temperatures. This study presents evidence of how OA and elevated temperature may affect this calcifying marine organism based on molecular level analysis and highlights the benefits of using this systems based approach to investigate the effects of global climate change in marine systems. (Abstract ID 10282)

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CONSISTENT TRENDS AND PATTERNS OF INTERANNUAL VARIABILITY IN SURFACE OCEAN CO2 AT CONTRASTING SITES WINDWARD AND LEeward OF THE HAWAIIAN ISLANDS

Sustained time-series have provided compelling evidence for progressive acidification of the surface oceans through exchange with the growing atmospheric reservoir of carbon dioxide. However, there are few such long-term programs, and extrapolation of results from one site to larger oceanic expanses is hampered by the lack of spatial coverage inherent to Eulerian sampling. Since 1988, the HOT program has conducted near monthly sampling of CO2 system parameters at Station ALOHA, a deep ocean site windward and 100 km north of Oahu, Hawaii. Since 1990, parallel surface measurements have been made at Station Kabe, a leeward site 10 km from the island and on the opposite side of the Hawaiian Ridge. The observed timescales of CO2 system variability are explained by a combination of annual seasonality, a linear trend and an 11-year cycle driven by salinity fluctuations. Despite having different physical settings, the sites exhibit identical linear rates of surface pCO2 increase and pH decrease, suggesting that atmospheric forcing dominates over local dynamics in determining interannual CO2 variability in the surface waters of the North Pacific Subtropical Gyre. (Abstract ID 10501)
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STRAIN-SPECIFIC RESPONSES TO NITROGEN SOURCE IN THE COCCOLITHOPHORE EMILIANIA HUXLEYI

Global warming and ocean acidification are predicted to increase nitrogen fixation and decrease nitrification, resulting in higher ammonium/nitrate ratios in ocean surface waters. Shifts in nutrient sources coupled with increasing seawater temperatures and changing ocean carbonate chemistry will likely affect calcifying marine phytoplankton (i.e., coccolithophores) which play an important role in the global carbon cycle. The world’s most abundant coccolithophore, Emiliania huxleyi, exhibits high inter-strain variation in genotypy, morphology, and physiological response to environmental influences. E. huxleyi’s response to environmental change is likely genetically based and oceanic processes involving coccolithophores may depend on specific genotypes in blooms. We investigated strain-specific variation in nitrogen metabolism using four strains of E. huxleyi, two type A (CCMP371, RCC 1258) and two type B/RCC (RCC 1211, NS10Y), grown on three different nitrogen sources: nitrate, ammonium, and urea. Growth rates in RCC 1258 and CCMP371 were highest in ammonium, while RCC 1211 and NS10Y grew slowest in ammonium. Inters-strain variation in response to nitrogen source could influence distribution, abundance, and ultimately carbon transport to the deep ocean and the global carbon cycle. (Abstract ID 10678)

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IMPACTS OF LARGE TIME SCALE ATMOSPHERIC FORCING (PDO AND NPGO) ON EUPHASIA PACIFICA POPULATION BIOLOGY IN THE CALIFORNIA CURRENT FROM 1991-2008

Long time-scale atmospheric patterns, the Pacific Decadal Oscillation (PDO) and the North Pacific Gyre Oscillation (NPGO), impact coastal productivity primarily through variation in surface water origin, and subsequent variation in associated plankton assemblages. The krill species Euphausia pacifica is an important trophic link connecting phytoplankton to higher trophic level predators and are present in the California Current zooplankton community during all phases of the PDO and NPGO. We present results from a coupled ocean circulation and biological model that explores the variability in E. pacifica population biology off Northern California in relation to long-time scale atmospheric forcing. Ocean simulations were run from 1991-2008 using the Regional Ocean Modeling System (ROMS), coupled with a Nutrient-Phytoplankton-Zooplankton-Detritus (NPZD) model and a 3-D individual-based model (POPCYCLE) parameterized to represent E. pacifica. Results of the model indicate that the PDO and NPGO had a significant impact on krill condition, abundance, and egg production, but had little impact on spatial distribution in the Northern California region. Our model results emphasize the within species change in population biology that can arise from large time-scale atmospheric forcing. (Abstract ID 12511)

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INTERNAL WAVE GENERATION, PROPAGATION, AND DISSIPATION IN THE BEAUFORT GYRE

As a result of the decreasing trend in seasonal sea-ice cover in the Arctic Ocean, internal gravity wave generation by storms is increasing. Our goal is to quantify this correlation and characterize the propagation and breaking of these waves in the Beaufort Gyre. In the strongly stratified upper water column, at depths of roughly 200-300m (the top of the Arctic Water layer), downward propagating internal waves encounter a double-diffusive staircase composed of multiple layers of near-constant density. The vertical scale of each layer is smaller than that of the waves, and the layers are persistent in time with large horizontal extent. We investigate interactions between this unusual stratification and the internal wave field using a combination of theory and observations (including salinity and temperature data collected during the last decade from ice tethered profilers and moorings). In particular, we examine changes in the stratification of the double-diffusive staircase due to mixing caused by breaking internal waves and investigate how these changes affect vertical heat fluxes and circulation in the Beaufort Gyre. (Abstract ID 12201)

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DECADAL ESTIMATES OF PRODUCTIVITY BY PTEROPODS AND LARVAECEANS IN THE COASTAL GULF OF ALASKA

The thecosome pteropod, Limacina helicina, and larvaeceans have been shown to be dominant components of the juvenile pink salmon diet. These gelatinous plankton are understudied due to their fragile structure that is easily damaged during collections. Preliminary estimates of their composition, abundance and biomass generated along the Seward Line in the Gulf of Alaska show high variability, partially due to the initial focus on the more dominant crustacean zooplankton. We present a refinement of these preliminary numbers and are extending the length of observation to over a decade. By applying literature-derived growth rates, we estimate the potential productivity levels of these groups in the Gulf of Alaska. As there is great uncertainty in the applicability of existing growth rates for the pteropod Limacina helicina, future work will target culturing them in the laboratory. Ultimately, we aim to explore if larvecean or pteropod biomass, or production, are correlated to regional patterns of pink salmon survival. (Abstract ID 12259)

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A COMPARISON OF NORTH PACIFIC AND NORTH ATLANTIC SUBTROPICAL MODE WATERS IN A CLIMATOLOGICALLY-FORCED MODEL

Subtropical mode water (STMW), a water mass with homogenous temperature and density and low potential vorticity, is formed in the subtropical gyres of both the North Pacific and North Atlantic Oceans. Eighteen Degree Water (EDW) in the Atlantic and North Pacific Subtropical Mode Water (NPSTMW) in the Pacific have many similarities, including the basic formation processes and physical characteristics. This analysis compares properties and intrinsic oceanic variability of EDW and NPSTMW, within the framework of a high resolution model with climatological atmospheric forcing. Interannual variability is evident in the volume and characteristics of EDW and NPSTMW, but the magnitude of variability is small. The most significant differences are found in the average ages. Circulation patterns lead to a higher average age in the North Atlantic, as EDW is more likely to be advected away from the formation region and remain subducted in the North Atlantic, while NPSTMW is more likely to be reintroduced the following winter in the North Pacific. Connections with western boundary current variability are explored. (Abstract ID 9618)

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PAYING IT FORWARD: ENGAGING SCIENTISTS IN COMMUNICATING OCEAN SCIENCE TO VOLUNTEER INTERPRETERS

Volunteer interpreters play an integral role in communicating ocean science to the public in informal science education settings, such as state parks, aquariums and science centers, and scientists are a valuable source of knowledge and information for training these interpreters. Evaluation data collected by COSEE Pacific Partnerships for the Oregon Coastal Master Naturalist Program highlights the value of engaging scientists as workshop instructors for interpretation audiences, and the challenges faced in attempting to effectively communicate science to those who communicate science with the public. Data was collected between May 2010 and September 2011 during the pilot phase of the Oregon Coastal Master Naturalist Program, and includes observations, interviews and surveys with both workshop instructors and participants. (Abstract ID 12255)

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WHO’S HELPING WHO!? THE MULTIFACETED VALUE OF ENGAGING OCEAN SCIENTISTS IN PROFESSIONAL LEARNING COMMUNITIES

Professional learning communities (PLCs) are one model for helping improve collaboration between scientists, educators and public audiences and hold inherent value for engaging scientists in educational and outreach programming. This session discusses evaluation findings from three different education and outreach programs in California and Oregon, including the Exploratorium’s Embedding NOAA in a Public Learning Laboratory, Oregon Coast Marine and Aquatic Partnership, and the Oregon Coastal Master Naturalist Program. Findings from these programs highlight the variety of ways collaboration in these communities are valuable to all members when members begin to recognize that they are both simultaneously learners and teachers. The findings also suggest that collaboration in PLCs does not happen naturally, but rather requires that particular strategies are necessary to support learning in all directions. We argue that scientists in PLCs have the potential to not only communicate science content but also learn about audiences, audience needs, and tools for communicating effectively. Concurrently, publics (including formal and informal educators) can benefit from PLCs by...
recognizing that they are equal contributors to the conversation around both science content and effective communication. (Abstract ID 12219)

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The ROLE OF LARGE-SCALE PHENOMENA IN VARYING THE SUBDUCTION OF MODE WATERS IN THE PACIFIC

Subantarctic Mode Water (SAMW) is a key player in the storage of anthropogenic carbon in the Southern Ocean. SAMW forms in regions where the deep mixed layers and wind-driven circulation are strongly associated with two large-scale phenomena, El Niño-Southern Oscillation (ENSO) and the Southern Annular Mode (SAM), particularly in the Pacific Basin. We use an eddying, data-constrained, global ocean and sea ice model solution to diagnose the influence of ENSO and SAM on the 1992 to 2009 variability in subduction of SAMW. We individually diagnose the geostrophic, eddy, and Ekman pumping components of subduction. We find that ENSO and SAM combined accounts for >50% of the variance (>30% individually) in the inter-annual variability of the subduction of SAMW, however; this strong influence is concentrated primarily in the Central and Eastern Pacific. In these regions, we find that strong positive SAM/La Niña (strong negative SAM/EI Niño) phases coincide with increasing (decreasing) SAMW subduction rates. We conclude that ENSO and SAM have a significant role in driving inter-annual variability in Pacific SAMW ventilation. (Abstract ID 11993)

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ON THE ROLE OF ADVECTION ON THE ECOLOGY OF ARCTIC AND SUBARCTIC SEAS

A brief review of water mass advection between the Arctic and Subarctic regions and the effects on their ecology will be presented. The influence of Arctic outflows through Fram Strait, the Barents Sea and the Canadian Archipelago on the subarctic regions and the inflow of Pacific waters through the Bering Strait and of Atlantic Waters through the Fram Strait and the Barents Sea on the Arctic will be discussed. In addition to describing temperature and freshwater fluxes between the two regions, the role of advection of sea ice from the Arctic and its associated flora and fauna to the Subarctic will be mentioned. Nutrient fluxes and influences on stratification will be presented in terms of their effects on phytoplankton production. Advection of water masses also transports zooplankton communities between the two regions, as well as some ichthyoplankton. Brief mention will be made on the role of fronts between outflowing Arctic Water and inflowing Pacific and Atlantic Water. Possible future changes in advective fluxes between the Arctic and Subarctic will be highlighted along with their possible effects on the marine ecosystem. (Abstract ID 12893)

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MODE WATERS IN THE PACIFIC:

Suspended sediment dynamics in Corte Madera Creek (Marin County). Using moored suspended-sediment concentrations in the estuary. Given these uncertainties, we investigated can be transported to and deposited in the tidal reaches of these tributaries, further reducing dissolved-sediment concentrations in the estuary. Given these uncertainties, we investigated suspended-sediment dynamics in Corte Madera Creek (Marin County). Using moored acoustic and optical instruments, we observed water velocity and suspended-sediment concentrations continuously for water years 2010-2011. During periods of low stream discharge, suspended-sediment concentration was greatest during flood tides. During periods of high stream discharge (corresponding to rainfall-runoff events), greater suspended-sediment concentrations were observed on ebb tides. These results suggest that estuarine tributaries may alternate seasonally as a sediment sink or source for the San Francisco Bay. (Abstract ID 11995)

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SUSPENDED SOLUTERN PCO:

IN-SITU PCO MONITORING IN A CORAL REEF ENVIRONMENT: EFFECTS OF OCEAN ACIDIFICATION ON BIOGEOCHEMICAL AND PHYSICAL PROCESSES

Four buoys, deployed in the coastal waters of Hawaii (three since 2008 and one since 2011), are producing high temporal resolution CO₂ records in four different coral reef environments as part of an integrated effort to understand CO₂ dynamics around Oahu. Each buoy measures CO₂ concentrations in both the atmosphere and seawater and serves as a platform for a variety of sensors measuring physical and biogeochemical parameters in support of the PacOOS water quality efforts. These data records, combined with data from a prior buoy deployment, synoptic spatial sampling, and in-situ experimental studies allow us to characterize how the biological cycles of productivity/respiration and calcification/dissolution and the physical process of ocean-atmosphere gas exchange occur on hourly to interannual time scales. The four locations, which encompass the backreef and forereef of a barrier reef, as well as two fringing reef sites, one of which is subjected to significant urban runoff, display a wide range of variability in CO₂ system dynamics in both the short- and long-term and demonstrate the need for high frequency data to accurately characterize the CO₂-carbonic acid system. (Abstract ID 10760)

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IN-SITU PCO MONITORING IN A CORAL REEF ENVIRONMENT: EFFECTS OF OCEAN ACIDIFICATION ON BIOGEOCHEMICAL AND PHYSICAL PROCESSES

Four buoys, deployed in the coastal waters of Hawaii (three since 2008 and one since 2011), are producing high temporal resolution CO₂ records in four different coral reef environments as part of an integrated effort to understand CO₂ dynamics around Oahu. Each buoy measures CO₂ concentrations in both the atmosphere and seawater and serves as a platform for a variety of sensors measuring physical and biogeochemical parameters in support of the PacOOS water quality efforts. These data records, combined with data from a prior buoy deployment, synoptic spatial sampling, and in-situ experimental studies allow us to characterize how the biological cycles of productivity/respiration and calcification/dissolution and the physical process of ocean-atmosphere gas exchange occur on hourly to interannual time scales. The four locations, which encompass the backreef and forereef of a barrier reef, as well as two fringing reef sites, one of which is subjected to significant urban runoff, display a wide range of variability in CO₂ system dynamics in both the short- and long-term and demonstrate the need for high frequency data to accurately characterize the CO₂-carbonic acid system. (Abstract ID 10760)
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A GLOBAL APPROACH TO THE ASSESSMENT AND MANAGEMENT OF LARGE MARINE ECOSYSTEMS

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Large Marine Ecosystems (LMEs) support 80% of the world's marine fisheries. The goods and services of LMEs, including fisheries, provide an estimated $12.6 trillion annually to the global economy. Presently, LMEs are being degraded by overfishing, coastal pollution, nutrient over enrichment, habitat destruction, biodiversity loss, and climate change. In a global effort to recover, develop, and sustain the world’s LMEs, economically developing coastal countries in Africa, Asia, Latin America, and Eastern Europe are implementing LME projects with grants from the Global Environmental Facility (GEF) and investment funds from the World Bank. The GEF in partnership with NOAA, five UN agencies, two NGOs, and the World Bank is assisting over 100 countries with $3.1 billion in financial aid to introduce ecosystem-based assessment and management practices using a modular approach to assess changing conditions in LME productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance. There has been substantial progress in applying the concept of ecosystem carrying capacity to actions for recovering and sustaining LME goods and services. (Abstract ID 10327)

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LIGHT INTERACTS WITH OCEAN ACIDIFICATION TO ALTER CALCIFICATION AND SURVIVAL OF CORAL RECRUITS

The influence of light on coral calcification is relatively well understood, however the effect of light has been absent from investigations of the effects of ocean acidification (OA) on coral calcification. We incubated 2 day-old Pocillopora damicornis recruits in 1 of 5 light treatments (226, 122, 70, 41, 31 µmol photons m⁻² s⁻¹) under ambient (493 µatm) or high pCO₂ (878 µatm) for 5 days. Calcification was significantly affected by pCO₂ and the interaction of pCO₂ and light. Recruits in high pCO₂ displayed a contrasting relationship to light compared to ambient pCO₂, resulting in a large disparity in calcification at intermediate light intensities, but similar rates at high and low light intensities. Survival was significantly affected by both light and pCO₂, and was highest at 122 µmol photons m⁻² s⁻¹ in both pCO₂ treatments; survival was not correlated with calcification. The demonstration that OA has light-dependent effects on the calcification of coral recruits suggests that some of the contrasting results that have been reported for the effects of OA on corals could be a result of dissimilar light regimes. (Abstract ID 10899)

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ON-EDDY COMPENSATION OF ENHANCED SEA-TO-AIR CO2 FLUXES DURING POSITIVE PHASES OF THE SAM

It is thought that the recent positive trend in the Southern Annular Mode (SAM) has weakened the Southern Ocean CO₂ uptake because of enhanced wind-driven upwelling of dissolved inorganic carbon (DIC). For greater mechanistic understanding, we made two simulations with a widening circulation model coupled to an ocean carbon model in a regional Southern Ocean configuration (28 km resolution at 60°S). The first simulation is run under preindustrial
atmospheric CO₂ but with modern interannual atmospheric forcing from reanalysis products; the second simulation uses the same forcing but adds a wind anomaly consistent with SAM positive phases. The response of natural CO₂ fluxes to the SAM is driven mainly by the competition between anomalous increases in surface DIC and alkalinity. Mixed-layer DIC increases mainly due to entrainment and diffusion, but there is little contribution from vertical advection. Below the mixed layer, one-fifth of the simulated increase in Ekman-induced DIC transport is compensated by transport from standing and transient eddies. Yet this simulated eddy compensation probably underestimates that of the real ocean because our eddy-permitting model only begins to resolve the eddy spectrum. (Abstract ID 9696)

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ANTHROPOGENIC AMMONIUM ECOSYSTEM EFFECTS: FROM RIVER TO ESTUARY TO COASTAL OCEAN.

Ammonium loading to the Sacramento River at a rate of 15 tons N daily, reduces primary production in the river and portions of the San Francisco Estuary (SFE), and also influences the pattern of primary production along the coast to the north of the Golden Gate. At the highest concentrations of ammonium the uptake of ammonium by the phytoplankton is inhibited. At relatively low concentrations of ammonium, nitrate uptake is suppressed. Both effects contribute to the very low primary productivity in SFE. Patterns of dissolved inorganic nitrogen (DIN) and primary productivity in the river, SFE and the adjacent coast will be presented. Criteria based on ammonium loading, river flow, and ammonium concentration have been developed to predict the conditions allowing spring blooms of phytoplankton to occur. A simple model incorporating these criteria predicts an ecosystem with 2 stable states, a low ammonium, high productivity mode and a high ammonium, low productivity mode. (Abstract ID 12823)

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DYNAMICS OF INTENSE NEAR-BOTTOM CURRENTS ALONG THE SIGSBEE ESCARPMENT, NORTHERN GULF OF MEXICO.

The Sigbee Escarpment is located at the offshore edge of the Central Slope south of the Louisiana-Texas Shelf where the seafloor drops dramatically to the Sigbee Plain of the Gulf of Mexico Basin. Deep ocean dynamics over the Sigbee Escarpment has been extensively studied over the last 15 years. Strong bottom intensified currents exceeding 1 knot (~0.5 m/s) have been recorded frequently along the escarpment. Despite the fact that strong deep events are well represented in the observational data, dynamics and generation mechanisms of the bottom intensified currents in the region are still not understood. Major questions still remain unanswered. To address some of these questions, a model study of the deep ocean dynamics in the area was conducted. Presented study analyzes results from a high-resolution model of the Sigbee Escarpment nested in the Hybrid Coordinate Ocean Model (HYCOM) of the Gulf of Mexico. Dynamical interpretation of simulated bottom intensified strong currents over the Sigbee Escarpment is suggested. Characteristics of simulated wave motions and propagation pathways of the strong events are discussed. (Abstract ID 10298)

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RADIATION LEVELS IN THE CENTRAL PACIFIC OCEAN AFTER THE FUKUSHIMA DIACHI NUCLEAR POWER PLANT ACCIDENT

The March 11, 2011 earthquake and tsunami made substantial damage to the Fukushima Daiichi Nuclear Power Plant. Electrical resistivity profiles show that the mound as a whole is underlain by 1-2 Ohm-m material, whereas the resistivity within the fault zones is higher (3-5 Ohm-m). There are also isolated 100 Ohm-m anomalies within the fault zones that extend to a depth of 40 m or more. I propose that the 100 Ohm-m anomalies are associated with thick lenses of hydrate within the fault zones and that the 3-5 Ohm-m zones contain thinner deposits of hydrate. The various features of the mound could be explained by the vertical movement of the thick hydrate lenses due to buoyancy forces. I use a finite element model to test the mechanical viability of this hydrate extrusion mechanism. The model shows that for reasonable values of sediment density and strength, hydrate lenses should begin moving upward after reach thicknesses of 1-2 m. (Abstract ID 12230)

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THE FINE SCALE HYDRODYNAMICS OF A SLOPING CORAL REEF: EILAT, ISRAEL.

Many corals are subjected to turbulent, wavy environments due to their inherent rough structure, and proximity to shorelines. However, large daily temperature variations in these shallow coastal environments produce a stratified environment thus damping turbulence. In this study we seek to understand how stratification affects turbulence above the corals, and how stratification affects the vertical fluxes of salt, heat, and plankton. In situ high-resolution velocity instruments were deployed to sample continuously over a 10 day period to measure key turbulence parameters including dissipation, Reynolds stresses, and turbulent fluxes at various depths above a sloping coral reef. Utilizing the work of Shih et. al. 2005, Bouffard (2011), and Ivey and Imberger (1991), these parameters were used to estimate mixing efficiency and vertical eddy diffusivity over the corals. In addition, phytoplankton concentration measurements were also made using a system of vertical pumping arrays arranged to form a 'control volume'. The coupling of the turbulence parameters phytoplankton measurements allows us to understand how the flux of inorganic nutrients is altered by changing hydrodynamic conditions. (Abstract ID 11471)

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EVIDENCE FOR VIRUS INFECTION IN THE CALANOID COPEPODS A. TONSA AND L. AESTIVA IN TAMPA BAY, FLORIDA

Copepods, the most abundant mesozooplankton, play important roles in marine food webs as food sources for higher trophic levels and mediators of carbon deposition to the ocean interior. However, little is known about causes of natural mortality in marine mesozooplankton. Using viral metagenomics, we have discovered novel single-stranded DNA viruses in the calanoid copepods Acartia tonsa and Labidocera aestiva from Tampa Bay, Florida. The copepod viruses have weak amino acid similarity to Circoviridae, but diverge significantly from vertebrate circoviruses. The copepod circoviruses are species-specific and were not detected in other zooplankton or bulk seawater. Quantitative PCR revealed viral loads of up to 10⁵ circoviruses per individual L. aestiva copepod, with active viral transcription detected by quantitative RT-PCR in several individuals. Combined with transmission electron micrographs demonstrating the presence of virus-like particles in A. tonsa tissue, these data suggest that virus infection may be common in natural populations of copepods. (Abstract ID 11290)

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OCEAN UPTAKE OF ANTHROPOGENIC HEAT AND CARBON IN TWO EARTH SYSTEM MODELS OF ALTERNATIVE OCEAN PHYSICAL CONFIGURATION

We assess the regional and global controls on ocean heat and carbon uptake in two new global coupled carbon-climate Earth System Models, ESM2M and ESM2G which differ exclusively in the physical ocean component; ESM2M uses Modular Ocean Model version 4-1 with vertical pressure layers while ESM2G uses the Generalized Ocean Layer Dynamics model with interior isopycnic coordinates. While each model has its advantages and disadvantages, both give similar fidelity in model's climate. Because both models utilize the same biogeochemical algorithms, this comparison affords us the unique ability to assess the role of ocean physical configuration.
on ocean heat and carbon uptake. While the baseline characteristics of these models have clear differences with often opposing biases relative to observations, we find remarkable similarity in the heat and carbon uptake magnitudes and patterns. While the Western North Atlantic dominates in terms of regional burden via its overturning circulation, the mid-latitude ventilation regions (mostly the Southern Ocean) dominate the global total. (Abstract ID 12280)

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EXCITATION OF MODE-TWO INTERNAL WAVES BY A MODE-ONE INTERNAL WAVE AND A MESOSCALE EDDY

The internal tide and mesoscale eddies are prevalent in the world's oceans however the interaction between them is not well understood. Here we conduct numerical experiments to investigate the interaction between a mode-1 internal wave and a mode-1 eddy. The analytic eddy is prescribed in the interior of a square domain and, after an adjustment period, analytic mode-1 internal waves are forced at the western boundary. The mode-1 waves then propagate eastward, interacting with the eddy, and eventually get absorbed by a sponge layer at the eastern boundary. Analysis of the resulting flow fields shows that a mode-2 internal wave is produced with energy levels of 1-4% of the forced mode-1 wave. A mode-3 internal wave is also produced, but at a much lower energy level. The strength of the mode-2 waves has a directional dependence which depends on the eddy. Internal wave focussing/shadow regions are observed behind the eddy. The enhanced energy levels in the focussing regions have implications for the internal wave energy cascade. (Abstract ID 11289)
analysis of the preformed and remineralised PO4 of seven biogeochemical ocean circulation models (OPA-PISCES, MPIOM-HAMOCO, CCSM3-BEC, MOM4-BLING, UVIC, CSIRO and MOM3) against observations (WOA). Deficiencies in the physics and high-latitude biogeochemistry are obvious from the analysis and compensated in some of the models most likely by tuning the biogeochemical model to fit PO4 fields. Inspection of total nutrients alone is hence not sufficient, since the same nutrient distribution may be achieved through very different combinations of ocean physics and biogeochemistry. Implications on suboxic regions extension are explicited. (Abstract ID 11823)

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MODELLING THE INTERCONNECTION BETWEEN ECOSYSTEMS AND BIOGEOCHEMISTRY IN A CHANGING OCEAN

We explore the interconnection of phytoplankton community and function, and the interaction with the biogeochemical and climate system. We use a numerical model of the global ocean that resolves many phytoplankton types with a range of functionality, and many different combinations of nutrient, temperature and light requirements. A suite of integrations, along with simple ecological theory, are used to illustrate how the planktonic ecosystem exerts strong control on the biogeochemical environment and how this control may alter in a future warmer ocean. Temperature-driven increase in biological rates promotes higher production, significant re-arrangement of species habitats, but little functional shifts in the community. In contrast lower nutrient supplies due to a slower circulation and increased stratification leads to reduced production and sharp shifts in functionality. We examine how these two aspects of a changing ocean compete in different regions, leading to alterations in the ecosystem, biogeochemistry, and ultimately the export of carbon to the deep ocean. (Abstract ID 12250)

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OBSERVATIONS BENEATH PINE ISLAND GLACIER, WEST ANTARCTICA

Thinning ice in West Antarctica, resulting from acceleration in the flow of outlet glaciers, is currently contributing about 10% of the observed rise in global sea level. Pine Island Glacier (PIG) in particular has shown nearly continuous acceleration and thinning throughout the short observational record. Rapid thinning of the floating ice shelf that forms where the glacier reaches the coast, driven by changes in ocean heat transport beneath it, and the consequent inland retreat of the line separating grounded and floating ice has been postulated to be the cause. Evidence gathered by shipboard observations and an Autonomous Underwater Vehicle (AUV) operating beneath the ice shelf shows that PIG was recently grounded on a transverse ridge in the sea floor, and that warm seawater now flows through a widening gap above the submarine ridge, rapidly melting the thick ice of the newly-formed upstream half of the ice shelf and delivering the upwelled melt water to adjacent bays. The ocean circulation beneath the glacier tongue is vigorous and topographically controlled, reaching 20 cm/s along the ridge crest and near the grounding line. (Abstract ID 9828)

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SEDIMENTARY RESPONSE OF THE DELAWARE ESTUARY TO EXTREME STORM EVENTS IN 2011

Passage of Hurricane Irene and Tropical Storm Lee through the Delaware River Basin in summer 2011 provided a rare view of an estuary's response to extreme river discharge and wind forcing. Freshwater flow peaked at 4,100 m^3/s during Irene and 5460 m^3/s ten days later during Lee. Over a million tons of suspended sediment was supplied to the watershed from the upper Delaware Estuary in association with these events, exceeding the typical load generated during an entire year. Riverflow and winds forced by Irene completely damped the flood tide in the upper estuary on 27 August, enhancing seaward transport of freshwater and sediment. During a post-storm hydrographic survey, the salt limit and turbidity maximum were observed during Lee. (Abstract ID 10664)

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A BIOCHEMICAL UPPER OCEAN STATE ESTIMATE IN THE SOUTHERN OCEAN GASER REGION

The processes controlling colored dissolved organic matter (CDOM) in the upper ocean are uncertain, specifically, the importance of advection, photodegradation, thermocline entrainment and in-situ biological sources. This issue is addressed using a biochemical/physical state estimate in the Southern Ocean Gas Exchange Experiment (SO GasEx). A high-resolution ocean general circulation model with realistic physics simulates the SO GasEx cruise near South Georgia in March 2008. The state estimate uses in-situ CDOM, temperature, salinity, and deliberately-released sulfur hexafluoride measurements, and remote-sensed CDOM, sea level anomaly, and sea surface temperature measurements. The method of Lagrange multipliers is used to find the initial conditions that generate the time-evolving biochemical and physical fields that fit the observations best. Photo-degradation of CDOM is included explicitly, but biological sources of CDOM are not. The state estimate accurately fits the data, implying that the biological CDOM sources and sinks are indistinguishable from zero. Lateral advection is very important for the mixed-layer CDOM, however. Both photo-degradation and thermocline entrainment are moderately important and decrease mixed-layer CDOM with timescales of 2-4 weeks, averaged over the region. (Abstract ID 10459)

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TRANSCRIPTOME AND PROTEOME PROFILING IDENTIFIES PATHWAYS OF NUTRIENT METABOLISM IN AUREOCOCCUS ANOPHAGEFFERENS.

Harmful Algal Blooms (HABs) such as the brown-tides caused by Aureococcus anophagefferens are a global problem. Recent analysis of the A. anophagefferens CCMP 1984 genome suggests it is uniquely adapted to the estuaries where it occurs, as the genome contains a large number of genes for the metabolism of nitrogen (N) and phosphorus (P). Here, transcript (N and P) and protein (P) profiling were conducted to screen for genes associated with N and P metabolism. Transcripts and proteins associated with P deficiency included a phosphate transporter, and an alkaline phosphatase and transcripts associated with N deficiency included an ammonium transporter and a xanthine uric acid(VitaminC) permease. Additional studies have confirmed that these genes are regulated by P and N and their expression can be identified in field populations. We are in the process of additional transcriptome profiling of A. anophagefferens CCMP 1850, and metatranscriptome profiling of samples taken during brown-tides. Together, this type of culture and field study will provide a comprehensive view of metabolic potential in A. anophagefferens , and likely drivers of bloom formation and decline in this and other harmful species. (Abstract ID 10122)

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COMPOSITION AND FUNCTIONAL DIVERSITY OF COPEPOD-ASSOCIATED PROKARYOTE COMMUNITIES IN A GREENLANDIC FJORD

We compared the prokaryote communities in pelagic water samples and those associated with two arctic copepod species, Calanus finmarchicus and Metridia longa, along a salinity gradient in Godthåbsfjord, Greenland. Based on DNA fingerprinting, the two copepod species carried distinctly different prokaryote communities, which were also different from that in the ambient water. Analyses of Bacteria, Alpha-proteobacteria, and Archaea revealed spatial variation in community structure along the salinity gradient. We also used PCR screening to compare the functional gene diversity between free-living and copepod-associated prokaryote communities. Functional genes for methanogenesis, nitrogen fixation, denitrification and ammonium oxidation were detected in the copepods, but were rare in the ambient water. Our results suggest that the presence of copepods support a higher-than-expected diversity of prokaryote community in the fjord, and that these host organisms function as microhabitats supporting increased prokaryotic microbial activity in the shallow water column. Changes in zooplankton community structure and trophic functions due to climate change may alter the anaerobic microbial activities associated with these zooplankton, affecting nutrient cycling and greenhouse gas production within the fjord. (Abstract ID 9394)
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Climate. (Abstract ID 11327)

...products include a new, higher-resolution 11 km global SST-based product suite to monitor...(DSS) monitoring multiple satellite and model-based parameters. Advances in satellite temperature (SST)-based tools to implementing a comprehensive decision support system to monitor coral reef environments.

To meet the needs of coral reef managers and scientists...

HELP MANAGERS PROTECT CORAL REEFS IN A CHANGING CLIMATE

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...height. (Abstract ID 10048)

...dynamics is necessary to explain the observed covariability between chlorophyll and sea surface...(Rossby) waves or eddies: comparing quasigeostrophic theory with ...

ROSSBY WAVES OR EDDIES: COMPARING QUASIGEOSTROPHIC THEORY WITH SATELLITE ALTIMETRY OBSERVATIONS

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...lived, nonlinear eddies. Using a reduced gravity shallow water model to diagnose coherency, propagation effects and spectral characteristics, it is shown that the linear Rossby wave description of these mesoscale features is inconsistent with the satellite altimetry observations. However, through these CRW now provides resource managers and scientists with a comprehensive DSS, using satellite, model, and in situ data to help protect coral reef ecosystems in a changing climate. (Abstract ID 11327)

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ROSBBY WAVES OR EDDIES: COMPARING QUASIGEOSTROPHIC THEORY WITH SATELLITE ALTIMETRY OBSERVATIONS

Satellite altimetry observations of sea surface height reveal that westward-propagating mesoscale features previously attributed to Rossby waves appear instead to be due to long-lived, nonlinear eddies. Using a reduced gravity shallow water model to diagnose coherency, propagation effects and spectral characteristics, it is shown that the linear Rossby wave description of these mesoscale features is inconsistent with the satellite altimetry observations. Instead, the observations are shown to be largely consistent with the hypothesis that the observed mesoscale signals represent eddies governed by nonlinear quasigeostrophic dynamics. The eddy interpretation is further supported by more recent evidence showing that nonlinear dynamics is necessary to explain the observed covariability between chlorophyll and sea surface height. (Abstract ID 10048)

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GAS HYDRATES OBSERVATORY AT MISSISSIPPI CANYON 118

The Mississippi Mineral Resource Institute (MMRI) at the University of Mississippi leads and manages the Gulf of Mexico Hydrates Research Consortium (GOMHRC). The GOMHRC has a goal to research and observe hydrates in situ in the Gulf of Mexico to understand the hydrates stability zone and the factors that cause changes in the stability of hydrates on and below the seafloor over time. The MMRI and the GOMHRC have been conducting research at MCH18 since 2001 and the block was set aside as a research reserve by the Minerals Management Service (now BOEMRE) in 2004. The hydrates research at MCH18 is designed to meet the objectives of the program for hydrate research (NOAA). This presentation will summarize the accomplishments to date of the GOMHRC at MCH18. The accomplishments to date include documentation of hydrate accumulation in fine sediments, successful prediction of the location of hydrates, relationships of faulting to fluid transport and chemistry, time series geochemistry in shallow subsurface and water column, documentation of faunal distribution at the gas-hydrate-bearing zone, and high-resolution mapping of seafloor and features. (Abstract ID 11403)

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MONITORING OF THE SOYA WARM CURRENT USING HF OCEAN RADARS, SATELLITE ALTIMETRY, COASTAL TIDE GAUGES, AND BOTTOM-MOUNTED ADCPS

The Soya Warm Current (SWC) is a coastal boundary current, which flows into the Sea of Okhotsk from the Sea of Japan through the Soya/La Perouse Strait, which is a border strait located between Hokkaido, Japan, and Sakhalin, Russia. In order to monitor variations in the SWC, three HF ocean radar stations were installed around the strait in 2003 and continuous monitoring has been conducted. It was shown that the SWC is a seasonal and subseasonal currents and the SWC. The surface transport by the Soya Warm Current shows a significant correlation with the sea level difference along the strait, as derived from coastal tide gauge records. The cross-current sea level difference, which is estimated from the sea level anomalies observed by the Jason-1/2 altimeters and a coastal tide gauge, also exhibits variation in response to along- and across-strait transport and contributes to the sea level difference. Volume transport of the SWC and its seasonal variation were revealed by combination of data from the HF radars and bottom-mounted ADCPs. (Abstract ID 9798)
**Abstract**

**TROPHIC RELATIONSHIPS OF FIVE SPECIES OF DEMERSAL FISHES IN THE CHUKCHI SEA, 2009–2010**

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MARINE ECOSYSTEM-BASED GRADUATE EDUCATION IN ALASKA AS A BEST PRACTICE TO MOVING ECOSYSTEM-BASED MANAGEMENT FROM PAPER TO PRACTICE

At the University of Alaska Fairbanks, graduate education in marine science now includes an interdisciplinary program that is geared to address the unique challenges of marine ecosystem-based management and to understand its implications for society. Graduate students gain a broad background in fishery science and management, ecology, marine science, marine policy, economics, traditional ecological knowledge and anthropology to complement their own specialized expertise acquired through dissertation research and study. The program challenges students to develop innovative approaches to pressing real-world problems. Representative student thesis and dissertation topics include investigating responses of coastal fishing communities to environmental changes, marine mammal fishing interactions, economic valuation of marine tourism and commercial fisheries, impacts of trawling on seafloor communities and habitats, and climate-change impacts on Arctic marine food webs. This interdisciplinary MS and PhD program prepares professionals to solve problems arising at the interface between dynamic environmental and social systems and to address ecosystem-based solutions to critical research and stewardship questions in the sustainable use of living marine resources, skills that are critically needed in today's society. (Abstract ID 9969)

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A SIMPLIFIED SPECTROPHOTOMETRIC METHOD FOR MEASUREMENT OF SEAWATER ALKALINITY

A simplified spectrophotometric procedure for analyzing seawater total alkalinity (TA) is presented. This method involves a closed cell, one point titration with a strong acid (hydrochloric acid). The excess hydrogen ion concentration after addition of acid is determined based on spectrophotometric principle using a sulfonaphthalein indicator (Bromocresol purple, BCP) at 25 ± 0.1°C. Absorbance ratios for BCP ((A589 - A750)/(A432 - A750)) were used to quantify the excess hydrogen ion concentration after titration. (H+ [m] as pH of the sample based on Breland and Byrne (1993). Total alkalinity is calculated as TA = m/m0 C - [H+]X (m/m0 + 1) where m0 is the volume of seawater; m and C are the volume and concentration of acid added respectively. The precision of this procedure fell between 0.3 and 1.0 µmolal, which is better than the desired precision of 2 µmolal (+0.1%) for TA measurements. The accuracy of this method fell between 0.6 and 5.0 µmolal compared with seawater measurements using standard open-cell titration procedure. The method has the advantage of fast measurement, limited drift in pH detection, and relative insensitivity to errors in delivering volume of acid and sample. (Abstract ID 9961)

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A CLOSURE FOR MESO-SCALE EDDY FLUXES DRIVING ZONAL JETS

Linear instability theory is used to predict the lateral diffusivity K for meso-scale eddy buoyancy fluxes in an idealized channel model featuring eddy-driven zonal jets. The vertical structure and magnitude of K agrees approximately with the non-linear model results. The lateral structure of K from linear theory lacks minima within eddy-driven zonal jets, pointing towards a non-linear mechanism for mixing barriers in the channel model. This effect can be accounted for by a modification of K from linear theory by the kinematic effect of the background flow. Implementation of this closure for K in an eddy mixing framework based on potential vorticity mixing in a zonally averaged model version yields approximate agreement with the zonally resolved version over a certain range of external parameters, in particular with respect to the reproduction of eddy-driven zonal jets. (Abstract ID 10283)

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**TROPHIC RELATIONSHIPS OF FIVE SPECIES OF DEMERSAL FISHES IN THE NORTHEASTERN CHUKCHI SEA, 2009–2010**

Fishes in the Arctic are important components of the ecosystem both as predators and as prey. From 2009-2010 fish collections in the Chukchi Sea supported by ConocoPhillips Company; Shell Exploration and Production Company, and StatOil USA E&P Inc., we examined stomach contents and stable isotopes of representative fish species. Five species were selected for diet analysis based on their prevalence on the sampling grounds and because they represented major taxonomic families present in the Chukchi Sea. The selected species were Arctic cod (Boreogadus saida; family Gadidae, cods), Arctic staghorn sculpin (Gymnoscopelus tricuspidis; family Cottidae, sculpins), polar eel pout (Lycodons polaris; family Zoarcidae, eelpouts), stout eelhenny (Anisarchus medius; family Stichaeidae, pricklebacks), and Bering flounder (Hippoglossoides robustus; family Pleuronectidae, flatfishes). Similarity of prey consumed was low within or among areas. Patterns of diet diversity and evenness indices were found among predator species; fish length affected the patterns for Arctic cod. Carbon and nitrogen signatures in the fishes were similar across sites. Some differences were found for all measurements within species and among area, season and length class. (Abstract ID 10576)

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VARIABILITY OF FLUORESCENCE-BASED PHYSIOLOGICAL PARAMETERS OF THE PHYTOPLANKTON PHOTOSYNTHESIS IN A TEMPERATE RIVER-ESTUARINE ENVIRONMENT

The application of active chlorophyll a fluorescence in assessing phytoplankton physiology and primary productivity is a major advancement in aquatic ecology, but has not been extensively used in river estuarine environment. This study examined the physiological parameters of photosynthesis-irradiance (PE) curves using the Fast Rate Repetition Fluorometry (FRRF) data obtained in Youngsan river estuary from January to June, 2011. Light limited photosynthetic rate (aFl) was derived as a function of effective Photosystem II (PSII) cross sectional area (ePSII) and maximum efficiency of PSII (Fv/Fm); light saturation parameter (E1K) was determined from the exponential curve fit of Fv/Fm and irradiance; and, light saturated photosynthesis rate at optimal irradiance (PmB) was measured as the product of the bio-optically derived aK and EK. Spatial and temporal variations of fluorescence-based aK, EK and PmB, and instantaneous depth photosynthesis rates were also investigated. The findings of the study could contribute to the development of a better estimate of phytoplankton photosynthesis in a highly dynamic ecosystem like the Youngsan river estuary. (Abstract ID 11309)

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THE EFFECTS OF POLYUNSATURATED ALDEHYDES ON THE MICROBIAL COMMUNITIES ASSOCIATED WITH SINKING POM FROM THE SARGASSO SEA DURING A SPRING BLOOM

Polyunsaturated aldehydes (PUAs) are toxigenic compounds produced by diatoms when cell integrity is comprised. The bulk of literature on PUAs has focused on the deleterious effects on diatom grazers. Very few studies have investigated the response of marine microbes to PUA exposure and even fewer studies still have been conducted outside of cultures. Sinking particulate-organic material collected during a bloom in the Sargasso Sea and the associated microbial communities were incubated for 24 h with varying concentrations of a PU cocktail (heptadecanal, octadecanal, and docosanal). PUAs were found to be bioactive, affecting respiration rates, enzymatic activity, intact polar lipid concentrations (a proxy for cell biomass), and the metabolite profile of the microbial community in a dose dependent fashion that suggest allelopathy. Furthermore, these findings indicate that PUAs produced during bloom decline have potential to impact organic matter export. (Abstract ID 11681)

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FOUR-DIMENSIONAL VARIATIONAL DATA ASSIMILATION IN THE CALIFORNIA CURRENT SYSTEM AND ITS IMPACT ON ECOSYSTEM STATE VARIABLES

Advanced data assimilation approaches connect temporally distinct observations explicitly through ocean model dynamics allowing longer sequential assimilation cycles than possible with more simple, non-dynamical methods. One example is the incremental, strong-constraint, 4-dimensional variational method which we apply to the California Current System using a 1/10 degree implementation of the Regional Ocean Modeling System. Assimilating sea surface temperature, sea surface height, and subsurface hydrography successfully reduces RMS error with both assimilated and independent data. Using the improved physical state estimate to drive ecosystem dynamics improves the correlation of biogeochemical metrics. However, adjustment of physical fields during each sequential assimilation cycle stimulates vertical nutrient fluxes that fuel overproduction. Such shocks can be reduced through overlapping assimilation cycles or temporal averaging of resultant fields and its effects can be accounted for through direct assimilation of biological fields. In this talk, we discuss all of the above including application of a logarithmic transformation in the assimilation method to ensure positive-definite biological states. (Abstract ID 10879)
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from fall test deployments and preliminary data from the winter field program will show how
hindcast error is used to choose the optimal operational configuration in real-time. Results
alternate patterns of glider navigation that take advantage of currents to sample more efficiently,
blooms off of Long Bay, SC. Two gliders, one occupying a cross-shelf transect and another
an ongoing winter field program (Jan-Apr 2012) to map and track persistent phytoplankton
LONG BAY, SC
IMPLEMENTATION OF A GLIDER COORDINATED CONTROL SYSTEM (GCCS) IN
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TOS/AGU/ASLO 2012 Ocean Sciences Meeting
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THE IMPORTANCE OF BATHYMETRY IN HIGH RESOLUTION LITTORAL MODELING
Characterization and forecasts of the littoral environment are valuable sources of information
for Navy missions including but not limited to ship movement of supplies and personnel and deployment, operation, and retrieval of sensors. Numerical models provide
estimates of dynamic littoral parameters such as current velocities and wave heights and
directions. Model resolutions of O(10 meters) or less are often needed to resolve these
parameters in the shoaling and surf zone regions. In addition, wave evolution and resulting
currents are highly sensitive to bathymetry. The effect of three different bathymetry sources
on results of the Delft3D model will be investigated. The Delft3D model was recently applied
to an area of freshwater Bay, Queensland, Australia for the ‘Taijusalu Saline 2011 exercise. For
the original application, the highest resolution bathymetry source was only O(100 meters).
Additional higher resolution bathymetric data were collected during the exercise—single beam
survey, multi-beam AUV-derived, and satellite-derived. Delft3D hindcasts of the exercise are
being completed using the additional bathymetry sources. A comparison of the Delft3D results
will be presented. (Abstract ID 11293)
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MAPPING M2 INTERNAL TIDES USING A DATA-ASSIMILATIVE REDUCED
GRAVITY MODEL
Low-mode internal tide (IT) signals of a few cm are clearly visible in along-track M2 harmonic
constants derived from altimetry data. Although ocean variability causes some temporal
fluctuation, most of the variance in these signals remains phase-locked to the surface tide. We
have developed a scheme for mapping this steady component of IT, by assimilating satellite
data into a reduced gravity (RG) model. A local flat bottom approximation allows decomposition
into modes, with each satisfying modified shallow water equations with spatially varying
coefficients derived from bathymetry and stratification. We implemented this scheme with
minor modifications to the OTIS barotropic tidal data assimilation (DA) system. As an initial
test we generated synthetic data from a 3D baroclinic simulation around Hawaii, sampled as by
the available altimeters, with realistic noise added. We then applied the RG DA to various data
subsets, and compared resulting maps of IT elevations and energy flux to those derived from
the full model 3D fields. The maps accurately reproduce the first mode elevation and energy
flux, when data from multiple satellites are assimilated. We then applied the RG inversion
to select the full set of internal tide signals in the Pacific and Atlantic Ocean, derived from all
available tide gauges and satellite altimetry data from Jason. In the deep ocean results from adjacent patches show excellent agreement at overlaps,
suggesting that global mapping of low-mode IT is practical. We present initial versions of such
maps. (Abstract ID 9970)
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THE SPATIO-TEMPORAL DYNAMICS OF THE NITROGEN FLUX ON THE
NORTHERN BENGAUJA HYPOXIC SHELF: A MODEL VIEW
We adopted a 3-D coupled ecosystem model to investigate the spatio-temporal variability of
the physical and biogeochemical nitrogen and oxygen fluxes in the Northern Benguela
upwelling system. This region is characterised by a strong coastal upwelling of nutrient-rich
water that sustains high rates of primary productivity. The estimated mean vertical nitrate
flux into the euphotic zone is 5-20 mmol m$^{-2}$ d$^{-1}$ on the shelf, but even higher in the conspicuous
upwelling cells (30-60 mmol m$^{-2}$ d$^{-1}$). Additionally, nutrient-rich but oxygen-depleted water is
advected from the North by the poleward Angola undercurrent and hypoxic conditions on the
continental shelf are wide spread. We estimated nitrogen fluxes and the biogeochemical oxygen
demand in the water column and the underlying sediments on the continental shelf and the
exchange of nutrients with the adjacent ocean. We paid particular attention to the interaction
between oxygen levels and nitrogen cycling of the aerobic and anaerobic mineralisation
pathways. This study is part of the GENUS-project (Geochemistry and Ecology of the
Namibian Upwelling System), an endorsed project of the Integrated Marine Biogeochemistry
and Ecosystem Research (IMBER). (Abstract ID 10199)
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EFFECTS OF ELEVATED CO$_2$ ON PHOTOSYNTHESIS, RESPIRATION,
CALCIFICATION AND SKELETONAL MINERALOGY IN THE RED ALGA
CORALLINA ELONGATA
We investigated the effects of near–future ocean acidification on the red calcareous coralline
algae $C_{.}$f corallina elongata collected from a low–shore tidal pool on the north coast of
Brittany. France. The algae were grown for one month a 1-atmospheric CO$_2$, concentrations, 380, 550,
750 and 1000 ppm. Photosynthesis, respiration and calcification rates were assessed through
measurements of oxygen, pH and total alkalinity fluxes in light and dark using incubation
chambers. Skeletal ratios of magnesium and calcium carbones (MgCO$_3$,CaCO$_3$) were
analysed for different skeletal parts. For comparison, the same parameters were also assessed
in situ under ambient conditions of pCO$_2$. Photosynthesis, respiration and light calcification
were not affected by elevated pCO$_2$. However, dissolution was observed after dark calcification
at elevated pCO$_2$, causing a significant effect on 14h calcification rates. Skeletal MgCO$_3$,CaCO$_3$
ratios did not differ between treatments, indicating no acclimation to more corrosive seawater
by incorporating less magnesium into newly formed skeletal parts. (Abstract ID 10506)
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POTENTIAL SEDIMENT EXCHANGE BETWEEN MARSHES AND ADJACENT
SUBMERSED AQUATIC VEGETATION (SAV) BEDS IN CHINCOTEAGUE BAY (MD)
Coastal marshes and submerged aquatic vegetation (SAV) beds within the Chesapeake Bay
have been declining in recent years. Though often located in close proximity, marshes and SAV
beds are not often studied from an ecosystem perspective, especially regarding the exchange of
sediment between them. For example, SAV diebacks can make sandy subtidal sediment available
for landward transport into the marsh, whereas diebacks of marsh vegetation can result in
seaward transport of peaty material to SAV beds. This study examines this potential exchange
in Chincoteague Bay (MD). A transect of cores, one within the SAV bed and four within the
marsh, were analyzed for grain size and organic content; sediment geochemistry were
established with $^{31}$P (half-life 232.3 y). The SAV core was generally composed of sandy and
low organic sediments, with one interval of finer and more organic sediment more typical of
marsh derived sediment. Marsh cores had surficial sand layers up to 20 cm thick, decreasing
landward, likely related to an SAV dieback event in 2005. Accumulation rates in the marsh
generally range 0.2-0.4 cm/y, comparable to sea-level rise. (Abstract ID 11638)
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TIDALLY-DEPENDENT STRATIFICATION, SHEAR AND SECONDARY CURRENTS IN YAQUINA BAY ESTUARY, OREGON

Tidal variations in stratification, shear, and secondary currents near the entrance of Yaquina Bay, a shallow estuary on the central Oregon coast, are quantified using current profile and surface and bottom conductivity/temperature time series collected in 2010. The data spanned typical periods of low, medium and high river discharge, Q (mean Q = 1, 5, 18 m³s⁻¹, respectively). Spring tides were distinguished from neap tides. For these data, stratification spanned typical periods of low, medium and high river discharge, Q (mean Q = 1, 5, 18 m³s⁻¹, respectively). Spring tides were distinguished from neap tides. For these data, stratification spanned typical periods of low, medium and high river discharge, Q (mean Q = 1, 5, 18 m³s⁻¹, respectively). Spring tides were distinguished from neap tides. For these data, stratification spanned typical periods of low, medium and high river discharge, Q (mean Q = 1, 5, 18 m³s⁻¹, respectively).

Variations in temperature, ionic strength, pH, and other factors influence partitioning of reactive constituents within the river-littoral zone. This alters the effective particle size spectrum and therefore determines net dispersion, distribution, and transport. In August, 2011, an experiment was conducted in the Pearl River estuary, Gulf of Mexico (GoM), to resolve the size spectrum of suspended matter through the estuary and to investigate factors controlling this distribution. Water samples were collected from the near-surface, mid-depth, and near-bottom of the estuary at eight stations along salinity gradient. Current velocities were determined with a downward-looking ADCP. Particle size distribution in each sample was determined in the laboratory using a Zeta-sizer to evaluate the nm-range size fraction and a nanoparticle tracking analyzer (NPA) to evaluate larger (> 30 nm) fractions, suggesting that algal/phytoplankton or competition interactions were enhanced with nitrogen enrichment. (Abstract ID 10924)

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BACTERIAL COMMUNITIES ASSOCIATED WITH THE PELAGIC TUNICATE D. GEGENBAURI AND THEIR FECAL PELLETS: WHAT IS THEIR ORIGIN?

Fecal pellets of pelagic zooplankton represent a major component of the vertical flux of organic carbon in the open ocean, and thus a potential sink in the global carbon cycle. The ultimate fate of these pellets is subject to their colonization and degradation by heterotrophic bacteria, yet little is known regarding the source or activity of these bacterial communities, especially those associated with gelatinous zooplankton species. To address this question we are investigating the origin of heterotrophic bacterial communities associated with the fecal pellets of the pelagic tunicate Doliolitta gegenbauri. Laboratory reared D. gegenbauri gonozoides were fed diatom cell cultures or freshly collected plankton-rich intrusions water from the South Atlantic Bight continental shelf. The relative abundance and composition of bacterial communities associated with food particles, full gut animals, stavged animals, and fecal pellets was determined based on 16S rRNA targeted qPCR data and clone library sequencing, respectively. The surprising paucity of bacteria associated with the animals themselves suggests that D. gegenbauri do not harbor endemic gut microbial communities and that the colonization of pellets occurs post egestion. (Abstract ID 11971)

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UREA IN CENTRAL MAINE COASTAL WATERS: CONCENTRATIONS AND INTERACTIONS WITH ALEXANDRIUM FUNDYENSE IN NATURAL MICROBIAL POPULATIONS

Urea use in fertilizers has increased in past decades, suggesting that agriculturally derived urea may be transported into coastal Maine waters where it is a potential nutrient source for blooms of Alexandrium fundyense. This study examined 1) urea concentration in the St. George River Estuary before and after a large rainfall event, and 2) the influence of nitrogen form, including urea, on growth of natural coastal microbial populations in biosalvages with and without added A. fundyense. A significant increase in urea concentration post-rainfall was documented at only one site in the lower river, suggesting that inputs may occur only immediately after fertilization, that in situ nutrient cycling occurs rapidly, or that urea inputs are minimal. In biosalvages, A. fundyense growth rate did not vary with nitrogen form, however, A. fundyense cell yield increased with all nitrogen additions, suggesting urea was bioavailable to A. fundyense. Alexandrium fundyense differentially influenced coincident microbial populations in all nitrogen enrichments, stimulating smaller (0.7–3 µm) chlorophyll fractions, and inhibiting larger (> 30 µm) fractions, suggesting that algal/phytoplankton or competition interactions were enhanced with nitrogen enrichment. (Abstract ID 10924)

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ALEXANDRIUM FUNDYENSE IN NATURAL MICROBIAL POPULATIONS

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the Kuroshio Extension where oxygen supersaturation varies seasonally by up to 15%; however, the float oxygen data are not presently accurate enough to estimate the air-sea flux. When this improves a widely distributed field of floats with oxygen sensors could provide a global determination of NCP. (Abstract ID 10754)

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AIRBORNE SENSING OF SEA SURFACE TEMPERATURE PATTERNS IN OIL COVERED WATERS

Airborne thermal infrared (IR) imagery is used to measure sea surface temperature (SST) patterns in oil-covered waters in the Gulf of Mexico during the 2010 Deep Water Horizon (DWH) oil spill. While previous studies of oil spills emphasized visible and synthetic aperture radar (SAR) imagery there are some significant advantages to using IR imagery. They include minimal oil film thickness detection limits, thermal signature variability of different oil film signatures during daytime solar heating input, and nighttime oil spill detection/monitoring for which aerial thermal imaging represents a uniquely practical solution. The oil system was used operationally throughout the DWH spill response to aid in response and recovery. Since calibrated, absolute IR images are useful for actual oil thickness computations we have also used the Ball Experimental SST (BEST) radiometer to make preliminary airborne measurements over the Gulf of Mexico in July 2010. In these 2D thermal infrared swaths, the relative contrast can, by itself reveal the locations of the thickest of oil patches. The BEST is based on a microbolometer and carries 2 black bodies for onboard calibration of the imagery. (Abstract ID 9893)

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EVALUATION OF DIRECT COVARIANCE AIR-SEA CO2 FLUX MEASUREMENTS IN THE COASTAL OCEAN

Field observations of ocean-atmosphere CO2 fluxes using the direct covariance method have a history of limited success that to date has mostly depended on the varied quality of open-path infrared gas analyzer measurements. This quality is in turn related to the low signal-to-noise environment for CO2 variability within the moist marine atmospheric boundary layer. Several recent advances in post-processing of these CO2 observations suggest that the reliability and capability for such gas flux subsystems may be poised for expanded application. This study will present results from several field deployments of eddy correlation packages in the coastal ocean with the objectives to assess viability and reliability of collecting long-term direct covariance sea flux measurements in the Gulf of Maine region. This shelf sea location provides conditions of variable and large air-sea gas disequilibria as well as a large dynamic range in wind and wave conditions. Systems were operated on both a discus buoy and island tower site for multi-month periods in 2009 and 2011. Issues of motion correction, accurate high rate CO2 measurements, and derived fluxes will be addressed. (Abstract ID 10213)

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CHANGING OCEANS, CHANGING ROLES: THE CHALLENGES AND OPPORTUNITIES FOR SCIENTIST COMMUNICATORS IN THE 21ST CENTURY

As the rate of change in the ocean increases through the next several decades, the need for scientists to help society understand and confront these changes also will grow. But navigating the challenges faced by scientists who seek to communicate across a cultural divide at the science-to-policy interface requires training beyond what traditional academic models provide. In addition, many scientists lack a conduit for understanding the needs of policymakers in terms of specific policy relevant scientific and technical expertise. COMPASS works at the intersection of the worlds of science, journalism and policy to support scientists in "escaping the ivory tower," helping them give their research real-world impact. Functioning as a boundary organization, COMPASS helps scientists connect what they do in ways that reach media and policy audiences more effectively – using tools of science synthesis, policy outreach, and communication training. This talk will use case studies from fields such as marine biology and ecology, climate change, and ocean acidification, in which scientist leaders connected their science to a dynamic policy landscape in ways that had lasting impact. (Abstract ID 12724)

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USE OF IN-SITU OPTICAL SCATTERING AND FLUORESCENCE MEASUREMENTS FOR THE REAL-TIME DETECTION OF DISPERSED OIL IN WATERS NEAR THE DEEPWATER HORIZON OIL SPILL.

Vertical and horizontal profiles of bio-optical measurements were collected on several cruises between May and August 2010. The profiles, which included chlorophyll and CDOM fluorescence as well as scattering measurements, were made both near the Deepwater Horizon oil spill and in Gulf of Mexico waters unlikely to be contaminated by the oil spill. Data from the vertical profiles support the hypothesis that below the near-surface layer (~50 m), a combination of chlorophyll fluorescence and single-angle scattering measurements allows estimation of anomalous scattering, and thus provides a real-time indication of dispersed oil in seawater. The data from the profiles indicate that this scattering anomaly approach is more sensitive to the presence of dispersed oil than detection solely on the response of a typical single-channel CDOM fluorometer. Measurements of near-surface bio-optical properties collected using continuous flow-through sampling provided insight into the spatial variability near the Deepwater Horizon oil spill, though the complexity of the near-surface bio-optical environment and paucity of appropriate hydrocarbon and baseline measurements increase the ambiguity of the near-surface observations’ interpretation. (Abstract ID 11839)

THE ROLE OF LATERAL FLOWS IN DRIVING TIDAL PERIOD ESTUARINE STRATIFICATION

Stratification in estuarine systems plays an important role in a number of physical and biogeochemical processes. We studied tidal period variability in stratification based on moored data from the Delaware River estuary. In the classic theory of tidal straining (Simpson et al 1990) stratification is enhanced on ebb relative to flood due to the vertical shear acting on along-channel gradients. On the other hand many estuarine systems exhibit strong lateral density gradients. Therefore we investigated how cross-channel flows affect intra-tidal variations in stratification based on data from a mooring array deployed in the Delaware River/Bay over a 3 month period. Analysis of the data indicated that the Delaware Bay strays away from the classic theory because it becomes more stratified on the flood instead of the ebb. It was also observed that along- and cross-channel stratification of the density field were around the same order of magnitude and therefore the cross-channel circulation appears to play an important role in tidal period variability in the stratification of the Delaware Bay. (Abstract ID 10096)

A NEW CENSUS OF EDDIES IN THE WESTERN MEDITERRANEAN FROM SATELLITE ALTIMETRY

Eighteen years of weekly SLA merged maps in the Western Mediterranean are analyzed using the new method proposed by Chelton et al. (2011) to identify and track mesoscale eddies. The highly productive Chukchi Sea shelf is a complex gateway into the Arctic, on which climate variation may have a profound impact. We examined summer zooplankton community structure in the Arctic waters between Alaska and Russia from the Bering Strait northward to Wrangel Island during 2004, 2009 and 2010 within the on-going RUSALCA (Russian-American Long-term Census of the Arctic) program. We also accessed secondary production by conducting egg production experiments on some of the most abundant copepod genera (Pseudocalanus spp., Metridia spp.), which have both Arctic and Pacific members. The total abundance and biomass of holozooplankton varied significantly across the area and between the years, averaging 3500 ind m-3 and 42 mg DW m-3 in 2004, 8250 ind m-3 and 78 mg DW m-3 in 2009, and 9700 ind m-3 and 69 mg DW m-3 in 2010, all based on 150 µm nets collections. The species composition also varied significantly; we encountered a total of 68 holoplanktonic species in the region, as well as a wide variety of meroplankton, which also contributed notably to community biomass and abundance. In contrast, temperature-adjusted reproductive rates showed little difference between years. Several major assemblages of zooplankton were identified using multivariate analysis and tied to distribution of the water masses present in the region. (Abstract ID 12035)
than the cyclones. The propagation speeds and direction show a wide range of values without a clear preferred direction, although there is a certain west-east dominance. The temporal evolution of the weekly number of eddies is also examined presenting a small trend modulated by intraannual and interannual variability. These are preliminary results that need to be further developed to understand the dynamical processes that can explain the observed variability. Future work also includes performing a sensitivity analysis on the parameters of the method as well as improving the eddy identification close to the coast. (Abstract ID 11019)

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PARTICLE CAPTURE BY BIOLOGICAL COLLECTORS IN AQUATIC SYSTEMS

The term particle capture refers to the physical process by which suspended particles come into contact with biological structures (‘collectors’) and adhere to the collector’s surface. One important occurrence of particle capture in aquatic ecosystems is the adhesion of particles over vegetation surfaces. This phenomenon defines the filtration and water purification capacity of vegetated wetlands. Particle capture is also of significant ecological importance in marine ecosystems; in particular, it controls the efficiency of seagrass polination, coral and benthos feeding, and larval settlement. Despite its fundamental ecological importance, particle capture in aquatic systems remains poorly understood. In order to better understand particle capture dynamics, a numerical model was used to determine the two-dimensional fluid flow and the motion of suspended particles around a single cylindrical collector. Accurate expressions for particle capture by inertial impaction and direct interception were obtained which compare very well to experimental data. As prediction of capture efficiencies for aquatic ecosystems is extremely limited, the obtained expressions are a very valuable tool for evaluating particle-collector interactions in aquatic ecosystems. (Abstract ID 11050)

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SUSPENDED SEDIMENT CONCENTRATION AND OPTICAL PROPERTY OBSERVATIONS OF MIXED-TURBIDITY, COASTAL WATERS THROUGH MULTISPECTRAL OCEAN COLOR INVERSION

Multispectral satellite ocean color data from high-turbidity areas of the coastal ocean contain information about the surface concentrations and optical properties of suspended sediments and colored dissolved organic matter (CDOM). Empirical and semi-analytical inversion algorithms published to date are insufficient to retrieve this information when suspended sediment concentrations exceed order 10^6 g m^-3. However, this is in part because high-gain “ocean” bands on orbiting sensors saturate over bright, turbid waters, and because of the difficulty of obtaining satellite/in situ field match-ups under high-turbidity conditions that persist for short periods of time. We present an alternative semi-analytical method that simultaneously utilizes high- and low-gain bands on the MODIS/Aqua sensor, and is tuned for coastal Louisiana using mass-specific inherent optical properties of local suspended sediments. The multispectral inversion method is applicable to both moderate and high turbidity conditions. We discuss the sensitivity of the algorithm to optical model assumptions, and compare inverted sediment and CDOM IOPs from MODIS/Aqua imagery to published data for the study region. (Abstract ID 9434)

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STUDENTS OF TEACHER RESEARCHER EXPERIENCES (SOTRE)

Mrs. Eubanks is the middle school teacher at St. Mark Catholic School and has taught all of the students excited for science. She has helped involve students in many different programs sponsored by the National Oceanographic and Atmospheric Administration (NOAA) and PolarTREC (Teachers and Researchers & Exploring & Collaboration). Being a part of these programs gives students special privileges such as being able to track tagged sharks, follow daily journals written on location, participate in live time webinars and take part in cross-continental experiments. In addition, the contacts, made through Teacher Researcher Experiences (TRE) give students an added set of resources for future reference. When doing experiments for class, Mrs. Eubanks can put students in contact with other scientists she has met and he offers the students a unique opportunity to work together with real scientists on school projects. Being a part of these relationships with NOAA, Polar TREC, and research scientists actively working in their fields of study, provides students, Students of Teacher Researcher Experiences (SOTRE), the ultimate scientific learning experience. (Abstract ID 11387)

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DEEP TIME FORAMINIFERA Mg/Ca PALEOTHERMOMETRY – ACCURATELY CORRECTING FOR SECULAR CHANGES IN THE Mg/Ca RATIO OF CENOZOIC SEAWATER

Mg/Ca-derived temperatures from foraminifera represent one of the best methods of oceanic paleotemperature reconstruction. However, besides temperature, a major control on the Mg/Ca ratio of foraminiferal calcite is the Mg/Ca ratio of seawater. This has undergone secular variation over the Cenozoic such that if the total range of Cenozoic Mg/Ca seawater values are considered this influence is approximately equal in magnitude to that resulting from temperature. Mg/Ca paleothermometry is furthermore complicated by uncertainty regarding seawater Mg/Ca values for climatically important time periods, where paleoceanic temperature reconstruction is a priority. We present the first Mg/Ca-derived temperatures (using highly spatially-resolved LA-ICPMS analysis) from foraminifera to be accurately corrected for paleoseawater Mg/Ca and extend our results to constrain the Mg/Ca value of Eocene seawater: Differences between our conclusions and previous studies arise from earlier assumptions regarding Mg/Ca variation with changing seawater Mg/Ca. We have also indirectly assessed the Mg/Ca seawater-Mg/Ca calcite relationship of species for which this aspect of Mg/Ca paleothermometry has not been directly studied. This allows us to discuss the implications of our findings for the Cenozoic benthic foraminifera Mg/Ca-temperature curve. (Abstract ID 11151)

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IMPACTS OF PLANETARY WAVES ON THE BERMUDA ATLANTIC TIME SERIES STUDY

Data from the Bermuda Atlantic Time-series Study (BATS) and satellite-based altimetry measurements are analyzed with the aim of better understanding the effects of westward propagating planetary waves on the vertical structure of the water column. Isopycnal displacement calculated as the deviation from the mean potential density profile between October 1988 and June 2011 reveal amplitudes of ±200m throughout the water column with maximum displacement between 1500-2500m. Band pass filtering (37 to 410 days), intended to distinguish isopycnal displacements with sea surface height anomaly (SSHa) filtered to isolate westward propagating features of the same period shows a strong coherence between these two fields. At the BATS site significant correlations between isopycnal displacement and SSHa are found between 100m and 1500m (R between 0.2-0.5). We argue that much of the isopycnal displacement at BATS is driven by westward propagating planetary waves and discuss implications of these dynamics as a mode of nutrient flux into the euphotic zone. (Abstract ID 10242)

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DISSOI LVED INORGANIC CARBON VARIABILITY IN THE SOUTH ATLANTIC SECTOR OF THE SOUTHERN OCEAN

In February/March 2008 and February/March 2009, hydrographic cruises were completed along Drake Passage (WOCE section S9), and along 30°S from the African continent to Antarctica (WOCE section S16). These hydrographic cruises were compared with previous cruise data from 1990 and 1996, respectively. The existing GLODAP and CARINA calculated
A REGRESSION MODELING APPROACH FOR STUDYING CARBONATE SATURATION STATES ON THE NORTHERN GULF OF ALASKA SHELF

The northern Gulf of Alaska shelf experiences manifestations of ocean acidification that have only been assessed on seasonal and annual time scales. Little information is available to resolve higher frequency variability in this region. We present a multiple linear regression modeling approach using a subset of hydrographic data collected along the North East Pacific (NEP) Global Ocean Ecosystem Dynamics (GLOBEC) Seward Line. The empirical algorithms predict dissolved inorganic carbon (DIC) and total alkalinity (TA) using observations of temperature, salinity, pressure and nitrate from the surface to 1200 m, with R2's > 0.97 and RMSE errors of 14 µmol kg-1 (DIC) and 11 µmol kg-1 (TA). Carbonate saturation states were then calculated from predicted DIC and TA. We applied these algorithms to a data set from a 24-hour glider occupying the inner shelf conducted in June 2011, and a SeaSoar data set collected during a 2003 NEP GLOBEC mesoscale mapping survey. Predicted saturation states provided valuable insights into the variability from tidal forcing and mesoscale eddies. This work is similar to recent studies aimed at predicting acidification in coastal margin settings, albeit demonstrates a nitrate-based approach applied to high-latitude data collected from platforms capable of high-frequency measurements. (Abstract ID 9433)

ADVANCES IN INCORPORATING BIO-OPTICAL DATA IN LONG TERM OBSERVING SYSTEMS: CHALLENGES AND SOLUTIONS

The Australian Integrated Marine Observing System (IMOS) is measuring bio-optical properties of the coastal ocean on an unprecedented scale. IMOS has developed a network of nine National Reference Stations across Australia's coastal seas where we measure physical and optical properties (fluorescence and backscatter) at 15 min intervals using WET Labs WQMs. Groundtruthing of the mooring data is done with monthly shipboard sampling using CTD profiles and biochemical analysis of water samples. IMOS data is made available to the scientific community through a central data repository. The continental scale of IMOS combined with the volume of data brings new complexities from the operational level through quality control and data analysis, particularly because we are combining optical data from multiple platforms and sensors. Here we use a near continuous 2-year data record from Sydney, Australia to examine the oceanography of this dynamic region. We investigate the covariance between optical signals and other sensor records as a way of estimating the quality of the timeseries data and we introduce stringent pre and post deployment checks to ensure the integrity of the long term data set. (Abstract ID 12589)

HIGH-RESOLUTION SEDIMENTARY RECORD OF DIATOM PRIMARY PRODUCTIVITY OF THE LATEST 60 YEARS IN YANGTZE RIVER ESTUARY AND ITS RESPONSES TO GLOBAL CHANGES

Based on the data of sedimentary biogenic silica (BSi) in a gravity core collected in the Yangtze River estuary and the using of annual sedimentary layer dating method, high-resolution record over the latest 60 years was established. The BSi record shows periodic changes of about 20 yr, 11 yr, 3 yr and 1 yr cycles, accompanying with a gentle increasing trend. The 20 yr and 11 yr periods are consistent well with the sunspot magnetic property cycle and sun spot number cycle. The 1 yr period is due to seasonal fluctuations controlled by the East Asian Monsoon. And the cycle of 3 yr with gentle increasing trend agrees with the North Pacific decadal oscillation (PDO). Contributions of seasonal process, PDO, and sunspot activities to total BSi variance are about 13%, 30%, and 25%, respectively. Meanwhile, increases of nutrients inputs, or decreases of sediments discharges, which are from increasing anthropogenic activities, are within the surface ocean of the Antarctic Circumpolar Current (ACC) fronts. Changes in the Redfield ratio of nitrate, phosphate and dissolved inorganic carbon (DIN) are examined for signals of biogeochemical and anthropogenic change. A comparison of Redfield ratios for each section shows no phosphate change, a weak nitrate increase and a greater increase in DIC. (Abstract ID 11029)
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**QUANTIFYING THE CONTRIBUTION OF MESOSCALE ANTICYCLONES TO THE IRMINGER SEA HEAT AND FRESHWATER BUDGETS**

The Central Irming Sea (CIS) mooring observed properties of two water masses from 2002 to 2009: Irming Sea Water (ISW) and Labrador Sea Water (LSW). In the ISW, the heat balance is dominated by surface and lateral fluxes. The freshwater budget is controlled by lateral and vertical fluxes. Lateral fluxes consist of anticyclonic eddies in the CIS basin which have anomalously warm, salty water. They form from the Irming Current at the Reykjanes Ridge, propagate into the CIS basin, and are mixed into the CIS during winter mixing. Eddy seasonal average temperature and salt contributions are estimated using a combination of satellite altimetry and mooring statistics. They are compared with surface heat and freshwater fluxes. Results show that on a seasonal timescale, the surface flux controls the heat variations in the ISW; however, over the 7-year timeseries, the total heat contribution from the anticyclones nearly balances the net surface heat flux. This suggests that over the long term, these eddies play a significant role in balancing the heat budget in the CIS. A linear increase in salinity is observed in the ISW and LSW over the 7-year period. Using only surface and eddy freshwater contributions, the average yearly ISW salinity is computed. The resulting trend is almost identical to the observed salinity trend in the ISW, suggesting that the salt transport due to the anticyclones can explain the salinity increase observed in the ISW layer. (Abstract ID 12254)

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**TIME REAL CAL/VAL WITH SATELLITE VALIDATION NAVY TOOL (SAVANT)**

A new capability for daily match-up of satellite products and in situ data streams enhances inter-satellite consistency of ocean color products. SAVANT enables an "end to end" capability to validate multiple satellites (MODIS, MERIS, VIIRS, GOCC) from sensor to end products. SAVANT includes a real time, web-driven SQL database, which integrates 65 satellite products (LW/10P, metadata atmospheric models, flags, solar angles, etc.) and in situ data (water, buoy, glider and ship data). SAVANT allows for evaluation of top of atmosphere (TOA) radiance monitoring in several coastal and ocean locations, operational algorithms with real time in situ matchups, and cross-calibration of upcoming sensors (VIIRS) with heritage missions (MODIS, MERIS). Presently, CAL/VAL activities are performed at 25 areas around the world. These “Golden Regions” represent different types of atmospheric and water types: AERONET-OC coastal sites, optical buoys (MOBY, Bousole) in blue waters, time series studies (HOT, BATS, PNB), regions where ship measurements are being collected and six oligotrophic ocean regions. These regions have been used for comparison and inter-calibration of ocean color sensors. (Abstract ID 11090)

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**NONLINEAR INTERNAL WAVES IN THE SOUTH CHINA SEA DURING WINTER 2010–2011**

In a pilot study of nonlinear internal wave (NLIW) generation and evolution, pressure-recording inverted echo sounders were deployed in Luzon Strait and the South China Sea (SCS) during 09/2010–06/2011. Acoustic echo times at 6-second intervals were retrieved at 3 sites from November 2010 to April 2011 (2 in Luzon Strait and one in the SCS). The observations reveal energetic NLIWs during the winter months, suggesting that lack of remotely-sensed NLIWs in winter is due to wind-induced surface roughness obscuring surface NLIW signals. Wave packets with relatively weak NLIWs were also observed from mid-November to mid-December 2010 and from mid-February to mid-March 2011. Comparisons with data-assimilated HYCOM outputs reveal that the weak NLIWs occurred when the Kuroshio intruded into the SCS or the weakened Kuroshio modified stratification in LS. Numerical simulations and a simplified 2-D internal wave model will be used to explore the impacts of background circulation and stratification changes on the evolution of NLIWs in the SCS. (Abstract ID 11395)

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**COASTAL CONNECTIONS: ADVANCES IN THE UNDERSTANDING OF THE INTERACTION OF FLUVIAL AND MARINE SYSTEMS**

Rivers are the primary delivery mechanism for sediment and dissolved material to the coastal ocean. A more clear characterization and quantification of the controls on contemporary delivery coupled with continued exploration of the sedimentary record have lead to tremendous growth in our understanding over the past few decades. In this review, we seek to present an overview of the growth in understanding across multiple temporal and spatial scales of the flux and fate of material from land to the ocean by examining the contributions of Professor John D. Milliman, his students and his collaborators. For decades, John Milliman has lead fellow marine and terrestrial scientists in collaborations to further understand the fluvial delivery, the marine distribution processes and the record that is stored in both terrestrial and coastal sedimentary records to better understand the complex linkages between land and sea. (Abstract ID 12836)
THE EFFECT OF WIND ON CURRENTS IN THE COLUMBIA RIVER

We have deployed an X-band Doppler radar over the north channel of the Columbia River (under the Astoria-Megler bridge) to measure along-channel surface currents. A six-month-long record of these currents indicates that, after removing tidal effects, the residual mean current is always toward the river mouth (as expected), and is highest when the wind direction is toward the mouth of the river and lowest when the wind direction is away from the mouth. Furthermore, the change in current between these two conditions increases with wind speed. This change is much larger than can be explained by a surface drift layer. Therefore we suggest that the current through the whole water column depends on the wind. This supposition is supported by the fact that the stage of the river measured at Astoria, normalized by the upstream discharge measured at the Beaver Army Terminal, is higher for winds toward the mouth and lower for winds away from the mouth. (Abstract ID 10433)

A SURVEY OF WAVES ON SUBSEASONAL TIME SCALES IN THE TROPICAL PACIFIC OCEAN

Data from satellite altimetry and from the TAO/TRITON mooring array are used to characterize and discuss wave-like variability in the tropical Pacific Ocean at periods of days to a few months. The goal is to provide a synthesis view of the variability on subseasonal time scales, with emphasis on an interpretation in terms of wave dynamics. At the higher frequencies (periods of 2-14 days), there is clear evidence for the presence of several basin-scale equatorial wave modes, including Yanai waves and inertial-gravity waves associated with baroclinic modes one and two. At the lower frequencies (periods of 1-2 months), the variability of sea level is dominated by equatorial Kelvin waves and tropical instability waves, although variability resembling barotropic Rossby waves and equatorial Rossby waves is also present. (Abstract ID 11666)


A ROMS-based data-assimilating ocean forecast system is being developed as part of the GOMEX-PPP (Pilot Prediction Project), which seeks to evaluate and demonstrate numerical model-based operational predictions of the circulation of the Gulf of Mexico. The primary drivers of this circulation are the Loop Current and its associated Loop Current eddies. The data assimilation component uses a multi-scale 3DVAR methodology which is flexible enough to allow assimilation of many different types of data and is also computationally efficient enough for real-time operations. Results produced by the system for 2010, including nowcasts and hindcasts for the period of the Deepwater Horizon oil spill event, will be presented. Real-time 3-month forecasts were begun in September 2011 and consist of a set of forecasts performed once every two weeks during the period September through December 2011. The skill of these forecasts will be evaluated with an emphasis on the variations in the Loop Current and associated eddies. In addition, the performance of ensemble forecasts - both traditional and multi-model - for this period will be evaluated. (Abstract ID 12422)

AN AUTONOMOUS DISSOLVED INORGANIC CARBON MEASUREMENTS ON A MOORED BUOY

The temporal and spatial richness of ocean carbon measurements has increased dramatically over the past 30 years; however, the constraint on even richer data sets has largely been due to sluggish technological advancement in this area. More recent interest in surface ocean biogeochemistry, due to the growing concern with ocean acidification and future ocean carbon cycling, has prompted calls for instrument advancement in the area of ocean carbon cycle observations. In response to the need for progress in this area, we have developed a robust dissolved inorganic carbon (DIC) sensor prototype. Building off of the NOAA Pacific Marine Environmental Laboratory moored pCO2 system (MAPCO2; now commercially available through the Battelle Memorial Institute), this DIC sensor uses the proven technology of infrared detection of CO2 in a gas stream. In this application we acidify a known volume of seawater, and quantify the CO2 that is evolved from the sample. This fast and reliable technique has been used routinely in shipboard systems to measure DIC, but has not previously been adapted for robust, long-term, autonomous DIC measurements on a mooring. Results from our first deployment of the moored DIC instrument prototype are presented here. (Abstract ID 11706)

PATHWAYS TO OCEAN SCIENCES: BROADENING PARTICIPATION IN OCEAN SCIENCES REU PROGRAMS

Increasing the number and diversity of students who successfully pursue careers in Ocean Sciences is key to addressing the growing demand for professionals in our fields who genuinely understand and realize a contribution to cutting-edge research. Summer research programs for undergraduates play a critical role in this process by creating environments where students
can develop the strategies and professional skills necessary to pursue meaningful careers in various STEM fields and by supporting students as they "bridge" between undergraduate and graduate studies. Within the framework of a diversity briefing illuminating the context behind efforts to broaden participation, the Institute for Broadening Participation (IBP) will provide a short overview on the current state of diversity in the Ocean Sciences community in general and the NSF Ocean Sciences REU community in particular, as well as offer a shared resource pool of studies, references, practical tools and strategies focusing on broadening the participation of women and underrepresented groups in higher education. IBP has been supporting diversity by fostering an on-going exchange of ideas and resources between students, faculty and administration since 2002. Their web portal, www.pathwaystoscience.org, provides easy access to many resources that support students in successful careers in the STEM fields, and support faculty and administrators in enhancing their efforts to increase diversity. (Abstract ID 10377)

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ESTIMATING GLOBAL OCEAN CARBON TRENDS USING IN-SITU pCO2 OBSERVATIONS, 1981-2010
Ocean carbon uptake significantly modulates the atmospheric CO2 levels, slowing the rate of anthropogenic change. The global ocean carbon sink appears to be changing, but it is difficult to distinguish the degree to which these changes are driven by anthropogenic climate warming as opposed to natural decadal timescale variability. Recent studies of the North Atlantic carbon cycle suggest conflicting flux trends: data-based extrapolations report a declining sink (Schuster et al. 2009), while models with suggested an increasing flux (Ullman et al. 2009). Through analysis of the Takashada pCO2 dataset in the North Atlantic, McKinley et al. (2011) find that changes previously termed “trends” were more likely driven by decadal timescale climate variability rather than anthropogenic climate change. However, we do find that anthropogenic warming is beginning to reduce carbon solubility on multi-decadal timescales in the subtropical gyre of the North Atlantic, which is consistent with recent modeling results (Le Quere et al. 2010). Using the vast, newly updated, in-situ pCO2 dataset and a similar methodology to McKinley et al. (2011), we assess global ocean pCO2 trends over recent decades for the major ocean basins, specifically focusing on results in the Pacific for this presentation. We present results for changes in carbon uptake over varying timescales and also assess mechanisms, particularly the degree to which warming is limiting carbon uptake. (Abstract ID 11749)

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STUDYING TROPHIC COMPARTMENTS OF EUKARYOTIC MICROBIAL FOODwebs USING A THYMIDINE ANALOG AND ENVIRONMENTAL DNA SEQUENCING
Eukaryotic microbes are a critical trophic link between prokaryotes and higher trophic levels, playing an important role in ecosystem function. Advances in molecular ecology have revealed a high taxonomic diversity of uncultured eukaryotes from aquatic environments. In an effort to determine the ecological role of these microbial eukaryote taxa, we added BrdU-labeled bacteria to culture bottles of environmental water samples. The bottles were then incubated to allow bacteria to be ingested and the BrdU label to become incorporated; the samples were filtered and whole DNA was extracted. BrdU-labeled DNA was isolated from whole DNA using immunoprecipitation. We analyzed the samples with both PCR-DGGE and amplicon pyrosequencing using universal eukaryotic primers. Our results show that the BrdU-labeled community is a distinct subset of the respective whole community. Certain cryptophyte, chrysophyte, and ciliate taxa in particular show labeling with BrdU. We suggest that these taxa be considered putative bacterivores and that this method has the potential to reveal actively feeding members of the microbial community. (Abstract ID 9982)

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HIGH-RESOLUTION MODELING OF CIRCULATION ALONG THE US WEST COAST
To study coastal and interior ocean dynamical interactions, a 2-km resolution model based on the Regional Ocean Modeling System (ROMS) is applied in the domain occupying an area in the north-east Pacific Ocean (35N–55N, 134W–120W). Initial and boundary conditions are based on the HYCOM-NCODA global 1/12th degree analysis. Atmospheric forcing is formed based on the North American Mesoscale Forecast System (NAM). Our study is initially focused on the fall transition and winter 2008-09, including formation and propagation of large-scale anticyclonic eddies, near-surface boundary layer dynamics during strong storms, and connectivity of the wide-scale eastern boundary California Current (flowing to the south) and the coastal current (flowing to the north, associated with seasonal downwelling). Both the HYCOM and the nested ROMS solutions are compared against available satellite SSH, SST, and in-situ glider and mooring data. Potential difficulties nesting our model in a data assimilated product include consistency of boundary fluxes and the area-averaged SSH variability and aliased high-frequency modulations extending to depth. (Abstract ID 12308)

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VERTICAL STRUCTURE OF TURBULENCE UNDER SURFACE BREAKING WAVES
Observations of the vertical structure of turbulence under breaking waves in a natural surfzone are sparse. In the surfzone, both the surface (via breaking waves) and the bottom (through bed-generated shear) can be significant turbulence sources. Here wave, current, and turbulence observations from the IB90 experiment (Fall 2009 at Imperial Beach CA) are presented. A cross-shore array spanning 150 m of 5 tripods were deployed with rapidly sampling pressure sensors, ADV current meters, thermistors, and dye-measuring fluorometers. In addition, in the mid-to-out surfzone an additional frame (denoted VS, vertical stack) with a vertical array of 3 ADVs, thermistors, and fluorometers spanning from within 0.2-1.6 m above. A nearby vertically profiling Aquadopp ADCP measured the vertical structure of the mean flow. In addition to wave and current statistics, turbulence statistics such as the turbulent dissipation rate, Reynolds stresses, turbulent vertical temperature flux, and dye tracer fluxes are estimated. From these observations turbulent energetic balances are examined to determine the contribution of bottom boundary layer turbulence relative to breaking-wave generated turbulence in the surfzone. (Abstract ID 11388)

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SPACE-TIME STATISTICS AND SPECTRA FROM STEREO MEASUREMENTS OF GRAVITY WAVES
Classical time series measurements of the ocean surface displacements at a fixed point P of the ocean are generally retrieved from wave gauges, ultrasonic instruments or buoys. Despite being very informative and widely acquired routinely, these data bring along low information to provide accurate predictions of the space-time wave dynamics and of the associated statistical and spectral properties over an area centered at P. As an alternative, an approach based on a stereo camera view would allow retrieving both spatial and temporal data. To prove this, an application of the Wave Acquisition Stereo System (WASS) is presented for the analysis of offshore video measurements of gravity waves over large areas of approximately 1100 m2. WASS was deployed at the oceanographic platform Acqua Alta in the northern Adriatic Sea, Italy. WASS analysis yielded accurate estimates of the sea surface and its associated directional spectra. Furthermore, the expected largest wave height over an area is estimated via Euler characteristics. It is found that waves over an area are larger than those expected at a given point in time. (Abstract ID 11148)

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EDUCATIONAL COLLABORATION AND RESEARCH BETWEEN ISLAND, COASTAL, AND ARCTIC INSTITUTIONS.
We present the results of an ongoing educational and research collaboration between the University of Hawaii, University of Puerto Rico, University of Alaska, the Stevens Institute (New Jersey), and future partners from other nations/states. Students from these institutions have built, tested and deployed passive acoustic recording systems and have shared their data as part of a collaborative research effort. Data are collected using identical systems and field collection protocols enabling direct analysis and comparison from various island, arctic and mainland coastal environments. The student-led experiments address real scientific questions and use research-grade equipment and analysis tools. Examples of projects include measuring background noise levels of coastal ocean environments and detect biological, physical, and anthropogenic changes. The program has educational initiatives that have sent students to summer programs at the Stevens Institute in Hoboken, New Jersey. We are currently organizing a program with the US Coast Guard to allow students who have been trained through the program in harbor protection to participate in multi-day Coast Guard deployments. (Abstract ID 12800)
This study focuses on the pronounced interdecadal AMOC variations simulated by many coupled climate models. Models, we conduct a stability analysis of a realistic ocean GCM and show the existence of an interdecadal, weakly-damped mode of oscillation centered in the northern Atlantic and related to ocean dynamics. The mode period is approximately 24 years and its manifestation is evident in the westward propagation of temperature anomalies in the upper Atlantic ocean. These temperature anomalies affect the ocean density field and hence ocean circulation (especially within the Subpolar Gyre). The most powerful mode to excite this mode is via optimal initial perturbations in surface temperature and salinity centered off the eastern coast of Greenland and Canada, south of the Denmark Strait. Simple estimates show that moderate changes in surface temperature or salinity in this region can lead to AMOC variations on the order of 10–20%. Next, we consider the IPSL coupled model that has the same ocean component and extends AMOC variations with a period close to that of the least-damped mode in the ocean-only GCM. We show that the mechanism of these variations in the coupled model is the excitation of the exact same oceanic mode by the atmosphere via the optimal perturbation mechanism. The excitation process involves changes in the southward flow through the Denmark Strait generating salinity anomalies downstream. These results are relevant to other models (e.g. CCSM3 and CESM). (Abstract ID 9735)

Pre-sampling assessments of decadal diversity on deep hard banks and surrounding sediments were continued post-spill under exigent NSF/Rapid and GRI/Stopgap programs. Rubble bank substrates (60-90m) were sampled with 1m box dredges and muddy substrates (150-200m) with 3m epibenthic skimmers. Post-spill sampling has been limited to three cruises, only one matching pre-spill sampling seasons. Diversity and abundance on hard banks decreased from pre-spill measures and across post-spill periods. Assemblage composition shifted dramatically on banks, including near extinction of the previously dominant brachyuran Maldanidae. General expression studies are underway to characterize responses of major lineages to oil-spill stressors. Epibenthic shallow interannual decads in post-spill samples often bear coatings of HC residues, especially on branchiae and appendages used for sediment manipulation. Frequency of lesions increased over post-spill sampling, though patterns were heterogeneous among decad lineages. Lesions appear to involve microbial activity, with possible attenuation of shell defenses by lipotic and chitinoclastic processes. We hypothesize infection pathways linked to weathering of dispersed HCs, enhancing recruitment of shell disease pathogens from natural reserves. Host vulnerability, physiological responses, and disease transmission routes remain our focus. (Abstract ID 11496)

Besides a sea level rise (SLR) trend from 1992 to 2010, the SSHA geographically and temporally varies in this region and is dominated by interannual and interdecadal variability. The SLR in the SGP developed at a reduced rate in the 2000s compared to rates in the 1990s. This rate reduction is accompanied by reduced amplitudes at low frequency SSHA oscillations. General decreasing sea level in the SGP appeared in the 2000s that is mostly associated with variations in the Irminger Basin sea level. Observed decreasing SSH and partially strengthening SGP circulation in the 2000s, however, cannot be explained by changes in the deep ocean convection in the Labrador Sea, even less by variations in the air temperature and the wind patterns in the northern North Atlantic. Rather, a reversal of the SSHA trends over past two decades might be related to the multi-decadal Atlantic meridional overturning circulation (AMOC) variability. (Abstract ID 12372)
UNDERSTANDING HYPOXIC AREA VARIABILITY IN THE NORTHERN GULF OF MEXICO FROM A THREE-DIMENSIONAL COUPLED PHYSICAL BIOGEOCHEMICAL MODEL

A three-dimensional, coupled physical-biogeochemical model (ROMS-Fennel) with an expanded oxygen component has been used to simulate the occurrence and spatial extent of hypoxia in the northern Gulf of Mexico from 1985-2009. Model skill was quantified by comparing simulated oxygen fields with available observations. The results show that the model overestimates bottom DO concentrations by about 1 mg/L, however observed bottom DO variability is successfully captured. Adding this 1 mg/L offset to the commonly used 2 mg/L bound for hypoxia allows the calculation of a simulated hypoxic area that is close to observations. An EOF analysis of monthly hypoxia frequency of the 25-year simulations showed several key spatial patterns. The first-two modes have strong seasonal patterns, explain 70% of the area variability and are highly correlated with Mississippi-Atchafalaya river flow, dissolved inorganic nitrogen concentration as well as wind duration and strength. The effect of wind stress and duration complicates the hypoxic area management strategy. Unlike riverine nutrient loading, which can be reduced through regulation, regional wind variability depends on inherent variations in the global climate system. (Abstract ID 10109)

MODELING RELEASE, TRANSPORT AND INACTIVATION OF FECAL INDICATOR BACTERIA AT AN EMBAYED NON-POINT SOURCE SUBTROPICAL BEACH

A 10-day intensive environmental monitoring effort was conducted at a subtropical beach located in southern Florida, USA (Hobe Beach, Miami) in the summer of 2010. This beach was characterized by frequent occurrences of exceedance of fecal indicator bacteria with the inter-tidal sediment as a major bacterial reservoir. The enterococci levels measured hourly at knee-depth locations demonstrated high spatio-temporal variability both in the water and the sediment. To better understand the role of complex hydrodynamic and morphodynamic processes in affecting microbial water quality, we utilized a nearshore process model (XBeach), coupled with a microbe advection-diffusion equation to represent the release of microbes from sand, entainment through shallow groundwater flow, runoff contribution, and sunlight inactivation. The model successfully reproduced the spatial and temporal trends of enterococci concentration in the beach water including the reproduction of strong diel and tidal signals and the rapid decrease of enterococci levels by one to two orders of magnitude in a 100-m distance offshore from the shoreline. The modeled processes and their sensitivity to environmental forcing by waves and tides will be presented at the conference. (Abstract ID 11643)

MINING EFFICIENCY IN NATURAL FLOWS

In evaluating vertical eddy diffusivities within oceanic stratified layers, a commonly used assumption is that the mixing efficiency G is constant. It is however shown that for stratified shear flows G is dependent on at least two parameters, the gradient Richardson number Ri and the buoyancy Reynolds number Re. Based on direct flux and gradient measurements in stable atmospheric boundary layer and using homogeneous/stationary TKE balance equations, it is shown that in limited parameter ranges the directly evaluated mixing efficiency is nominally similar to that evaluated based on scale balance equations. When Ri and Re are outside these ranges, one or more assumptions used in developing the methodology of flux estimation break down. The results shed light on the wide variability of G noted in previous studies. (Abstract ID 10045)

CLEAN COASTAL WATERS AND PRODUCE BIOFUELS

Nutrient pollution is a growing problem in estuaries and coastal waters throughout the world and innovative strategies are needed to address this environmental problem. As part of a multi-institutional, interdisciplinary effort, we are investigating the culture of wild attached algal communities as a tool for simultaneously removing nutrients from eutrophicated waters while using the accumulated algal biomass for biofuel production. Two research-scale algal flows (25 m long) were established on a tributary of the Chesapeake Bay and operated for 1-2 years to provide reference data on algal production, lipid content and composition, and nutrient concentration and removal. Overall, algal biomass accumulated at moderate to high rates (annual average production = ~20 g m$^{-2}$ day$^{-1}$; peak production [Jun-Oct] = 50 to 60 g m$^{-2}$ day$^{-1}$). Generally, total lipid content of the algae was low and averaged <5% of dry mass for the upper and lower portions of the flows. Our results demonstrate that attached algal flows are highly effective at nutrient removal, thus providing an effective approach for improving water quality. (Abstract ID 9883)

The characteristics of the Probable Maximum Tsunami (PMT) generated by the Probable Maximum Earthquake (PME) at the Makran Subduction Zone (MSZ) where a historic tsunami originated in 1945 was evaluated. The wave run-up/down resulting from the PMT was computed at a typical location in the south central portion of the Arabian Gulf. Seven earthquake scenarios were developed to identify the characteristics of the PME. A separate Seismic Hazard Analysis was conducted to determine the magnitude of the PME. The seven earthquake scenarios were first examined using the European Commission Tsunami model (ECIRC) to determine tsunami scenarios that could impact the site. Later on, Delta3D-FLOW was utilized to compute the wave height near the site. A sensitivity analysis was conducted on the following parameters: bathymetry, tide factor, layout of the site, and modeling techniques. (Abstract ID 10673)

USING A SIMPLE CONVECTION MODEL TO DIAGNOSE GULF OF MEXICO WINTER MIXED LAYER VARIABILITY

Convective overturning is a critical process in the global climate system. The intensity of these processes determines the depth of the Mixed Layer (ML) and ultimately the amount of the water mass formed. Such processes occur in Willingham Basin (WB) in the Gulf of Maine. We present preliminary results on the evolution of the winter ML. Using both observed data and simulations with the Price, Weller and Perles (1986) model (PWP). One of the advantages of PWP allows the user to study the effect of winds and convection separately. The WB atmospheric records exhibit different air-sea exchange scenarios including (1) net surface cooling due to a combination of relatively large air-sea temperature difference and moderate offshore southeastward winds; and (2) surface cooling due to a combination of strong storm-related southeastward winds and a more modest air-sea temperature difference. Preliminary PWP results show a ML deepening due to the cooling observed in the first half of the study period. However, PWP did not reproduce the observed re-stratification during the second half because of the lack of model lateral advection. (Abstract ID 11567)

BIOGEOCHEMICAL CONTROLS OF NITROGEN FIXATION IN THE OXYGEN MINIMUM ZONE OF THE EASTERN SOUTH PACIFIC REGION

Nitrogen fixation was studied between 2007 and 2010 through 15N assimilation in the seasonally active upwelling system off central Chile (35° - 37°S). Intense suboxia causes this site to show important nitrogen sinks through denitrification and anammox near the coast while oceanic waters sustain high levels of primary production fueled by wind driven upwelling of denitrified waters. N2 fixation was an almost permanent feature in the study area. In the euphotic zone, biological nitrogen fixation was detected during the entire study period with rates going from 0 to 5 mmol L$^{-1}$ d$^{-1}$ (0.32 ± 0.17 mmol L$^{-1}$ d$^{-1}$) in 2006 and 0 to 2.93 mmol L$^{-1}$ d$^{-1}$ in 2009 (0.69 ± 0.56 mmol L$^{-1}$ d$^{-1}$). Also, a temporal survey revealed the occurrence of N2 fixation in subsurface suboxic conditions, mainly during non upwelling periods (winter). In order to explore the control factors of this process, the appearance of N2 fixation in the area was analyzed in a wide biogeochemical context, evaluating possible interactions with chlorophyll content and the CN ratio of phytoplankton, as well as the dynamics of other dominant microbial processes in the area such as nitritation. Results suggest that the presence and magnitude of diazotrophic communities is related to the physiological status and composition of the microbial community rather than the extent of N deficiency translated in low N ratios. (Abstract ID 9678)

MIXING EFFICIENCY IN NATURAL FLOWS

In evaluating vertical eddy diffusivities within oceanic stratified layers, a commonly used assumption is that the mixing efficiency G is constant. It is however shown that for stratified shear flows G is dependent on at least two parameters, the gradient Richardson number Ri and the buoyancy Reynolds number Re. Based on direct flux and gradient measurements in stable atmospheric boundary layer and using homogeneous/stationary TKE balance equations, it is shown that in limited parameter ranges the directly evaluated mixing efficiency is nominally similar to that evaluated based on scale balance equations. When Ri and Re are outside these ranges, one or more assumptions used in developing the methodology of flux estimation break down. The results shed light on the wide variability of G noted in previous studies. (Abstract ID 10045)
The annual cycle of phytoplankton growth in many parts of the ocean is dominated by a population explosion in late winter early spring, the so-called spring bloom. High levels of primary production during the spring bloom, and the subsequent sinking of organic material contributes significantly to the carbon flux to the deep ocean. The onset of the spring bloom has been traditionally associated with the shoaling of the mixed layer above a critical depth at the end of winter. However we will argue that the onset of the spring bloom is more likely triggered by the reduction in air-sea heat loss at the end of winter. When net cooling subsides at the end of winter, turbulent mixing in the ocean becomes weak, thereby increasing the residence time of phytoplankton cells in the euphotic layer and allowing a bloom to develop. The necessary change in the air-sea flux generally precedes mixed layer shoaling, and provides a better indicator for the onset of the spring bloom than the mixed layer depth. We will illustrate our results with a combination of theory, numerical simulations, and analysis of remote sensing data. (Abstract ID 11697)

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VIRTUAL TOOLS TO AID SCIENTISTS IN DEVELOPING BROADER IMPACT PROJECTS

COSEE Networked Ocean World (COSEE NOW) is dedicated to supporting ocean scientists in successfully communicating the broader impacts (BI) of their research. We have created a suite of new online resources for scientists, which complements and enhances our existing social networking portal (http://coesewnow.net) that brings together researchers and educators from the ocean science community. The “BI Assistant” provides a user interface that guides users through a series of well-defined steps necessary for the construction and implementation of a broader impact statement required in research proposals. The site also features a collection of resources that provides guidance on selecting potential audiences, identifying appropriate collaborators, and developing activities that achieve broader impacts. Case studies highlighting high quality education and public outreach (EPO) projects are included to offer scientists effective strategies for integrating the intellectual merit and broader impacts components of their research. The consolidation of these features into one online environment encourages interdisciplinary sharing of expertise and resources, which consequently enhances the quality of EPO products and promotes dissemination of scientific research. (Abstract ID 11697)

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HOW DO OCEAN CIRCULATION AND BASIN GEOMETRY REGULATE THE LARGE-SCALE DISTRIBUTION OF DISSOLVED OXYGEN IN THE GLOBAL OCEAN?

Here we examine fundamental controls on the large-scale oxygen distribution using a suite of integrations with a coupled ocean-atmosphere-sea ice general circulation model, overlain with a simple ocean biogeochemistry parameterization. Basin geometries are idealized, ranging from a pure Aquaplanet (no geometrical constraints) to a more complex, Jurassic-like configuration comprising a small enclosed basin and a large basin. The simulations cover a wide range of ocean circulation regimes, sea-ice covers and climates. Importantly, a configuration with idealized present-day geometry captures the main features of the observed oxygen distribution. The suite of models lead to three key inferences: (i) the expected decrease of the mean O2 concentration with increasing mean temperature (solubility effect) can be significantly disrupted by extensive ice cover and/or weak nutrient utilization, (ii) the presence (and extent) of anoxic waters is poorly correlated with the global mean oxygen concentration but is controlled by large-scale ocean circulation, and (iii) deep anoxia is a possible solution, favored by the presence of 2 basins. Implications of our results for interpreting paleoclimate records and future climate change are discussed. (Abstract ID 11725)

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THE EFFECTS OF UV/OD Dopamine RELEASE ON BARNACLE FEEDING BEHAVIOR

The catecholamine dopamine, well known for its role as a neurotransmitter in animals, functions as a herbivore deterrent in the green alga Ulva linza. In addition to its role as a chemical defense, dopamine and its oxidative products have been implicated in reducing the success of competitive algae and larval invertebrates when released by Ulva linza into surrounding waters. Here, we investigated the impacts of Ulva linza dopamine and dopamine on the feeding behavior of the barnacle Chthamalus dalli, a species common in areas that experience large green algal blooms. When exposed to Ulva linza exudates, barnacle cirral extension rates were suppressed relative to seawater alone. Subsequent trials conducted with dopamine, its oxidative products, or seawater confirmed the inhibitory effects of dopamine on barnacle feeding behavior. Our results suggest that high dopamine concentrations associated with Ulva linza blooms can have negative impacts on adult invertebrates including barnacles. (Abstract ID 11360)

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COMMUNITY ECOLOGY: HOW OPPOSING DEMOGRAPHIC PROCESSES ARE CONTROLLED BY ONE, AND THE SAME, MOLECULE

Opposing demographic processes are driven by the recognition of sensory cues indicative of suitable habitat and/or prey. In some instances, the signals that induce settlement of, and predation on, a species are one and the same, and so population balance rests on a single compound. We have identified one such molecule produced by barnacles (Balanus glandula)—MULTIFUNCin. At natural concentrations, MULTIFUNCin induced significantly more larvae to settle than did controls. Moreover, MULTIFUNCin triggered predation in five species of barnacle-consuming whelks (Acanthinaulax serpula, Nucella angari, N. osteria, N. lamellosa, N. canaliculata) and sea stars (Pistaster ochraceus). Analysis revealed the nucleotide and amino acid sequences of this protein. The full amino acid sequence of MULTIFUNCin established it as a globular glycoprotein requisite to barnacle cuticle/shell formation. A homologous protein was identified in each of three additional barnacle species (Semibalanus cariosus, Chthamalus stellatus, Amphibalanus amphiibius), indicating conservation of the bioactive compound. When each respective protein was isolated, purified, and imbedded in faux prey, each whelk and seastar species preferentially chose the MULTIFUNCin-laced mimic. MULTIFUNCin recognition thus plays a key role in balancing opposing demographic processes (immigration and death by predation) that determine barnacle population dynamics and structure species assemblages on rocky wave-swept shores. (Abstract ID 12713)

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DYNAMICS OF ORGANIC AND INORGANIC CARBON IN A MANGROVE-DOMINATED ESTUARINE SYSTEM (SHARK RIVER, FLORIDA)

We report the results from a Lagrangian SF6 tracer release experiment conducted in Shark River in November 2010, where we examined the source, fate and transport of dissolved carbon in a mangrove-dominated estuary. The main objectives in this experiment were: 1) to determine hydrological parameters, such as net advection, dispersion and residence time of water; 2) to quantify air-water gas exchange; 3) to provide a Lagrangian frame of reference to examine carbon transformation rates. SF6 was released on November 19th 2010 and sampled for 6 consecutive days following the injection. Along with SF6, we made underway measurements of temperature, salinity, dissolved oxygen and partial pressure of CO2 in the tracer-tagged waters and throughout the estuarine salinity gradient. We also collected discrete water samples at different sites along the tracer patch for the analysis of dissolved and particulate organic carbon (DOC, POC), total alkalinity, dissolved inorganic carbon (DIC), DOC optical properties, POC biomarkers and δ13C of DIC, DOC and POC. The results suggest that the Shark River and surrounding intertidal sediments are active sites for mangrove-derived carbon mineralization. (Abstract ID 12299)

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GLORYS 1/4° GLOBAL OCEAN REANALYSES AND SIMULATIONS OF THE PERIOD 1992-PRESENT

We present here the French GLORYS (Global Ocean ReanalYses and Simulations) project, in which several global ocean reanalyses have been carried out. GLORYS reanalysis system describes the evolution of the ocean and sea-ice states and is based on Mercator Ocean operational 1/4° global eddy-permitting ocean analysis and forecasting system (http://bulletin.mercator-ocean.fr/html/products/ps3v3/ps3v3_data_en.jsp). The NEMO ocean model
is forced by ERA-Interim atmospheric parameters including satellite-based fluxes corrections. The data assimilation method is based on a reduced order Kalman filter (SEEK formulation) in conjunction with a bias correction scheme for temperature and salinity. Assimilated data are delayed time SST, along track SLA and in situ T,S profile data. Two reanalyses and one reference simulation with no data assimilation have been produced, validated and are distributed. The first stream covers the “auger era” (2002-2008) and was produced end 2009. The second stream covers the “altimetric era” (1992-2009). We present in this study the skill of GLORYS reanalyses and give an overview of results obtained in a wide range of areas such as climate, meso scale processes, mixed layer processes, sea ice... (Abstract ID 11420)

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LONG-TERM MONITORING OF ERUPTIONS AND GAS HYDRATE DYNAMICS AT THE HÅKON MOSBY MUD VOLCANO, BARENTS SEA SLOPE

Located at 1250 m water depth on the Barents Sea slope, the Håkon Mosby mud volcano was the focus of a long-term observation within the framework of the ESONET demonstration mission LOOMÉ. Previous investigations had indicated persistent high rates of seepage as well as abundant gas hydrates and led to the installation of an un-cabled modular seafloor observatory. Temperature at the seabed and in the sediment along with pressure, temperature, current speed and direction, pH, and oxygen in the bottom water were recorded from July 2009 until September 2010. These time series document several eruptive events associated with explosive uplift of the seafloor, sharp drops in bottom water pH and oxygen, and increased turbidity and sediment temperatures, and rapid mud expulsion. Based on the timeline of these events, we propose a conceptual model that explains how episodic seepage of warm fluids controls gas hydrate dynamics and triggers eruptions of the Håkon Mosby mud volcano. (Abstract ID 11087)

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THE SPECTRAL SLOPE COEFFICIENT OF CDOM (S_CO) AS A TRACER OF TERRIGENOUS DOC IN RIVER-INFLUENCED OCEAN MARGINS

Rivers exert an important control on carbon dynamics and CO2 fluxes in ocean margins by improving ocean margin carbon budgets. Here, we observed a strong disturbance caused by the passage of tropical storm Kiko through the study area in early October, with effects cascading from the physical environment up to top predators. Surface temperature mean and patchiness decreased with an increase in macrozooplankton biomass, although changes in dietary composition were slight. Hypotheses are presented to explain how Kiko induced these bottom-up ecosystem changes. (Abstract ID 10008)

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DO THE SILICIFIED WALLS OF DIATOMS CONFER PROTECTION AGAINST COPEPOD GRAZING?

Many groups of marine protists (algae and protozoa) are “armored” with thickened cell walls, coatings of scales, hard “cases” (tests, loricas), or latticework “skeletons”. One of the inferred evolutionary functions of these mineral deposits is to deter grazing. However, to date there are no direct measurements of grazing rates on protists as a function of their mineral content. With the recent development of silica stains we directly test the relationship between the per cell minerals quota of 2 diatoms species (Thalassiosira sp.) and the ingestion rates of copepods. Mineral load were determined chemically (chemical digestion), visually (confocal microscope) and photometrically (flow cytometry). Using well controlled algal rearing techniques, we grew phytoplankton cells with a 3 fold difference in silification. Our results show that for small cells (T. pseudonana) the degree of silification showed no effect on grazing rates by Acartia tonsa. For larger cells (T. weissflogii), we found a significant effect of silica but only at high cell concentrations. These results support the hypothesis that silification in some cases does confer protection against mesozooplankton grazing rates. (Abstract ID 11038)

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GULF OF MAINE AND THE WORLD OCEAN REU: ATTRACTING AND RETAINING MINORITY STUDENTS IN OCEAN SCIENCES

Bigelow Laboratory for Ocean Sciences, site of the Gulf of Maine and the World Ocean REU, provides undergraduates the opportunity to develop skills conducting independent scientific research in lower trophic level oceanography using state-of-the-art methods and research technologies. Our goal is to increase the number of underrepresented minority students pursuing graduate degrees in ocean science, with an emphasis on engaging Native Americans. We work directly with minority-serving institutions and organizations to meet this goal. To date, twenty-four students have participated in the REU, with over 40% minority participation during the last two years. Nine students have received funding to present their work at international science meetings. In August 2011, an external evaluator was hired to assess our first three years as an REU site; here we present these evaluation results, focusing on the short and long-term impacts of the program on minority participants and their post-program academic and career paths. Effective strategies for recruiting and mentoring underrepresented minority students, as well as challenges faced in meeting our recruitment goals and lessons learned, will also be discussed. (Abstract ID 9764)

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SENSOR EVALUATION OF THE HYDROC-CO2 FROM VARIOUS FIELD TESTS

Driven by the need for small, versatile, autonomous and reliable sensors for the partial pressure of carbon dioxide (pCO2), the development of the HydroC-CO2 was initiated in 2007. The HydroC is an in situ or flow through instrument that determines the CO2 concentration optically by means of non-dispersive IR-spectrometry (NDIR) within a membrane-equilibrated gas stream. Within the last years various successful laboratory and referenced field measurements were conducted. The track record comprises deployments for timescales extending from hours to months in rivers, coastal waters and the open ocean. The instruments were installed on or integrated into diverse platforms ranging from stationary buoys over research vessels to modern moving platforms such as AUVs or even profiling floats. Data was collected in surface waters during underway measurements and within the water column during profiling CTD casts down to 2000 m. This contribution aims at providing a comprehensive performance assessment of the HydroC-CO2 instrument. Considering its versatility, potentials and limits are discussed as well as areas of future optimizations identified. (Abstract ID 17178)

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ELEVATED TEMPERATURE/PCO2 SYNERGISTIC EFFECTS ON TROPICAL MARINE MACROALGAE AND SEAGRASSES

Ocean pCO2 is expected to approach ~1,000 ppm and temperatures increase by ~4°C by 2100. We present data on the physiological responses of tropical calcifying and non-calcifying macroalgae and seagrasses with important roles in reef, lagoon, estuarine and open-water systems to the interactive effects of elevated pCO2 and temperature. Our ongoing research is evaluating metabolic effects of and growth of elevated pCO2 across seasons using a well-controlled mesocosm facility (16 500L tanks) with a web-controlled monitoring system that injects CO2 to maintain pH (±0.03; verified CO2SYS & measuring pCO2aq). In May/August 2011, we evaluated elevated temperature (28/34°C) and pCO2 (PH 7.69) to controls (24/30°C pH 8.07) and photosynthesis/photoinhibition irradiance parameters (Pmax, Ic, Ik, and α) determined. At high pCO2 and ambient temperature, Pmax was elevated in all species. An increase in production was also observed in Halimeda at high pCO2 x high temperature in spring; however, high pCO2 x high temperature in summer lowered production. Our data indicate tropical macroalgae and seagrasses adjust to elevated pCO2 and temperature through temperature controls on respiration and photosynthesis; with threshold responses observed approaching thermal limits. (Abstract ID 112683)

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A HIGH-FREQUENCY, BROADBAND ACOUSTIC BACKSCATTERING SYSTEM, FOR IMAGING, CLASSIFICATION, AND QUANTIFICATION OF WATER-COLUMN SCATTERERS FROM AUTONOMOUS VEHICLES

For decades, significant research effort has been directed at using high-frequency acoustic scattering techniques to remotely investigate marine organisms and small-scale fluid processes. Acoustic scattering techniques provide a rapid, high-resolution, synoptic, remote-sensing tool that complements more traditional sampling strategies such as nets and optics. Autonomous vehicles offer advantages in persistence and spatial coverage, and are expected to play a critical role in ocean observing systems. Emerging broadband scattering techniques result in increased range-resolution and spectral coverage, improving imaging, classification and quantification capabilities. A low-power, short-range, compact, autonomous, broadband (120–1200 kHz) backscattering system appropriate for mounting on autonomous platforms has been developed. After successful tests in an estuary to image stratified turbulence, this system was recently mounted on a REMUS-100 AUV for studies of zooplankton and fish ecology. Test deployments off of Stellwagen Bank demonstrated the system is most suitable for measuring strong scattering at short ranges, and that the system was able to perform multi-mode operations of varying depths, spatial patterns, and transducer orientations, complementing data collected simultaneously with ship-board acoustic systems and traditional optical and net systems. (Abstract ID 111667)

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THE RATIONALE FOR A SUSTAINED DEEP OCEAN OBSERVING SYSTEM: OCEAN AND CLIMATE PHYSICS

The deep ocean emerges as a crucial player of ocean and climate variability on longer time scales. The ability to understand and quantify physical processes affecting its variability sets stringent budget and drift constraints on ocean state estimates. They are also crucial to improve climate models, a prerequisite for decadal to century-scale global and regional climate projections. Finally, well-constrained global physical circulation fields are crucial for driving coupled biogeochemical and ecology models, for which the source of uncertainties in the physical state ought to be minimized in any possible way. (Abstract ID 11438)

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PAH BIOACCUMULATION IN MARINE BIOFOULING INVERTEBRATES IN THE NORTHERN GULF OF MEXICO

The northern Gulf of Mexico continental shelf is among the most ecologically productive regions in North America. However, it is also rich in oil deposits resulting in continuous natural seepage of oil components into the ecosystem. The natural release of oil is potentially enhanced by the approximately 6,000 petroleum platforms present in the gulf. The net result is an ecosystem highly exposed to petroleum polyaromatic hydrocarbons (PAHs). Sesel marine invertebrates have routinely been utilized to examine oil exposure and PAH accumulation (e.g. NOAA Mussel Watch program), but few studies have examined the extent of PAH bioaccumulation in biofouling organisms living in such highly exposed regions. This study examined PAH bioaccumulation in two common biofouling invertebrates: the oyster, Ostrea equestris, and the coral, Turbinaria crocea, located on artificial structures throughout the northern Gulf of Mexico. For both organisms, 52 individual PAHs, including alkylated and non-alkylated forms extracted from whole animal samples, were measured by GC/MS and normalized to lipid content. For oysters, PAH bioaccumulation will be subsequently compared to biomarker analysis of PAH exposure and effects in digestive tissue. (Abstract ID 11570)

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CLIMATE CHANGE INFORMATION NEEDS IDENTIFIED BY CALIFORNIA COASTAL MANAGERS

Decision-makers in California's coastal areas generally recognize that climate change will impact their communities and coastline and are at different stages in developing and/or implementing climate change adaptation plans. Many communities understand the need to include the best available science in their planning and decision-making. We conducted a statewide survey, in partnership with 15 California local, regional and state-based organizations, aimed at coastal professionals, to understand the scientific information, data, training, and technical assistance needs as well as barriers coastal communities face in planning for climate change impacts. This survey builds on a survey conducted in 2005 and provides the first-of-its-kind longitudinal analysis of climate change adaptation planning for the state of California. Often there is a disconnect between what information decision-makers need to move forward in adaptation planning, compared to what scientists believe decision-makers need. Effective communication of scientific results requires first understanding the needs of the target audience. The results of the 2011 survey and the comparison with the earlier one give insights into what decision-makers identify as their science needs and the manner in which they can utilize this information, allowing us to find more useful ways of translating the science for these end-users. (Abstract ID 12231)

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VORTICITY BALANCE IN DRAKE PASSAGE

As part of the CDrake experiment, an array of current meter-pressure sensor-inverted echo sounders deployed at 46 km spacing in the Polar Frontal zone in Drake Passage has provided three years of daily near-bottom current, bottom pressure, and round trip vertical acoustic travel time between sea floor and sea surface with spatial resolution sufficient to capture mesoscale eddies. Using empirical relationships determined by historical hydrography, objective maps of travel time data can be converted to vertical profiles of baroclinic currents. Daily geostrophic currents and bottom pressure thus enable us to estimate the terms of the geostrophic momentum and vorticity balances. Relative vorticity advection is an order of magnitude larger than planetary vorticity advection. (Abstract ID 10698)
**OCEAN OBSERVING SYSTEM**

The “Framework for Ocean Observing” is fully described at [http://www.oceanobs09.net](http://www.oceanobs09.net). The Framework is being utilized as a tool to reform and further develop the Global Ocean Observing System (GOOS). It provides a system-level view of best practices for setting requirements, coordinating observation networks, and delivering information products for sustained global ocean observing to address scientific and societal issues. The Framework brings together a suite of ideas to re-energize development of global ocean observing infrastructure. It embraces a key theme of OceanObs’09 to broaden sustained global ocean observing across ocean science disciplines. It suggests appeal to international conventions beyond the United Nations Framework Convention on Climate Change. The concept of communication across the system in terms of “Essential Ocean Variables,” is modeled after the open ocean. Data was extracted from vessel mounted ADCPs during survey cruises in a 10 by 10 degree area covering the North Atlantic Oxygen Minimum Zone (OMZ). Shear spectral levels are a proxy for turbulent diapycnal diffusivity which in turn allowed calculation of diapycnal gas transports. The used 75 kHz ADCPs, after corrections for underway biases, resolve the occurring range of internal wave shear from background levels up to peak levels. To relate finescale shear to turbulent mixing, the existing finescale parameterization was checked against own microstructure observations showing general agreement. Nonetheless, here we suggest a simpler empirical parameterization, more appropriate for ship cruise needs. The analysis of data from below the sharp thermocline down to 500m depth showed horizontal patterns of topographically enhanced internal wave activity, and revealed diapycnal oxygen transport as one key supply for the OMZ. Given internal wave breaking as dominant source of turbulence and given detectable concentration gradients, the method should be adaptable at similar ADCP frequencies to other regions and substances. (Abstract ID 11321)

**UNDERWAY ACOUSTIC SURVEY OF INTERNAL WAVE SHEAR; AND ITS USE TO ESTIMATE DIAPYCNAL MIXING AND TRANSPORTS IN THE INTERIOR OCEAN**

We report on continuous underway acoustic measurements of internal wave shear in the open ocean. Data was extracted from vessel mounted ADCPs during survey cruises in a 10 by 10 degree area covering the North Atlantic Oxygen Minimum Zone (OMZ). Shear spectral levels served as proxy for turbulent diapycnal diffusivity which in turn allowed calculation of diapycnal gas transports. The used 75 kHz ADCPs, after corrections for underway biases, resolve the occurring range of internal wave shear from background levels up to peak levels. To relate finescale shear to turbulent mixing, the existing finescale parameterization was checked against own microstructure observations showing general agreement. Nonetheless, here we suggest a simpler empirical parameterization, more appropriate for ship cruise needs. The analysis of data from below the sharp thermocline down to 500m depth showed horizontal patterns of topographically enhanced internal wave activity, and revealed diapycnal oxygen transport as one key supply for the OMZ. Given internal wave breaking as dominant source of turbulence and given detectable concentration gradients, the method should be adaptable at similar ADCP frequencies to other regions and substances. (Abstract ID 11321)

**MODELING OF DALL’S PORPOISE HABITAT PREFERENCES: USING ACOUSTIC OBSERVATIONS**

This investigation is focused on the nearshore wave field transformations by combining spectral wave simulations, SWAN, and wave field measurements (provided by BSH) for a broad variety of different meteorological and oceanographic conditions. The default SWAN and a modified version of SWAN, Veermany et al. (2010), which uses the variational approach in order to assimilate measured wave spectra and to apply them as boundary conditions, are applied for the North Sea. The outputs of the two models are validated at different depths and the spectra of the models are intercompared, in order to identify and quantify the wave energy dissipation. In this frame, the outputs of SWAN, in littoral zone, are compared with measurements of the velocity of wave crests and of the probability of wave breaking derived from Doppler X-band radar measurements (data provided by HZG), Flammarion (2010). The comparison proves significant correlation between measurements and models, but also their combination permits the determination of the contribution of each wave energy dissipation component (breaking and bottom friction). (Abstract ID 10586)

**MODELLING OF DALL’S PORPOISE HABITAT PREFERENCES: USING ACOUSTIC DETECTIONS TO IMPROVE ECOLOGICAL UNDERSTANDING**

A fundamental step in modeling species ecology is the collection of accurate population size and distribution data. This is especially challenging for less conspicuous or deep-diving cetaceans. Dall’s porpoise, a common, vocally-active cetacean found in cool waters of the North Pacific, is nearly impossible to sight in rough seas due to its small body and group
EXPLORING UNDERWATER FEATURES AT BIRKA, A VIKING HARBOR, USING A MULTIRESOLUTION ACOUSTIC ARRAY

Ocean exploration can involve travel to the ends of the Earth, but there is much to learn in our own back yard. We recently conducted an ultra high resolution multibeam survey using a new EM2040 multibeam survey system in Lake Malaren off the Viking trading port of Birka which was active in the 8th through 10th century. Those connections were cut off as post-glacial rebound caused the ocean to retreat. This World Heritage Site has been studied for over 200 years and is less than 10 km west of Stockholm. Divers have found an offshore palisade of poles, and the multibeam exposed poles are in areas of minimal recent sediment accumulation, and this observation helps to plan a strategy to search for Viking materials in sedimented areas. Our results here are consistent with those from the Hudson River where high resolution multibeam data near our own back yard. We recently conducted an ultra high resolution multibeam using a new

EXPLORING UNDERWATER FEATURES AT BIRKA, A VIKING HARBOR, USING A ULTRA HIGH RESOLUTION MULTIBEAM ECOSOUNDER

Ocean exploration can involve travel to the ends of the Earth, but there is much to learn in our own back yard. We recently conducted an ultra high resolution multibeam survey using a new EM2040 multibeam survey system in Lake Malaren off the Viking trading port of Birka which was active in the 8th through 10th century. At the time Birka was a coastal community and connected to the Baltic, but those connections were cut off as post-glacial rebound caused the ocean to retreat. This World Heritage Site has been studied for over 200 years and is less than 10 km west of Stockholm. Divers have found an offshore palisade of poles, and the multibeam exposed poles are in areas of minimal recent sediment accumulation, and this observation helps to plan a strategy to search for Viking materials in sedimented areas. Our results here are consistent with those from the Hudson River where high resolution multibeam data near an urban center revealed hundreds of shipwrecks. (Abstract ID 12721)

FLORIDA KEYS BIOGEOCHEMICAL CYCLE RESEARCH AND UNDERSTANDING, AND THE ROLE OF MIXED LAYER DYNAMICS

In the first half of 2009, anomalous cooling of sea surface temperatures (SSTs) in the equatorial North Atlantic (ENA; 2N-12N) triggered a strong Atlantic meridional mode event. This study uses in situ and satellite observations to examine the mechanisms responsible for the anomalous cooling in the ENA during boreal winter and spring of 2009. It is found that the cooling was initiated by stronger than normal trade winds during Jan-Feb 2009 associated with an anomalously strong SST gradient. These results emphasize the importance of mixed layer dynamics in the evolution of the meridional mode event of 2009 and the potential for positive coupled feedbacks between wind-induced upwelling and SST in the equatorial North Atlantic. (Abstract ID 9755)

PALEOCEANOGRAPHY AND BIOGEOCHEMICAL CYCLE RESEARCH

Stable isotope analysis is gaining momentum as a tool for investigating the trophic ecology of gelatinous species and to complement existing dietary studies. Strangford Lough (Northern Ireland, UK) is a large, semi-enclosed embayment that is characterised by an elevated diversity of gelatinous zooplankton; as such, it represents an excellent location to examine the functional role of these taxa. Here we report isotopic data from six abundant species of gelatinous zooplankton (ctenophora and cnidaria). To understand the role of these taxa in coastal marine waters, we examine δ13C and δ15N stable isotope ratios and use mixing models to examine (1) intra-guild predation amongst gelata, (2) allometric shifts in diet, and (3) how temporal shifts in community structure alter the combined impact of gelatinous zooplankton on temperate coastal food webs. (Abstract ID 11069)

ESTIMATING THE ISOTOPIC DISTRIBUTION OF DISSOLVED ORGANIC MATTER

Carbon isotopes are one of the most effective tools we have to understand the sources, composition and cycling timescales of dissolved organic matter (DOM) in the ocean. The past decade has seen an evolution of isotope measurements from bulk techniques to analyses targeted at specific fractions and molecular components of DOM. We have expanded this approach by coupling ultraviolet oxidation analysis of whole seawater with inverse numerical techniques to estimate the distribution of carbon isotopes within DOM. The isotopic distributions from a simple depth profile (50, 500, and 2000 meters) at Station ALOHA, off Hawaii, are compared to the standard two-component model of labile and recalcitrant DOM cycling. Our analyses suggest that there are at least four distinct components of DOM occurring throughout the water column, and that the carbon flux through deep ocean DOM could be an order of magnitude larger than current models predict. (Abstract ID 12165)

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A STRONG ATLANTIC MERIDIONAL MODE EVENT IN 2009: THE ROLE OF MIXED LAYER DYNAMICS

In the first half of 2009, anomalous cooling of sea surface temperatures (SSTs) in the equatorial North Atlantic (ENA; 2N-12N) triggered a strong Atlantic meridional mode event. This study uses in situ and satellite observations to examine the mechanisms responsible for the anomalous cooling in the ENA during boreal winter and spring of 2009. It is found that the cooling was initiated by stronger than normal trade winds during Jan-Feb 2009 associated with an anomalously strong SST gradient. These results emphasize the importance of mixed layer dynamics in the evolution of the meridional mode event of 2009 and the potential for positive coupled feedbacks between wind-induced upwelling and SST in the equatorial North Atlantic. (Abstract ID 9755)
As part of a study looking at lateral dispersion processes on the continental shelf, we present analysis of hydrodynamic data from a high density array of velocity, temperature, and salinity and meteorological conditions over the middle and outer continental shelf and how the larger scale dynamics drive local scale motions and stratification. We speculate that the regional shelf scale meteorology and hydrodynamics are inherently linked to the local scale variability and lateral dispersion observed on the inner shelf. (Abstract ID 11536)

Although Euterina acutifrons is identified as a monotypic species, the existence of species complex has been suspected because of its wide distribution and the geographical variations of male dimorphism. While the karyological study is one of the approaches to reveal the existence of species complex in copepods, it is difficult to perform an accurate karyotyping under light microscopy observation because of small size of copepod chromosomes. In order to observe the copepod chromosomes in higher resolution, we investigated the application of rotary shadowing process for SEM observation. Copepod chromosome for SEM observation. Relative length, arm ratio, and centromic index were determined on 2n = 20 chromosomes for the four regional populations. The karyotype formula of E. acutifrons showed chromosomal polymorphism among different populations, implying E. acutifrons species complex may exist. (Abstract ID 10856)

Quantifying the net flux of organic carbon and dissolved nutrients from the terrestrial to the coastal environment via a tidally varying estuary presents particular problems when using wet chemical analyses and conventional hydrological discharge estimates. We used a side looking velocimeter attached to a pylon, in conjunction with a range of high frequency bio-optical instruments to infer the fluxes of dissolved organic and nitrate from the periurban Logan estuary in Queensland, Australia. We discuss how the estimated fluxes vary, the size of the relative errors and their dependence on the number of observations, and the changes in estimated flux due to variations in the freshwater discharge. The estuarine output fluxes are compared to upstream inputs from known point sources. In addition, we made short term deployments of the same suite of bio-optical instruments, an ADP velocimeter, and a continuous PC02 device at several other sites within the estuary. At several sites the strong coupling between water column PC02 and the water velocity is attributed to intermittent resuspension of a heterotrophic sediment layer. (Abstract ID 10761)

The shelf-slope system in the southeastern Beaufort Sea is characterized by extreme physical and biochemical gradients and represents an ideal region to investigate ecosystem processes in the rapidly changing Arctic Ocean. Here, we explore the dynamics of vertical POC/PON fluxes across this region using a high-resolution dataset collected during the Malina campaign in late summer 2009. Vertical fluxes were derived from the size-distribution of large aggregates (0.1-4 mm) as recorded at 154 occasions with an Underwater Vision Profiler and following a calibration against sediment trap data. Spatial interpolation of vertical flux profiles across the 3D shelf-basin environment revealed a patchy distribution associated primarily with: 1) a widespread subsurface chlorophyll maximum, 2) the resuspension and transport of shelf sediment, 3) the turbid Mackenzie River plume. Statistical analyses between the magnitude of POC/PON fluxes and ancillary environmental conditions (sea ice, runoff, hydrography, depth), biological factors (phytoplankton dynamics, bacterial production, zooplankton biomass) and qualitative parameters (lipid tracers, stable isotopes) were conducted to better understand the complex interplay of variables that governs the vertical export of POC and PON across the Beaufort shelf-basin system. (Abstract ID 11613)

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understanding of mixing parameters remains very weak. In the quasi-absence of direct observations, most estimates rely on high resolution model diagnostics and indirect inferences of mixing from observations. Here we use the MITgcm/ECCO state estimation technology to make inverse estimates of ocean mixing. Three types of mixing coefficients (vertical, isopycnal and eddy) were therefore added to the list of adjustable parameters in ECCO. Along with forcing and initial condition adjustments, the adjusted mixing proves very efficient in improving the state estimate and the fit to observations. In this presentation, we first demonstrate this result, and discuss the relative importance of the different mixing parameters in our experiments. We then assess the inverted mixing maps and put them in the perspective of previous estimates and theoretical work. (Abstract ID 12476)

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OBIS-USA: A NATION BIOLOGICAL DATA RESOURCE FOR ANALYSIS AND MODELING

The Ocean Biogeographic Information System – USA (OBIS-USA) is a national marine biogeographic data asset that contains biological occurrence data that are taxonomically spatially and temporally resolved. Linked to the Intergovernmental Oceanographic Data and Information Exchange, international OBIS, (iOBIS), it is a model for Federal data systems to manage data throughout its life-cycle. The database contains over 7 million records including more than 84,000 species from US marine waters. The data conform to an international data schema (Darwin Core) that renders them interoperable both internally and with other resources. Each individual dataset within OBIS-USA is documented using the FGDC (Federal Geographic Data Committee) metadata content standard, and essential aspects of ISO and CF (Climate & Forecast) metadata conventions are also addressed. This presentation briefly summarizes the OBIS-USA data process; describes OBIS-USA goals for data quality; suitability for use, richness of detail and extensibility; and describes OBIS-USA strategies and technologies for data analysis and integration with in situ data and applications such as modeling and forecasting. (Abstract ID 12394)

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INTERNAL WAVE ENERGY AND TURBULENT BREAKDOWN OF LEE WAVES GENERATED OFFSHORE COSTA RICA THROUGH SEISMIC OCEANOGRAPHY

The acoustic imaging and data analysis techniques currently employed in seismic oceanography are rapidly becoming more complex; beyond first-order observation of oceanic structures it is possible to extract quantifiable information about internal wave energies and turbulent dissipation rates. We use two consecutive acquisition surveys at the same location, varying in shot spacing and time, to image a standing lee wave pattern created by flow over rough isopycnal displacements. Through a horizontal wavenumber analysis of tracked continuous reflections in the seismic image we estimate internal wave energy and its associated turbulent dissipation rates across the seismic image. We find increased internal wave energy and associated non-local turbulent dissipation around the lee wave as compared with background ocean levels at two points in the tidal cycle. (Abstract ID 12527)

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NANOSMIS IMAGING OF N. C. AND P. ASSIMILATION IN FIELD POPULATIONS OF DIATOM-RICHELIA SYMBIOSES AND TRICHODESMIUM SSP FROM THE WTN

During two separate field expeditions to the western tropical North Atlantic (WTNA), the heterocystous cyanobiont, Richelia intracellularis were observed in association with diatoms Hemiaulus and Rhizosolenia. High cell densities (10^6-10^8) estimated by qPCR were observed during the summer 2010 cruise, and were regularly observed at intermediate to higher salinities (>32-35 PSU). During fall 2011, Hemiaulus-Richelia symbioses co-occurred with the filamentous non-heterocystous cyanobacteria Trichodesmium spp. at modest cell densities (100-300 cells L^-1). NanoSIMS imaging of individual Hemiaulus-Richelia symbioses show high N-enrichment (atm% 0.4413-1.492) than measured on the bulk particles (atm% 0.3708-0.4368) during summer 2010, suggesting an underestimation of N2 fixation by a bulk approach. The C-enrichment, however, showed an opposite trend. Surface cell concentrates containing Hemiaulus-Richelia and Trichodesmium show similar 33P uptake (43-45 nM h^-1) compared to bulk measures (50-60 nM h^-1). NanoSIMS imaging and cell specific 15N, 13C, and 33P assimilation in individual diatom symbioses and Trichodesmium will be compared to the bulk analysis. (Abstract ID 10882)

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USING SURFACE PRESSURE DATA TO IMPROVE TROPICAL CYCLONE SAR WIND RETRIEVALS

We seek optimal surface wind vector fields and sea-level pressure (SLP) patterns derived from SAR images of the sea-surface underneath tropical cyclones. Geophysical model functions that link the surface wind vector and the SAR radar backscatter are currently poorly characterized in the very high wind conditions that are present in TCs. In situ calibration and validation wind data are rare in much of the world’s oceans and often (GPS-drop sondes and airborne stepped-frequency microwave radiometers aside) suspect. However, surface pressure observations are less susceptible to measurement errors in the harsh TC environment. We use North Atlantic and images acquired during the CNR-sponsored ITOP experiment in the West Pacific (2010) and drop sonde data to demonstrate the technique. We show that re-derived surface wind field from the SLP pattern are a significant improvement on the directly retrieved input wind vector fields. This is because the SLP is a scene-wide integration of the wind field that optimally spreads the inherent error across the whole scene; the lowest-quality wind vectors tend to be modified more than the highest quality wind vectors. (Abstract ID 12495)

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LEARNING FROM SCIENTISTS AT SEA: THE GREAT BELT RESEARCH CRUISE AS AN INTERDISCIPLINARY TEACHING TOOL

In early 2011, scientists from seven institutions spent five weeks in the South Atlantic examining phytoplankton in the Great Southern Cocolithophore Belt, an 88 million km² region in the Southern Ocean with high concentrations of cocolithophores. I joined the NSF-funded “Great Belt” research cruise as an Educator at Sea to connect students and the public with the cruise, focusing on engaging inland and underrepresented minority students. Goals of the project were to increase ocean literacy through exposure to oceanographic fieldwork and provide opportunities for scientists to share their research with new audiences. More than 550 students participated in activities during the expedition, learning about the overall goals of the research, sample collection methods, data processing, hypothesis testing, ecosystems, ocean science careers, life at sea, and engaging in hands-on investigations in their classrooms. Cruise data, daily updates, photos and interviews were shared through a website, blog, photos and direct interactions through email and Skype. This presentation describes the project activities and accomplishments, including ways to evaluate and improve ship-to-school projects in the future. (Abstract ID 10591)
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BIOMAGNIFICATION OF MERCURY AND ARSENIC IN THE EASTERN CHUKCHI SEA

Concentrations of Hg, As and stable nitrogen isotopes were determined for eight lower trophic level organisms from the eastern Chukchi Sea (mixed zooplankton, Ampeclocula macrochropha, Astarte borealis, Baccinum sp., Neptuna hros, Chionocytes opilio, Boreogadus saida and PleisicusKeysry). Such information is needed to determine the present-day status for species that may show increased bioaccumulation and biomagnification in a changing climate. Average concentrations of total Hg (THg) increased with trophic level from 7.8 ng/g (dry weight) in zooplankton to 456 ng/g in P. Keysry. As much as 20-fold ranges in THg values were obtained for a given species due to various environmental parameters. Despite this variation, the percent monomethylmercury increased by a relative standard error of <1% for each species. Biomagnification of THg was found to follow the equation log[THg] = 0.19[(δ15N] - 6.63 (r²=0.80, p<0.05). Like Hg, As concentrations varied within and among species with a range for all species of 1.6-154 µg/g (dry weight). Biomagnification of As also was observed with a biomagnification power of 0.26 following the equation log[As] = 0.26[(δ15N] - 2.07 (r²=0.82, p<0.05). (Abstract ID 11878)

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AN OVERVIEW OF THE NOAA INTEGRATED APPROACH TO OCEAN AND COASTAL MAPPING

This paper provides an overview of the NOAA Integrated Mapping Program (IOCM) and presents examples of how interagency and internal Ocean and Coastal Mapping (OCM) efforts are working to address the complex and pressing issues identified in the 2010 National Ocean Policy (NOP) and recent legislation, the Ocean and Coastal Mapping Integration Act of 2009. The Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) continues to address accessibility to and discovery of OCM data, and has recently developed a prototype OCM Inventory, which is discussed in the draft NOP Strategic Action Plan. We will discuss how NOAA is streamlining operations, minimizing redundancies, improving efficiencies, and developing common data standards. The emerging NOAA Rolling Deck to Repository (NOAA R2R) effort, based on the UNOLS R2R, illustrates how OCM data and products are managed and made publicly available to users. (Abstract ID 12209)

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BIOGEOGRAPHY AND THE MANAGEMENT OF LARGESCALE ECOSYSTEMS (LMEs)

Large Marine Ecosystems (LMEs), the opportunity for a network of LMEs spanning space, time and stakeholder scales is becoming a reality. These networks define specific components of interest to support the implementation of NOAA's Driver-Pressure-State-Impact Response framework (DPSIR) decision framework and the cyberinfrastructure technologies to ensure data interoperability and reuse. Until now, what was lacking was a process to bring together existing knowledge networks to identify, review, and synthesize the best assessment and management practices among the community of LME practitioners facilitating exchange of lessons learned. The scope of the network includes key stakeholders in four areas: scientists and data providers, agencies, national communities of practice, and decision makers/policy developers. Key to developing network activities is semantic rich use case development using expertise in semantic web methodologies, especially related to diverse vocabulary needs across the stakeholder areas. (Abstract ID 12402)

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PARAMETERIZATION OF SUBMESOSCALE AND LANGMUIR-SCALE PROCESSES AND INTERACTIONS

Recent work has shown that small-scale processes, even on the scale of 1m to 10km, have significant systematic impact on the climate. Restratiﬁcation by submesoscale mixed layer eddies has been parameterized in many of the models for the upcoming IPCC ﬁfth assessment. Additional mixing due to surface waves driving boundary layer turbulence (Langmuir turbulence) has also been tested. The impacts of parameterizing these submesoscale and Langmuir-scale phenomena in climate models will be quantified. Remaining issues, especially parameterization of the coupling between Langmuir-scale and submesoscale processes in Large Eddy Simulations of the boundary layer and the implications for parameterization, will be discussed. (Abstract ID 10618)

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DIVERSITY AND COMMUNITY STRUCTURE OF CORAL-ASSOCIATED BACTERIA AND ARCHAEA: INTERSPECIFIC, VERTICAL AND SPATIAL VARIATION

Bacterial and archaeal communities associated with the surface mucus layer of three Caribbean reef-building corals (Montastraea annularis, Porites astreoides and Siderastrea siderea) were investigated from two depths (5 and 15m) and at varying spatial scales off Curaçao. Three colonies were sampled per species from three different reef patches at three distinct reef locations (n=162). Water column and sediment samples were taken as reference sites. Prokaryotic community structure was determined using terminal restriction fragment length polymorphism (T-RFLP) and automated ribosomal intergenic spacer analysis (ARISA). T-RFLP and ARISA profiles were correlated to, respectively, 165 and 166-IT5 rRNA clone libraries to identify microbial taxa involved in community shifts. Our findings suggest that mucus-associated prokaryotic communities vary substantially with host species and depth, but also at a small spatial scale between neighboring reef patches. Understanding the distribution of bacterial and archaeal communities thriving on coral mucus is part of a broader effort to link the dynamics in the chemical composition of the mucus layer, its secretion and release to related changes in the structure, abundance and function of its associated microbial communities. (Abstract ID 11032)

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CORAL GROWTH ANOMALIES AT WAIOPAE, HAWAII

Coral health throughout the world is declining due to stressors like coral diseases, one of which is called coral growth anomaly (GA). GAs affect the physiology of coral, causing a reduction in coral growth, and are generally associated with heavy metal and pathogenic bacterial and archaeal communities. GAs are thought to be driven by environmental factors such as changes in water temperature, pH, salinity, and nutrient levels. To better understand the causes of GAs, it is important to study the factors that control their occurrence and severity. In this study, we investigated the factors that control GAs in a coral reef located in the Waiopae, Hawaii, USA. We monitored the occurrence of GAs over a period of two years and analyzed the environmental factors that contributed to their occurrence. The results showed that the occurrence of GAs is influenced by changes in water temperature, pH, and nutrient levels. These results suggest that changes in environmental factors can lead to the occurrence of GAs, and that efforts to mitigate these factors could help reduce the occurrence of GAs in coral reefs. (Abstract ID 10790)

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HIGH-RESOLUTION OBSERVATIONS OF WINTERTIME DEEP CONVECTION IN THE LABRADOR SEA

Seagliders are used to make high resolution observations during wintertime deep convection in the Labrador Sea. Using novel methodology to derive vertical velocities from the glider CTD measurements, we test theoretical scalings for vertical velocities in narrow convecting plumes vs. the wind-driven mixed layers. While convecting plumes had vertically well-mixed and active mixing temperatures, salinities and densities, the horizontal density variations between sectors.
plumes exceeded 0.02 kg m⁻². This locally available buoyancy has important ramifications for restratification processes after deep convection. (Abstract ID 12175)

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NEW OOI PLATFORMS FOR LONG-TERM SAMPLING OF THE ENTIRE WATER COLUMN IN ROUGH SEAS NEAR THE COAST

This year the Ocean Observatories Initiative (OOI) tested platforms for consideration at its 25m depth Oregon and Washington long-term observation sites. These sites are particularly challenging for moorings and cabled profilers that sample up to the air-water interface because wave heights at them annually exceed 1.5m mean depth. To reduce mooring line tension, OOI will deploy surface buoys that submerge under crests of large waves and which attach to anchors with elastic stretch hoses. A test mooring was successfully deployed for five months at OOI Inshore Oregon site with improvements based on prior testing. This platform, developed for OOI at the Woods Hole Oceanographic Institution, can support a large sensor suite at the top and bottom of the water column, but not along the stretch hose. Coastal surface piercing profilers (CSPPs) will fill this gap. This summer, CSPP technology was assessed with two concurrent month-long field demonstrations near OOI Inshore and Shelf Oregon sites. Results of the mooring's and profilers' mechanical performance are shown along with an illustration from these data of the scientific value these paired platforms will provide. (Abstract ID 12806)

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GROWTH AND GRAZING MORTALITY OF NANO- AND PICOPLEANKTON IN THE SARGASSO SEA

The microbial loop mediates the transfer of carbon from primary producers to higher trophic levels in the ocean and thereby influences the potential of the system to export carbon. We investigated the growth of and grazing on different groups of phytoplankton, with special attention to Synechococcus, Prochlorococcus and pico-and nano eukaryotes in the Sargasso Sea utilizing the dilution method. The experiments were carried out at or near BATS (Bermuda Atlantic Time-series Station) during February and July 2011 in several depths in the euphotic zone. We analyzed the plankton community change during the incubations by measuring chlorophyll a and changes in cell abundance by flow cytometry (FCM) and epifluorescence microscopy. Some experiments were nutrient amended and we observed significant enhancement of growth and sometimes of grazing rates in the upper mixed layer. Growth and grazing on Synechococcus was enhanced positively by nutrient amendment, indicating their potential in responding to short term nutrient injections. We will be reporting group specific production and grazing and will discuss their seasonal variability in the context of the production regime of the Sargasso Sea. (Abstract ID 12227)

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A CONSERVATION-BASED GROUP RESEARCH PROJECT IN A REQUIRED UNDERGRADUATE LABORATORY COURSE

While learning standard research techniques, undergraduates in a marine biology laboratory class at Hawai'i Pacific University collect “citizen science” data in group research projects. In 2010, students collected data on coral and seaweed percent cover and diversity in the Waikiki Marine Life Conservation District (MLCD). This data, together with similar data collected by undergraduate interns, will be used to validate a community-based volunteer monitoring project in the Waikiki MLCD and help with resource management in the area. Although all science laboratory classes constitute active learning, this project was a good way to train students on how to conduct rapid ecological assessments using a quantitative photo quadrant survey method while simultaneously providing conservation-based applications for the data. The group project involved both field and computer-based image analysis components. (Abstract ID 12617)

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IN-SITU MEASUREMENTS WITHIN MOBILE BED LAYERS WITH “ELECTRONIC PEBBLES”

In-situ measurements of the mobile bed layer are now possible with new state-of-the-art micro-electronic machines (MEMEs). These electronic pebbles (ePebbles) are 2.8x1.5x1.4 cm and are equipped with 2 tri-axial accelerometers, battery, and wireless transmitter. The plastic enclosure is comparable in size to coarse gravel. The size and density was chosen based on mobility criteria for small-scale flumes. We are testing the ePebbles in a laboratory wave facility to explore the incipient motion of a sediment bed and relate it to the combination of shear stress and pressure gradients that act on exposed particles. We hope experiments with these devices will provide significant insight into incipient motion and sediment transport under free-stream and oscillatory flow fields in the nearshore environment. (Abstract ID 12756)

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TOWARD ESTIMATING THE PAN-ARCTIC DIVERSITY OF EUKARYOTIC MICROBIAL PLANKTON

Microbial plankton play a pivotal role in the polar ecosystems, characterized by the complex mixing of Pacific and Atlantic waters into the Arctic Ocean. However, their taxonomic diversity has been relatively unstudied. This study will provide metagenomic description of eukaryotic microbial diversity in the Barents, Beaufort and Beaufort Seas, which all are undergoing changes in sea ice cover. Samples were collected from contrasting depths, hydrographic regions and seasons. In the Barents Sea, collections were made in May 2010 and June 2011 in open Atlantic-influenced waters, ice-covered Arctic waters and at the Polar Front. In the eastern Beiring Sea, samples were collected in March 2010 from the shelf during a diatom bloom. In the Beaufort Sea, samples were obtained in July-August 2011 from ice-covered Beaufort Gyre waters from several depths down to 3,500 m. Short (ca. 350bp) segments of the 18S ribosomal DNA gene were amplified for 454 sequencing, which yielded from 3,000 to 10,000 sequences from each of the ten community samples. Initial analyses revealed common generic elements among all water masses but with strikingly different relative abundance profiles. (Abstract ID 11686)

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HORIZONTAL AND VERTICAL PROCESSES CONTRIBUTING TO NATURAL IRON SUPPLY IN THE MIXED LAYER IN THE ONA BASIN IN SOUTHERN DRAKE PASSAGE, ANTARCTICA

Natural iron fertilization in the Ona Basin is driven by a variety of physical processes, including lateral advection, vertical mixing, and mixed-layer entrainment. Comparison of sea surface height and Chl-a concentrations for the years 1997-2010 shows >95% correlation between Chl-a levels and lateral advection of iron-rich waters during November and December. However, no significant correlations are found from January through April, even though high Chl-a levels persist through March. Comparison of Chl-a and zonal wind stress shows a similar correlation pattern, suggesting that lateral transport alone cannot support the bloom after December. Vertical mixing and mixed-layer entrainment are considered as additional mechanisms for delivering iron into the Ona Basin mixed layer to sustain the bloom. Estimates of iron flux based on cruise data from summer of 2004 and winter of 2006 suggest that mixing can supply iron to the base of the mixed layer at a rate of 96 ± 9 nmol m⁻² day⁻¹ in the winter and 64 ± 2 nmol m⁻² day⁻¹ in the summer. In addition, the summer mixed layer in Ona Basin deepens from January into April, allowing for additional iron entrainment. Numerical simulation indicates that mixing and entrainment combined can supply 176 ± 44 nmol m⁻² day⁻¹ into the top 30 m from January to April, which is believed sufficient to sustain the bloom that throughout the summer. (Abstract ID 10026)

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DYNAMICS AND STOICHIOMETRY OF NUTRIENTS AND PHYTOPLANKTON IN WATERS INFLUENCED BY THE OXYGEN MINIMUM ZONE IN THE TROPICAL SOUTH EAST PACIFIC

The tropical South East Pacific is characterized by strong coastal upwelling on the narrow continental shelf and an intense oxygen minimum zone (OMZ) in the intermediate water layer. These hydrographic properties are responsible for a permanent supply of water rich in nutrients and with a remarkably low inorganic N:P stoichiometry to the surface above the shelf. We investigated the impact of OMZ-influenced upwelling waters on phytoplankton growth, elemental and taxonomical composition, by collecting data for hydrographic and biogeochemical parameters along an east-west transect at 10°S off Peru, stretching from the...
upwelling region above the continental shelf to the well-stratified oceanic section of the eastern boundary regime. New production in the area of coastal upwelling was driven by large-sized phytoplankton with a generally low N:P ratio (16:1). A deep chlorophyll maximum consisting of nano- and microphytoplankton occurred in the shelf-open ocean transition zone above the shelf break and featured intermediate N:P ratios close to Redfield proportions. High PON/P (20:1) was observed in the stratified open ocean, coinciding with the abundance of the pico-cyanobacterium Prochlorococcus. Excess phosphate (P\textsuperscript{ex}) present along the entire transect did not stimulate growth of nitrogen-fixing phytoplankton. Instead, a large fraction of P\textsuperscript{ex} generated within the OMZ was consumed by non-Redfield production of large phytoplankton in shelf surface waters. (Abstract ID 9688)

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MICROZOOPLANKTON GROWTH AND HERBIVORY PATTERNS ACROSS A TEMPERATURE GRADIENT IN THE BARENTS SEA

Microzooplankton play a pivotal role in the ocean, but their response to climate change in the Arctic remains to be understood. A set of shipboard experiments was conducted in the Barents Sea between 70°N and 79°N in 2010-2011 to examine the hypothesis that microzooplankton growth and grazing rates will be enhanced in warmer open waters as opposed to cold ice-covered waters. The maximum growth rates of 27 predominant morphospecies ranged between 0.27 and 1.83 d\textsuperscript{-1} and were weakly related to sea temperature. In the polar waters east of Svalbard (-1.8 to 0.0°C) ciliates grew faster (up to 200%) than predicted by several published equations relating their intrinsic rates to the cell volume and temperature, whereas in the Atlantic waters off the north coast of Norway (5.0 to 8.6°C) their growth rates were close to predicted. Microzooplankton community herbivory rates increased with temperature (p<0.05), but their maximum impact on primary production (over 100% removed daily) was observed within the Polar Front (1.0 to 4.0°C). The potential confounding effects of phytoplankton prey composition and internal predation within microzooplankton communities will be considered. (Abstract ID 12843)

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DIRECT OBSERVATION OF SUBTROPICAL MODE WATER CIRCULATION IN THE WESTERN NORTH ATLANTIC OCEAN

Eighteen Degree Water (EDW) is the dominant mode water of the North Atlantic subtropical gyre and an interannual reservoir of anomalous heat, nutrients and CO\textsubscript{2}. Although isolated beneath the stratified upper-ocean at the end of each winter, EDW may reemerge in subsequent years to influence mixed layer properties and consequently air-sea interaction and primary productivity. We report on recent and unique direct measurements of EDW circulation and stratification in the western subtropical gyre using an array of 40 acoustically-tracked, isotherm-following, bobbing profiling floats. These subsurface drifters, programmed to track and intensively sample the vertically-homogenized EDW layer, reveal convoluted circulation pathways and coherent features unresolved by previous studies. (Abstract ID 9954)

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EFFECTS OF THE APRIL 2010 DEEPWATER HORIZON CRUDE OIL SPILL ON OFFSHORE SEAWEED DIVERSITY IN THE NW GULF OF MEXICO

Results from three post-spill dredging expeditions aboard the R/V Pelican indicate that seaweed diversity in all dredged sites offshore LA, MS and AL was severely depressed relative to pre-spill sampling. Whereas Ewing Bank (~28°51’70”N, 91°01’289”W) was one of the northern Gulf’s most algal diversity-rich sites pre-spill, only a limited number of benthic species - characterized by surface cell layers that can slough off or are embedded in a gelatinous matrix- were dredged at this site in Dec. 2010. Species diversity at Ewing Bank had increased to 20 during April 2011, but subsequently had significantly declined during August 2011. Rare or partly algal-derended unconsolidated rubble retrieved from the 2011 cruises have been maintained in salt-water tanks in our lab, and the subsequent rate and diversity of algal colonization on these rocks documented. In addition to our ongoing biodiversity research, in the future we plan to characterize the transcriptome of carefully selected taxa in order to assess how offshore seaweeds respond to and recover from hydrocarbon insult. Funding by NSF (RAPID grant) and GSI RFP-III to Frederico (seaweeds) and Felder (macrocrustaceans). (Abstract ID 10034)

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FUTURE OCEAN MEASUREMENTS FROM SPACE

Seasat, launched by the U.S. National Aeronautics and Space Administration (NASA) in 1977, was the first dedicated ocean-viewing satellite. Since then NASA, the European Space Agency, France’s Centre National d’Etudes Spatiales, the Indian Space Research Organization, the Japan Aerospace Exploration Agency, and the China National Space Administration have all launched ocean-viewing sensors or dedicated ocean viewing satellites. Properties currently measured from space are sea surface temperature, topography (height), salinity; significant wave height and wave spectra; surface wind speed and vectors; ocean color; continental and sea ice flow, deformation, thickness; ocean mass; and to a lesser extent, surface currents. By 2025 one additional measurement will likely become available – total surface currents – but the largest foreseen improvements are increased spatial and temporal resolution and increased accuracy for all the currently measured properties. This study is based on Freeman et al., Ocean Measurements from Space in 2025, Oceanography, 23 (4), 144-161, 2010, with some updates. (Abstract ID 9723)

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GLIDER OBSERVATIONS OF BIO-OPTICAL PROPERTIES IN THE COASTAL WATERS OF THE SANTA BARBARA CHANNEL, CALIFORNIA

Characterizing and understanding the vertical, temporal and spatial variability of coastal water processes at small regional and short time scales requires frequent sampling and integration of multiple data sources to support observations. Here we present repeated glider observations of relevant oceanographic properties, including temperature and salinity, chlorophyll fluorescence, optical backscattering and dissolved oxygen, across 2 target areas of the Santa Barbara Channel: along the Santa Barbara shoreline (a saw-tooth deployment of ~7 days each, 1-3km offshore, 0-50m deep), ideal to observe the scales of diurnal variability and the effect of episodic processes such as buoyant plumes, as well as a 4-km cross-shelf mission. We compared individual transects to satellite imagery for the period. The dense sampling allowed inferences about the scales of variations in net primary productivity, as well as indicated the potential of using glider data to understand phytoplankton response to quick variations in environmental conditions. (Abstract ID 10630)

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EVALUATING THE FATE AND EFFECTS OF THE DEEPWATER HORIZON OIL SPILL ON WATER COLUMN BIOTA

The Deepwater Horizon oil spill in the northeastern Gulf of Mexico was not only the largest oil spill in US history, but unprecedented amounts of dispersants were applied both at the subsurface release-point and in surface waters to entrain the oil into the water column with the intention of reducing impacts to wildlife and shorelines. The enhanced entrainment and reduction in dispersed oil droplet sizes caused by dispersant use would be expected to increase water column biota impacts. Thus, evaluation of impacts to water column biota is of particular interest for this spill and in consideration of the risks associated with future deepwater blowouts. Oil fate and effects modeling is being used to quantify water column impacts in support of claims for natural resource injuries being developed by natural resource trustees. The on-going modeling analysis involves considerations of current data and/or hydrodynamic modeling at a range of scales; oil fate modeling, exposure and toxicity analysis, fish and invertebrate distributions, and population modeling to determine long-term effects. The approach and supporting data collections being developed for this analysis will be presented. (Abstract ID 12869)

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ON THE IMPACT OF EDDIES ON THE SOUTHERN OCEAN CHLOROPHYLL DISTRIBUTION

The Southern Ocean is a region of intense eddy activity, yet the long-term mean influence of eddies on biological productivity and biogeochemistry is poorly known. To study this influence, we identified and tracked over 100,000 eddies including their associated chlorophyll-a (CHL) based on satellite observations of sea level anomalies and CHL from 1997 to 2010 south of 35°S. This gave us an excellent mean statistics despite missing values in CHL of 45%. We find that eddies account for 25% of the total CHL on average, highlighting their potential role in the climatological distribution of CHL in the Southern Ocean. Secondly, our analysis reveals a significant mean negative CHL anomaly of about -4% for anticyclones versus a mean positive anomaly of 2% for cyclones compared to the climatological CHL, however with some spatial variability: cyclones as well as anticyclones contain anomalies of opposite sign in the core of the Antarctic Circumpolar Current (ACC) compared to both, north or south of it. The net effect of these anomalies for instance in the ACC is a CHL increase of about 2%. (Abstract ID 10975)

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A CLIMATIC PULSE IN THE HEART OF THE OXYGEN MINIMUM ZONE

Oxygen (O2) is a critical constraint on marine ecosystems. As oceanic O2 falls to hypoxic concentrations, habitability for aerobic organisms decreases rapidly. We show that the spatial extent of hypoxia is highly sensitive to small changes in the ocean's O2 content, with maximum responses at suboxic concentrations where anaerobic metabolisms predominate. In model-based reconstructions of historical oxygen changes, the world's largest suboxic zone, in the Pacific Ocean, varies in size by a factor of two. This is attributable to climate-driven changes in the depth of the tropical and subtropical thermocline which have multiplicative effects on respiration rates in low-O2 water. The same mechanism yields even larger fluctuations in the rate of nitrogen removal by denitrification, creating a link between decadal climate oscillations and the nutrient limitation of marine photosynthesis. (Abstract ID 10267)

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LIGHT TRANSMISSION THROUGH OCEAN WATERS BENEATH MELT-SEASON SEA ICE IN THE CHUKCHI AND BEAUFORT SEAS

The Chukchi and Beaufort Seas have experienced significant declines in sea ice over recent decades, including reductions in thickness as well as seasonal duration of sea ice cover. These changes in sea ice have important cascading impacts on the physical, biological, and biogeochemical state of the overall marine environment throughout the region. Here, we present observations of light transmission through the top 30–50 meters of ocean waters beneath both ponded and upwelled sea ice surfaces, collected at nineteen sites in the Chukchi and Beaufort Seas during the NASA ICESCAPE missions in June-July of 2010 and 2011. The transmission of light to the upper ocean was found to be spatially heterogeneous and dependent on wavelength, ice thickness, and the areal and vertical distribution of bare ice and melt ponded surfaces. In particular, light transmission through ponded ice was up to four-fold greater than through upwelled ice, although these differences dissipate and become negligible with depth. The complex under-ice radiation fields are additionally presented in the context of a suite of biogeochemical properties of both the ice and under-ice water column. (Abstract ID 12741)

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ASSESSMENT OF A REDUCED RANK SMOOTHER IMPLEMENTATION WITH A 1/4 DEGREE OCEAN MODEL

Retrospective data assimilation methods such as 4Dvar or smoothers designed after Kalman’s DEGREE OCEAN MODEL suggest the upper 10-15 cm of each core may record a single depositional event, possibly along the axis of the bedform field. Distinct physical structures and radioisotopic signatures excess of 100 m, and are likely the product of density currents associated with large floods of the Stehekin River, or slope failures on the delta front. Radioisotope, x-ray, and grain-size analysis of NEMO (Nucleus for European Modelling of the Ocean), highlighting its attractive additional computation complexity when it is implemented with an already-existing Kalman filter. The smoother is then assessed through twin data assimilation experiments involving realistic observation types and density. It is shown that the smoother further reduces the errors that remain in the state estimates after the filter pass. Moreover, the smoother estimates can be advantageously used to obtain observation-constrained model’s trajectories over limited time intervals, as 4Dvar does. Other benefits, but also caveats, will be presented. (Abstract ID 12021)

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BEHAVIORAL ECOLOGY OF GOLIATH GROUPER SPAWNING AGGREGATIONS

The goliath grouper, Epinephelus itajara, is the largest group fish in the Atlantic ocean. E. itajara is extremely vulnerable to overfishing due to slow growth, long life, late sexual maturity, strong site fidelity and formation of spawning aggregations. Juveniles (< 1.20 m total length) inhabit fringing red mangrove (Rhizophora mangle) shorelines and adults inhabit coral reefs, reef- rock ledges and artificial structures. Field-based research on spawning aggregations has been limited to incidental observations of E. itajara courtship behavior. Here, I used SCUBA-based fieldwork to investigate the behavioral ecology of E. itajara spawning aggregations off east Florida, during two spawning seasons. The spawning sites contained year-round residents (2-10 fish) and breeding season transients (up to 50 fish). Peak aggregation activity was limited to September and October. The shape of the aggregation significantly changed depending on oceanographic conditions and lunar cycle. It is unclear how timing of arrival, aggregation persistence and aggregation response to environmental conditions affect reproductive output, but these results strongly suggest that the spawning aggregation is not a structure as rigid as previously thought. (Abstract ID 12654)

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INTERNAL WAVE GENERATION AND VARIABILITY OVER ROUGH TOPOGRAPHY

Rough topography can promote mixing within the water column, and the intensity of the mixing varies with background flow. To quantify this mixing, an intense study was conducted at East Flower Garden Bank, part of the National Marine Sanctuary system. In addition to long-term instrumentation including acoustic Doppler current profiles (ADCPs) and temperature and salinity (TS) strings, short-term moorings were deployed for approximately ten days during the summer of 2011. These included 5 upward-looking ADCPs and one downward-looking ADCP each with a one-minute sampling frequency over and around the bank, and two TS string moorings that sampled every minute both over the bank and to the east of it. The string moorings had vertical spacing of approximately 10 meters. Additionally, either high-frequency pressure instrumentation or a wave-tide gauge was collocated with each ADCP. This suite of high-frequency measurements has allowed characterization of high-frequency internal waves over and around the bank, including spatial variability and changes relating to background flow conditions. High-frequency wave amplitudes were elevated northeast of the bank during the mixing experiment. (Abstract ID 9977)

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LINKING DAETETIC AND DEEP-WATER SEDIMENTATION IN LAKE CHELAN, WA

The connection between deltaic and deep-water sedimentation is examined in Lake Chelan, WA, where external forces (e.g. tides, waves) have a negligible effect on sediment dynamics. Characterizing the linkage between these two environments provides an important boundary condition for understanding and modeling both nearshore and deep-water depositional systems. A detailed bathymetric and sub-bottom survey of the delta top, foreset, and adjacent deep-water setting reveals a largely muddy foreset biected by a tongue of large-scale (h = 2-10 m, λ = 20 m) bedforms. These sandy bedforms extend roughly 1 km down lake into water depths of excess 100 m, and are likely the product of density currents associated with large floods of the Stehekin River, or slope failures on the delta front. Radiocarbon, x-ray, and grain-size analysis of six gravity cores flanking the bedforms indicate that sedimentation is episodic and focused along the axis of the bedform field. Distinct physical structures and radiocarbon signatures suggest the upper 10–15 cm of each core may record a single depositional event, possibly the 100-year flood of the Stehekin River in 2006. (Abstract ID 10661)
FAUNAL DIVERSITY IN THE WORLD’S OXYGEN MINIMUM AND CARBON MAXIMUM ZONES

Oxygen minimum zones (OMZs) have high dissolved inorganic carbon concentrations (Paulmier et al. 2011) and varying temperatures, making them useful models for study of changing ocean environments. Where OMZs intersect margins the benthic faunas are known to exhibit reductions in macrofaunal abundance, altered composition, decreases in species richness and increases in dominance below oxygen concentrations of 0.1-0.2 ml/l (5-10 μmol/ kg). While oxygen has been interpreted as the primary driver of macrofaunal diversity patterns in these regions, we ask how fauna respond to the corresponding carbonate chemistry trends using international DIC and O2 databases. Cross-margin transect data from the NE and NW Arabian Sea, OR, CA, Peru, and Chile suggest that at bathyal depths, oxygen drives abundance and diversity patterns whereas carbonate chemistry may have greater influence on taxonomic composition. Carbonate chemistry differs among OMZs due to regional differences in T, S, alkalinity and depth; saturation states of calcite and aragonite within the OMZ are highest in the Arabian Sea and decrease from Peru to Oregon to California. Faunal patterns across OMZs may offer insight into ocean ecosystems of the future. (Abstract ID 12190)

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RESULTS OF THE US IOOS TESTBED FOR COMPARISON OF HYDRODYNAMIC AND DISSOLVED OXYGEN MODELS OF THE CHESAPEAKE BAY

Results from multiple 3-D hydrodynamic and dissolved oxygen models for Chesapeake Bay have been compared to each other and to EPA monitoring data for the years 2004 and 2005. On seasonal time-scales, the models all do well in capturing fundamental aspects of the hydrodynamic and oxygen fields, although the intensity of the pycnocline is underestimated. Models with constant net respiration independent of nutrient supply reproduce hypoxia nearly as well as much more complex, nutrient-dependent ecological models. Seasonal variation in DO was insensitive to seasonal cycles in the respiration rate, freshwater input, and density stratification. Rather, seasonal variation in DO was found to be very sensitive to seasonal variations in the wind, likely due to seasonal variations in the nature of wind-induced lateral and longitudinal advection. The overall intensity of stratification and resulting hypoxic volume was also found to be sensitive to numerical formulations of turbulence closure and advection. Another significant finding with regards to future modeling strategies is the result that the ensemble hindcast for dissolved oxygen using multiple models was more accurate than the hindcast from any one model. (Abstract ID 12613)

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COASTAL CARBON FLUXES ALONG THE U.S. EASTERN CONTINENTAL SHELF DERIVED FROM A COUPLED BIOGEOCHEMICAL-CIRCULATION MODEL

The role of coastal margins in regional and global carbon budgets is not well understood, primarily because many key shelf fluxes are not yet well quantified over annual time scales, e.g. the exchange of carbon across the land-ocean and shelf-slope interfaces, air-sea exchange of CO2, burial, and biological processes including productivity. Because of the temporal and spatial undersampling typically associated with most observational studies, model-derived carbon flux estimates are likely to be the only viable approach for defining these fluxes in a consistent manner on annual time scales. A primary goal of our USECoS (U.S. Eastern Continental Shelf carbon cycling) project is to estimate coastal carbon fluxes in this region using models quantitatively evaluated by comparisons with observations. Our preliminary carbon budget for this region suggests that the USECoS region is a sink of atmospheric CO2. In

SOLAR ROBOTIC MATERIAL SAMPLER SYSTEM FOR ADAPTIVE SAMPLING OF CHEMICAL, BIOLOGICAL AND PHYSICAL PARTICLES

Visible ecosystem impacts of events such as oil spills and HAB blooms receive most of the attention from the public. However, oil, HABS and other types of accidental contaminants, such as radioactive particles, have fundamental impacts on less-visible portions of delicate chemical and biological ecosystems. How to respond to an event in a timely fashion? How to track the dynamically changing distribution of contaminants through the water column? Where and how are the contaminants dispersed? These key questions need to be addressed over large spatial dimensions and over long time frames. This paper describes the development of an autonomous robotic sampling platform, deployable for long-term monitoring missions and capable of collecting samples to track contaminant dispersion. The system is a fusion of a sensor-equipped AUV with a robotic sampling platform for adaptively sampling the water column. Field samples taken are analyzed shore side using lab-based analytical instrumentation. Lastly, the mobile sampler system can be guided by remote sensing data for focused sampling of wide area dispersions. (Abstract ID 12047)

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ANTHROPOGENIC OCEAN HEAT AND CARBON UPTAKE IN CMIP5 EARTH SYSTEM MODELS: THE ROLE OF SYSTEMATIC AND RANDOM UNCERTAINTY

A new set of Earth System Models (ESM) show that the Southern Ocean (SO) south of 30°S absorbs on average 70% of anthropogenic heat and 42% of anthropogenic carbon, indicating that the SO thus plays a central role in determining the rate of climate change. However, the exact processes determining the magnitude and regional distribution of heat and carbon uptake remain poorly understood with models showing the largest disagreement in the SO due to their widely divergent representation of physical circulation and atmosphere-ocean interactions. Indeed, the fraction of the simulated uptake within the SO ranges between 30 to 160% for excess heat and between 38 to 47% for anthropogenic carbon. Natural unforced variability in models and observations further complicates the detection and attribution of changes. We compare heat and carbon uptake in CMIP5 ESAs using an analysis framework that includes both novel skill-score metrics and investigations in density spaces. We assess the contribution of internal variability to model-model and model-data differences by using an ensemble of six simulations with different initial conditions of a single ESM. (Abstract ID 12052)

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COMPACT OCEAN MODELS ENHANCE ONBOARD AUTONOMY OF UNDERWATER VEHICLES

Underwater vehicles are typically centrally controlled from shore, limiting their ability to adapt to new observations which would inform more effective sampling strategies. This inflexibility stems from the intermittency of communications and low bandwidth between shore and submerged mobile platforms. To enable greater autonomy for underwater vehicles, we developed a compact ocean modeling and assimilation system that can be deployed on-board of an underwater vehicle. The developed system estimates a synthetic picture around the vehicle by assimilating data from the vehicle undereway system. As a result, we bypass communication bandwidth and delay limitations by assembling both synoptic and local data on a vehicle. The developed modeling system is based on a statistical model that is trained to emulate the dynamics of surface currents observed by HF-Radar. Our statistical model reduces spatial complexity using empirical orthogonal functions (EOF) and captures the dynamics of the EOF coefficients using an autoregressive model. Our statistical model was trained using two years of HF-Radar observations off Monterey Bay, California. Our data assimilation system is implemented using a reduced-dimension Kalman filter that operates in the EOF space. We test the performance of the system in a series of computational experiments, where we assimilate underway velocity measurements to optimize transit time for an AUV deployed off Monterey California. (Abstract ID 10071)

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LARGE-EDDY SIMULATION OF BREAKING INERTIA-GRavitY WAVES

Inertia-gravity wave breaking is an important process in maintaining the general circulation in both the atmosphere and the ocean. However, its dynamics are still not sufficiently well
understood, in part because the wide range of length scales involved, from the wavelength of the wave and the primary instability structures to the turbulent small scales where energy and momentum are dissipated, make numerical simulation difficult. We investigate inertia-gravity wave breaking using a novel form of Large-Eddy Simulation (LES), performed using the Adaptive Local Deconvolution Method (ALDM), wherein the truncation error in the discretization of the governing equations is tuned so as to function as an implicit sub-gridscale turbulence parameterization. Although tuned for three-dimensional homogeneous isotropic turbulence, it has proved effective also for stratified flows. The initial conditions for the simulations are obtained from linear stability analysis (normal mode and singular vector analysis) of monochromatic inertia-gravity wave solutions. Both low- and high-frequency waves, with amplitudes both above and below the threshold for static stability, are considered. The ALDM results are compared to standard LES schemes and to direct numerical simulations. (Abstract ID 12212)

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The ALDM results are compared to standard LES schemes and to direct numerical simulations. Both low- and high-frequency waves, with amplitudes both above and below the threshold for static stability, are considered. The ALDM results are compared to standard LES schemes and to direct numerical simulations. (Abstract ID 12212)

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DECADAL VARIABILITY IN THE THERMOCLINE OF THE AZORES FRONT REGION AND ITS IMPACT ON DEEP OCEAN PARTICLE FLUX

29 years of daily temperature and current data from the deep-sea mooring site KIEL276 in the subtropical northeast Atlantic (33°30′N, 22°W) between 1980 and 2009 were used to study decadal variability in the permanent thermocline (240 m and 500 m). Both the temperature and the current velocities and directions show significant differences between the three decades. In the 1980s, the temperature decreased resulting in the 1980s being the coldest decade. An increasing trend in 1990s was observed leading to the warmest decade in the 2000s with a strong temperature gradient in the last years. Inter-decadal variability in the currents was seen with relatively weak currents in the 1980s and 2000s but intensification in the 1990s pointing to a displacement of the North Atlantic Subtropical Gyre. North- and southward propagation of the Azores Front, which separates the colder northern water from warmer Sargasso Sea water, leads consequently to frequent changes in the biological environment over the mooring position, which is revealed in mass flux derived from a sediment trap in 2000 m from 1994 to 2008. (Abstract ID 9491)

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TRACING THE CARBON LINKAGES BETWEEN MISSISSIPPI RIVER NUTRIENT INPUTS AND HYPOXIA FORMATION ON THE LOUISIANA CONTINENTAL SHELF

Nutrients from the Mississippi River traditionally have been viewed as fueling summertime hypoxia across the Louisiana continental shelf. But recent modeling assessments offer a contrasting view; that non-riverine carbon sources are important fuels because the shelf strongly exports nutrients and carbon to deep offshore waters. These contrasting views were investigated during annual 2007-2011 July shelfwide cruises. Measurements of surface dissolved inorganic carbon (DIC) indicate largely balanced community production (P) and respiration (R) for most of the shelf, except in nearshore low-salinity (<25) areas most strongly influenced by river inputs. In these nearshore areas, DIC loss from surface waters rather closely matched results expected for complete nutrient uptake by phytoplankton and sedimentation of phytoplankton carbon to bottom waters. These results indicate a system that is strongly retentive for river nutrients and carbon, with little leaky offshore export. Investigations also suggest a new coupled physical-biological model for hypoxia formation based on low-oxygen waters spreading from nearshore hotspots of carbon cycling. (Abstract ID 11061)

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ADAPTATION OF THE MARINE CYANOBACTERIUM TRICHOCESIDIUM TO ELEVATED CO2

Elevated CO2 has been shown to stimulate N2 fixation in the marine N2 fixing cyanobacterium Trichodesmium, but published studies have generally used cultures acclimated under high CO2 conditions for only a few generations. To examine the potential for long-term adaptation, we cultured 6 replicate cultures of Trichodesmium at 380 and 750 ppm CO2 for more than 3 years. Physiological parameters, elemental ratios, and gene expression were then measured in both adapted treatments, as well as in adapted cultures switched to the opposite CO2 treatment (750 to 380 and 380 to 750). Even after ~50 generations N2 fixation rates were still significantly higher in high CO2 treatments; surprisingly, these high CO2-adapted cultures also continued fixing N2 at increased rates even when returned to 380 ppm growth conditions. Trends in growth rates were similar to those for N2 fixation, but CO2 fixation trends differed. Transcriptome samples are currently being analyzed for all treatments. Results will be discussed in terms of the potential for adaptation of Trichodesmium to elevated CO2 in the future acidified ocean, and the consequences for the marine N cycle. (Abstract ID 12105)

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TURBULENCE DISSIPATION RATE AND MIXING ON THE LAN-YU RIDGE OF THE LUZON PASSAGE

The waters of the Luzon Passage are among the most energetic environments in the global ocean. Tidal currents as large as 0.8 m/s and strong stratification over the steep ridge topography give rise to internal wave generation, driving baroclinic currents. In addition, the Kuroshio Current often drives strong flow through the area. Not surprisingly, this environment supports exceptionally turbulent energy levels distributed over full depth, leading to mixing between the South China Sea and Kuroshio water masses. Here, we present the first full-depth, direct measurements of turbulence along the Lan-Yu Ridge of the Luzon Straits over a spring neap cycle of tidal forcing. Data were collected on the east and west slopes of a ridge crest suggested by model results to be the site of exceptional baroclinic conversion of the barotropic tide. Measurements at each of these locations show that the strongest turbulence levels occur during the phase of the flood-ebb cycle when flow is in the downwelling direction, indicating either hydraulic or slope convection processes. Our analysis shows very large turbulence levels, with dissipation rates reaching 10^-5 W/kg at 1000-m depth, and depth-integrated dissipation rate levels reaching 1 W/m2. This implies that at least 10% of the locally generated baroclinic energy is dissipated directly before radiating away and suggests that local turbulent processes have considerable impact on the internal wave generation occurring at this region. (Abstract ID 12186)

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TURBULENCE-INDUCED SINKING AND SUBSTRATE TYPE IMPACT SETTLEMENT PATTERNS OF OYSTER LARVAE

Feedbacks between turbulence-mediated larval behavior and substrate roughness could influence the distance that larvae travel before contacting the bottom from a given height, known as the “hitting distance.” These feedbacks may be particularly important for oyster settlement, because oysters naturally form discrete patches of reef that are rougher than restored reefs or surrounding mud flats. Here we estimated the hitting distance for oyster larvae (Crassostrea virginica) settling over four different substrate types: mud, natural reefs, and restored reefs constructed from oyster or whelk shell. Larval behavior was modeled using laboratory data on the responses of larval oysters to turbulence dissipation rate. Flow velocity and turbulence profiles were based on measurements collected in coastal Virginia. These measurements were integrated with McNair’s Hitting-Distance model to calculate the larval probability of contacting the bottom as a function of downstream distance. Within an average reef patch length of 30 m, the cumulative probability of hitting bottom was highest over natural reefs (natural reef > whelk shell > mud > oyster shell). Results suggest that substrate roughness is important for successful oyster reef restoration. (Abstract ID 10571)

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BENTHIC FLUXES ON THE OREGON SHELF

Benthic chamber experiments were performed on the Oregon shelf at 50-150 meters depths in June and August 2009. Similar oxygen fluxes between eddy correlation and benthic chamber techniques in permeable sediments indicate limited pore-water advection. In chamber incubations, oxygen and nitrate fluxes were into the sediments while silicate, iron and ammonium fluxes were out. Benthic fluxes were similar in value and sign to those from Washington and California. Water 3 meters from the bottom was consistently hypoxic (-52 µM O₂) and had ammonium concentrations up to 5.4 µM. Given measured ammonium fluxes, it would take several months to achieve such high bottom water concentrations. Benthic oxygen fluxes (-4.7 to 13 mmol/m²*d) were sufficient to draw down bottom oxygen concentrations by 15% per month. Iron fluxes (average of 8 µmol/m²*d) would increase bottom water concentrations up to 38% per month while loss of fixed nitrogen (-0.8 to -3.4 mmol/m²*d NO₃ and 0 to +1.2 mmol/m²*d NH₄) due to denitrification in the sediments, decrease nitrate concentrations by 3-5%. Thus, benthic fluxes, in the net, increase primary productivity in this upwelling system. (Abstract ID 10594)
AUTOTROPHIC DENITRIFICATION FOUND IN THE BOSPORUS PLUME OF THE BLACK SEA

Autotrophic denitrification was measured in the southwest coastal Black Sea where the Bosporus Plume injected oxidized chemical species (especially O₂ and NO₃⁻) into the oxic, suboxic and anoxic layers of the Black Sea. To determine the bacterium responsible for autotrophic denitrification, depth profiles of three autotrophic bacteria, members of the SUP05 and BS-GSO2 groups of gammaproteobacteria and the epsilonproteobacterium Sulfurimonas, were examined. Sulfurimonas (BS139) was the most likely to mediate autotrophic denitrification. Anammox activity was not detected at that station though low levels of Scalindua DNA were present. These results provide evidence for a modified ecosystem and different N cycling. These findings, particle-attached N and S pathways should be examined in oxygen deficient waters such as the Black Sea and oxic oxygen minimum zones. (Abstract ID 11682)

INFLUENCE OF THE EXTRATROPICAL OCEAN CIRCULATION AND SURFACE HEAT EXCHANGE ON THE TROPICAL CLIMATE IN A SECTOR COUPLED CLIMATE MODEL

This study shows that induced MOC hemispheric asymmetry causing interhemispheric asymmetry in extratropical surface ocean heat exchange can control aspects of tropical circulation and the position of ITCCZ. We aim to further understanding of key mechanisms hence we employ an intermediate complexity coupled climate model derived from GFDL CM2.5. Through a set of modular simplifications in sector geometry, configuration with closed rectangular ocean randomly places the dominant deep-water production and heat release in one hemisphere. Advection and convective feedbacks in extratropical ocean cause this forced hemispheric symmetry breaking that leads to positioning of ITCCZ in the MOC dominant hemisphere. Opening of circumpolar channel in subpolar region of MOC dominant hemisphere reduced ocean heat release there due to decrease of OHT and expansion of sea ice. This forced hemispheric symmetry breaking moves the dominant region of deep-water circulation and the position of ITCZ. We aim to further understanding of key mechanisms as asymmetry in extratropical surface ocean heat exchange can control aspects of tropical circulation and the position of ITCCZ. We aim to further understanding of key mechanisms hence we employ an intermediate complexity coupled climate model derived from GFDL CM2.5. Through a set of modular simplifications in sector geometry, configuration with closed rectangular ocean randomly places the dominant deep-water production and heat release to opposite hemisphere that causes shift of ITCZ across the equator. Overall, in this simplified coupled system, ITCCZ is always downstream (upstream) of the cross-equatorial OHT (AHT) controlled by hemispheric asymmetry in extratropical ocean circulation and surface heat exchange. (Abstract ID 12616)

A high resolution ice-ocean coupled model is configured for the northern Sea of Okhotsk to simulate the transport of the dense shelf water produced in the coastal polynyas. However, the nearshore process of larval transport is not well understood. In the summer 2010, physical data and biological samples were collected at the surf zone in Sand City, CA. Preliminary results show that concentrations of barnacle larvae were higher in the rip current than in the surf zone ridge. Phytoplankton was also more abundant in the rip current than in the surf zone ridge. The differences between the rip and the rip concentrations were greater with the phytoplankton than zooplankton. This might be partially explained by the sinking behavior of larvae in turbulence. We simulated this mechanism using bio-physical coupling method. The collected benthos data were used for initializing the surf zone hydrodynamic model by Delt3D. The flow velocities and dissipation rates from the physical model were then transferred to a biological model to investigate the role of turbulent flow in the behavior and transport mechanism of barnacle larvae. The combined simulation method can be useful for further investigation of larval transport mechanism. (Abstract ID 12515)

ICE-OCEAN COUPLED MODEL WITH 1KM GRIDS TO STUDY THE DENSE SHELF WATER TRANSPORT IN THE SEA OF OKHTOKS

A high resolution ice-ocean coupled model is configured for the northern Sea of Okhotsk in order to simulate the transport of the dense shelf water produced in the coastal polynyas. Spatial resolution is 1km for the continental shelf region. The primitive equations and a z-o coordinate are used for the ocean part. The ice model consists of the dynamic process and the thermodynamic process. The ice internal stress is calculated based on the elastic-viscous-plastic rheology as well as ice rotation. The total stress is then calculated and applied to the ice model.

HORIZONTAL DISTRIBUTION OF PHYTOPLANKTON COMMUNITIES DURING LATE SUMMER IN THE WESTERN ARCTIC

TO THE NORTH ALONG 155ºE, A MIXED LAYER DEPTH (MLD) DEEPENED GRADUALLY, REACHING 104 M ON 15ºN AND THEN SHOAL ED AGAIN. THE TOP OF NITRACLINE WAS AT OR BELOW THE MLD AND DEEPEST (138m) ON 15ºN. IN THE LATITUDE OF 0–29ºN, THE DEPTH OF CHL A MAXIMUM (DCM) WAS DEEPER THAN THE TOP OF NITRACLINE AND WAS OBSERVED AT THE 2.4±1.3% LIGHT DEPTH (RELATIVE TO 0 m). THE PHOTOCHEMICAL EFFICIENCY (Fv/Fm) MEASURED WITH THE FRR FLUOROMETER HAS BEEN USED AS AN INDICATOR OF PHOTO-PHYSIOLOGICAL STATE, AND THE MAXIMAL DEPTH OF Fv/Fm WAS UNDERLYING DEEPER THAN THE DCM, AND CORRESPONDED TO THE 0.8±0.2% LIGHT DEPTH. HERE, WE DISCUSS THE RELATIONSHIP BETWEEN PHYTOPLANKTON DISTRIBUTION AND PHOTO-PHYSIOLOGICAL STATE, COMBINED WITH THE RESULTS OF PIGMENT COMPOSITION. (ABSTRACT ID 10788)
The response of phytoplankton community to recent environmental changes in the western Arctic Sea (the northern Chukchi Sea), especially shrinking of sea ice, was assessed. Phytoplankton groups based on HPLC phytoplankton pigments had been analyzed in the late summers of period 2008–2010. Steel-Dwass’ multiple-comparison tests were performed for some physical, chemical and biological parameters among the groups. We found significant difference in the distribution of surface phytoplankton community between the year of remarkable sea ice decline (2008) and other (2009 and 2010). Haptophytes and some other phytoplankton groups dominated and distributed widely in the surface layer during 2008 whereas prasinophytes or chlorophytes dominated in the light limited region spread in 2009 and 2010. This change in the phytoplankton communities is attributed to release from light limitation as a consequence of less sea ice in 2008. Expected long-duration of open water area spread during summer in the future may change biogeochemical cycle due to the shift of phytoplankton community in the western Arctic. (Abstract ID 12824)

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DEPENDENCE OF THE AXES OF TROPOSPHERIC WESTERLIES AND STORMTRACKS ON THE LATITUDE OF AN EXTRATROPICAL OCEANIC FRONT AS REVEALED FROM IDEALIZED AGCM EXPERIMENTS

L latitudinal dependency of the thermal influence of an extratropical oceanic front on the atmospheric circulation is investigated through a set of perpetual AGCM experiments with zonally uniform SST prescribed at the model lower boundary. In each of the winter and summer hemispheres the latitudinal SST profile is characterized by a single front. Its latitude is varied systematically from one experiment to another while its intensity is unchanged. These idealized aqua-planet experiments reveal a climatological tendency for a storm track and eddy-driven polar-front jet (PFJ) in the lower troposphere to be organized near the SST front if located in the midlatitudes or subtropics, although this tendency is somewhat less evident in the upper troposphere. For the SST front located at a subpolar latitude, in contrast, eddy activity tends to be weaker and both the storm track and PFJ form equatorward of the front, as in another experiment from which the frontal SST gradient is removed and thus the influence of internal dynamics prevails. Sensitivity of the annual variability to the latitude of the SST front is also discussed. (Abstract ID 10178)

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REAL-TIME PUBLIC AND STUDENT ENGAGEMENT DURING THE OCEAN OBSERVATORIES INITIATIVES VISIONS 2011 EXPEDITION TO AXIAL SEAMOUNT

The VISIONS11 expedition took place aboard the R/V Thomas G. Thompson with the remotely operated vehicle (ROV) ROPOS in support of the ongoing installation of the Ocean Observatories Initiative’s high-power and high-bandwidth cabled ocean observatory at Axial Seamount, a volcano on the Juan de Fuca Ridge that had erupted just 4 months prior. Here we describe our successes and lessons learned in engaging onboard scientists, students, and the public through the various outreach efforts employed during the expedition including: 1) live high-resolution video and audio streams from the seafloor and ship; 2) social media interactions; 3) direct connections to a science center and classrooms across the country; 4) an onboard immersion experience for undergraduate and graduate students; and 5) a routinely updated website. During the expedition, we had over 2.5 million hits on our website that hosted live high-resolution video and audio streams. Additionally, we interacted with over 500 followers across the globe through various social media sites while they were seeing active research in real-time. (Abstract ID 11756)

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INTERANNUAL SURFACE FLOW VARIABILITY IN THE EQUATORIAL ATLANTIC OCEAN

Equatorial Atlantic surface currents between 5°S and 5°N derived by applying equatorial geostrophy to altimetric sea surface height data are combined with surface drifter and ARGO float surface drift velocities to investigate the time-space pattern of the interannual zonal surface flow variability. High baroclinic mode waves, so-called Equatorial Deep Jets (EDJ), were observed in moored current meter records obtained since 2002 at 0°N, 23°W. At a 4.5 year periodicity, they have harmonic amplitudes of more than 10 cm/s at intermediate depths and vertical wavelengths of about 400 m. These high-baroclinic-mode waves have smaller meridional scales compared to wind-generated low-baroclinic-mode equatorial waves. Using higher-order polynomials in the analysis of altimetric surface geostrophy which allows resolving similar scales at the surface leads to general good agreement between geostrophic zonal surface currents from altimetry and surface drift data. A 4.5 year period similar to the observed periodicity of EDJs at depths is found in the geostrophic zonal surface velocity data available since 1992 with maximum amplitudes of 2–10 cm/s located about 100 km north of the equator. (Abstract ID 11129)

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A DETAILED LOOK AT COLD-VENTS USING HIGH-RESOLUTION AUV DATA: A MODEL OF GAS VENTING EVOLUTION ON THE NORTH CASCADIA MARGIN

The Northern Cascadia Margin has long been identified as a prolific gas hydrate province and has been studied for the past 25 years with a focus on the physical properties of hydrate-bearing sediments. In 2009, high-resolution bathymetry and sub bottom profiler data were acquired with the Dr. Allan B. AUV by MBARI. The data was collected in part to assist in navigating of the ROV (Doc Ricketts) during subsequent investigations of particular sites of interest, including Bullseye Vent, Spinnaker Vent, and hydrate outcrops at Barclay Canyon. The data allow for detailed mapping of surface, and shallow subsurface features associated with the onset, growth, and maturation of gas venting, gas hydrate, and seafloor chemosynthetic communities. Early degassing and arrival of chemosynthetic communities, early diagenesis and carbonate precipitation, formation of pockmarks, and mature fluid carbonate platforms barren of life are stages of observed venting. The results will assist in future IODP drilling, CORK installations, and understanding of time series work linking fluid expulsion to earthquake shaking. (Abstract ID 12292)

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FLOCCULATION OF COLLOIDAL MONTMORILLONITE: A MODELING APPROACH

The physicochemical forces between individual sediment particles affect the strength of the bulk sediments. The same forces also influence the particle flocculation in the water column. Thus, the understanding of the flocculation processes allows the understanding of inter-particle forces in bulk sediments. We investigated the effect of organic matter (OM) on the flocculation of colloidal montmorillonite through laboratory experiments and computational flocculation modeling. The model, based on Smoluchowski coagulation model and population balance equation (PBE), was established with two key parameters, sticking efficiency and breakup parameter. The experiments tracked the temporal evolution of the floc sizes. The key parameters were calibrated through the interactive optimization of the model results against the laboratory results. The calibration showed that OM has a varying influence on the flocculation behavior. Xanthan gum does not influence flocculation, which is primarily determined by the DLVO interaction energies, whereas chitin modifies both the sticking efficiency and breakup parameter. This study shows there is no universally predictive correlation between DLVO energies and flocculation parameters. Some OM has the negligible influences whereas others exert non-DLVO interactions such as repulsive hydration and steric repulsion. Further understanding of the physical-chemical properties of OM is needed in order to predict the flocculation behaviors. (Abstract ID 9387)

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IMAGING FLOWCYBOT DASHBOARD: WEB-BASED SUMMARIZATION, BROWSING, AND ACCESS TO NEAR-REALTIME PHYTOPLANKTON IMAGERY

 Imaging FlowCytobot is an automated flow cytometer that continuously samples seawater and provides near-real-time photometric and imaging observations of marine phytoplankton. IFCB has been deployed at the Martha’s Vineyard Coastal Observatory for over six years and has collected over 500 million images with associated fluorescence and scattering data.
Accessing and exploring this large time-series dataset has been difficult because FCB data is in non-standard formats and was only accessible within the research developer’s laboratory. As part of an Informatics Bridging Team effort pairing science users with informaticists, we have developed an interactive, web-based interface for displaying and browsing visual summaries of "live" FCB data. The interface is backed by RESTful web services providing FCB data in its native formats as well as multiple standard representations (PDF, XML, JSON, and CSV). The services provide FCB data with persistent, citable URLs for easy sharing and distribution, an approach we expect will be broadly applicable to other instrument platforms and sensor networks. (Abstract ID 11297)

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TESTING THE BIOGEOCHEMICAL IMPACTS OF UPPER TROPHIC LEVELS WITH A STRUCTURALLY EFFICIENT GLOBAL MODEL.

Marine ecosystems are exceedingly complex, involving thousands of species of phytoplankton, zooplankton and nekton, all subject to the turbulent whirls of the chaotic physical environment. Parsing this complexity into comprehensible processes is difficult, and mechanistic plankton ecology has tended to focus on primary producers - visible by satellite - as the primary drivers of ocean biogeochemistry, with remineralizing organisms enslaved to variability in the primary producers. However, metazoans are also sensitive to environmental parameters, such as light, temperature and oxygen concentrations. As efficient metabolizers, these organisms can influence the distribution of remineralization, thereby altering the availability of nutrients and causing a feedback on phytoplankton. In order to test this, we introduce upper trophic levels as simple parameterizations in a structurally-efficient biogeochemical model, BLEN. We then isolate the effects of individual behavioral patterns, such as daily vertical migration, particle dynamics, and sensitivity to low oxygen concentrations. (Abstract ID 12568)

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MINDING THE GAP: AMPLIFYING THE VOICE OF SCIENCE IN THE WIDER WORLD

Fundamental change in science is often the result of unexpected connections. Across disciplines and institutions, these connections often come about as a result of creative thinking about who to have in the room to tackle questions that are particularly timely or broad in scope. The Communication Partnership for Science and the Sea (COMPASS) helps ocean scientists connect themselves and their science to the wider world. We do this, in part, by ensuring that the latest science informs, frames, and catalyzes ocean policy discussions. For cases in which the science exists, we facilitate fitting the pieces together into a cohesive whole through synthesis and seed new collaborations. In other cases, we catalyze new science through scholarly workshops and working groups. We also create and capitalize on opportunities to connect scientists to decision makers through briefings, meetings, and other venues. These connections often feed back to generate additional ideas to advance the science. I will provide examples of each of these activities to illustrate how the resulting dialogue has built community, advanced the science, and informed policy. (Abstract ID 12468)

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INFLUENCE OF WATER MASSES ON THE DISTRIBUTION AND ABUNDANCE OF SEABIRDS IN THE NORTHEASTERN CHUKCHI SEA

We examined relationships between oceanography and the distribution and abundance of seabirds in the northeastern Chukchi Sea in 2008–2010 as part of an interdisciplinary ecological study (Chukchi Sea Environmental Studies Program; funded by ConocoPhillips, Shell, and Statoil). We sampled 3 study areas located ~110–180 km offshore and known as Klondike, Burger, and Statoil. The total density of seabirds was considerably higher in 2009 than in 2008 and 2010 and generally was higher in Klondike than in Burger in 2008 and 2009; however, densities did not differ significantly among Klondike, Burger, and Statoil in 2010. Species-composition varied among study areas, seasons, and years, and the numerical dominance of alcid species in all study areas combined increased from 2008 to 2010. The distribution of seabirds may be influenced by advective processes that transport oceanic water from the Bering Sea to the Chukchi Sea. This transport differed among years and resulted in a broader northeastward intrusion of Bering Sea Water, higher abundance of oceanic zooplankton, and greater abundance of planktonivorous seabirds in 2009 than in 2008 or 2010. (Abstract ID 10399)

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NONHYDROSTATIC HINDCASTS OF NONLINEAR INTERNAL WAVES IN THE LUZON STRAITS AND NORTHERN SOUTH CHINA SEA – TIDES AND THE KUROSHIO

Complex, large amplitude, Nonlinear Internal Waves (NLIWs) are generated in the Luzon straits by tides, by the Kuroshio and by their interactions with the bathymetry. These waves interact with each other and the topography to form highly energetic packets of NLIWs that propagate across the South China Sea. Nonhydrostatic hindcasts have been conducted at 500 m resolution in the Luzon Straits (18.5N – 21N, 119E – 124E). These hindcasts covered the period of the Internal Waves in Straits Experiment pilot cruise from August 1 to September 11, 2010. NLIWs originate from several sources around the Batan and Bahayan Islands. They interact to form a complex, energetic wave field which forms into NLIW packets that propagate westward. The Kuroshio significantly influences the flow in the Luzon straits. The results are in good agreement with moored measurements and remote sensing. These hindcasts were forced using data from hydrostatic hindcasts of the northern South China Sea (17N – 23.5N, 116E – 125E) at 2 km resolution. The hydrostatic hindcasts were initialized and forced using archived forecast fields from the global NCOM and the OSU tidal database. (Abstract ID 11437)

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GRAIN SIZE AND MORPHOLOGICAL VARIABILITY

Grain size on beaches is often assumed to be uniform to reduce complexity in modeling studies and because measuring grain size is tedious and time consuming. Rubin (2004) introduced a technique for measuring grain size using auto-correlation of digital images. We used a similar technique for surveying grain size on beaches during two experiments in TrueVer90, spatial survey. Surface grain size were completed every few days over a large (~500x500m) intertidal area. Results indicate that grain size varies spatially with the morphology of beach features (e.g., rip channels and shoals) and changes with the dynamics of that morphology. The REX09 experiment focused on twice-daily sampling of two cross shore lines to examine temporal grain size variability of the intertidal beach. It was found that very coarse sediments are associated with the energetic shore break and swash on the steep foreshore. And that this pattern moves and changes with tide level, wave energy, and morphodynamics. These data being used to examine the relationship between morphological, sedimentological and hydrodynamic variability using Xbeach, a model for waves, currents, transport and morphodynamics. (Abstract ID 11655)

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MEAN FLOWS AND WAVES IN BETA-PLANE TURBULENCE

The behavior of a strongly nonlinear system featuring inverse energy cascade and Rosby waves can be characterized in terms of a zonostrophic index (ZI) which measures the width of the zonostrophic inertial range. The latter is a part of the Kolmogorov energy transfer range where, due to the beta-effect, the anisotropy is strong. When ZI > 2.5, a flow is dominated by a system of strong, stable, long-lived zonal jets with a steep zonal spectrum. This regime is classified as zonostrophic turbulence. Its existence has been confirmed by the data collected during the recent fylyer near Jupiter of the Cassini space station. For 1 < ZI < 2, the flow is anisotropic but zonal jets are unstable and not well pronounced. This regime is typical of the ocean where ZI is only about 1.7 or less. Our simulations demonstrate that large-scale Rosby waves, energized by the inverse cascade, generate secondary, nonlinear, non-dispersive waves termed zonons. Zonons survive in a flow long after the forcing is switched off. Further analysis indicates that zonons are maintained and guided by the meridional shear of the zonal velocity, i.e., they reveal the attributes of the Rosby solitary waves. Zonons are the medium that facilitates the energy exchange between zonal flows and eddies by morphing them into a symbiotic relationship. These results shed new light upon the mean flow – eddy dynamics in beta-plane turbulence. (Abstract ID 12752)

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MODULATION OF ATMOSPHERIC RESPONSE TO NORTH PACIFIC SST FROM GLOBAL WARMING: A STATISTICAL ASSESSMENT

The modulation of ocean-to-atmosphere feedback over the North Pacific in early winter from global warming is investigated based on observational data and multiple climate model simulations. It is found that global warming can significantly enhance the ocean-to-atmosphere feedback over the North Pacific, characterized by a robust warm ridge pattern. This enhancement is likely associated with the intensification of storm tracks in a warm climate. (Abstract ID 9367)
Eddy characteristics in the northeastern South China Sea are studied using the AVISO merged Sea Level Anomaly data from October 1992 to December 2010. Clustered in three Eddy-active periods, the northwest South China Sea is divided into three Eddy Centers, EC1-3, there were more anti-cyclonic eddies (ACEs) than cyclonic eddies (CEs). EC1 is situated west of Xisha Islands, with EC2 and EC3 north and northeast of Xisha, respectively. The occurrence of ACEs was highest in summer and lowest in winter; whereas the occurrence of CEs was higher in spring and fall. Most of the ACEs found in EC1 in the summer were generated southeast of EC1 in the spring, while most of the CEs found in EC1 in the fall were generated locally. On the other hand, most eddies found in EC2 and EC3 propagated to the areas from east. Eddy generation and propagation are further investigated in relation to the general circulation, wind stress patterns, and topography in the northwestern South China Sea. (Abstract ID 9750)

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THE FORMATION, PATHWAY AND DESTINATION OF THE NORTH PACIFIC SUBDUCTION WATER IDENTIFIED BY A SIMULATED PASSIVE TRACER

The formation, pathway and destination of the North Pacific subduction water are investigated by using a simulated passive tracer, based on oceanic transports. The subduction water then participate in the subtropical gyre of north Pacific. About 30% of the subducted water up to the local mixed layer in early 2-3 years, and more and more subducts along the pathway of the Southern Ocean gyre is least efficient. A shallow mixed layer in low-NAO conditions is observed to initiate an earlier spring bloom in all three gyres. (Abstract ID 12014)

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HICO ON-ORBIT CALIBRATION AND DATA CORRECTION

The HICO instrument (Hyperspectral Imager for the Coastal Ocean) is an imaging spectrometer presently onboard the International Space Station. This instrument does not carry any onboard optical radiometric calibration sensors. We have developed vicarious calibration techniques that have been used in converting the HICO L1A digital numbers to the L1B radiances. Spectrum-matching techniques are used to refine the wavelength and spectral resolution calibrations. Radiometric calibrations are made through inter-satellite data comparisons, mainly between HICO data and the radiometrically calibrated EOS/MODIS data. (Abstract ID 11662)

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COMPARISON OF DECADAL CHANGES IN THE CARBON SINK AND POTENTIAL RESPONSES TO CLIMATE CHANGE IN THE WESTERN ARCTIC OCEAN AND THE SOUTHERN OCEAN

Model results show that the Southern Ocean (SO) carbon sink has weakened with global climate change. Our results out 3 years of observation, however, show that this is only partly true. Overall, the pCO2 in surface sea water increased faster than it increased in the air and there was ocean acidification. There were, however, seasonal differences, such that the above was the case in December, but not in January. The difference in pCO2 between air and the surface sea water (PpCO2) decreased dramatically from 1999 to 2007 in December, but not in January. The difference in the ΔpCO2 change between December and January suggests that the biological pump in the SO might have been enhanced under climate change. This is a potential feedback of the SO to climate change: The Arctic carbon sink increased between 1999 and 2010, as sea ice cover decreased. Increased ice melt in summer is projected to occur in the future with increasing speed. The increased CO2 uptake by the Arctic Ocean slopes and basins, thus, may provide a negative feedback mechanism to reduce atmospheric CO2 and thus the rate of global warming. This CO2 sink may gradually weaken, although it will remain higher than today. Furthermore, increased warming and ice-melt will also promote permafrost thawing in the Arctic landmass and thus increase river inputs of DIC and organic carbon, which will likely be recycled as CO2, further reducing the capacity of the Arctic Ocean to absorb atmospheric CO2. (Abstract ID 12854)

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SEABORNE HYPERSPECTRAL REMOTE SENSING: AUTOMATED SUNGLINT FLAGGING AND FOREL-ULF CLASSIFICATION

Quality control of remote sensing measurements plays a vital role in the accurate determination of remote sensing reflectance (Rrs) or ocean color products, and the accurate estimation of optically active water constituents. We present a state-of-the-art setup for automated sunglint flagging and unmanne seahorse hyperspectral optical measurements. Simultaneous to optical measurements a dual-camera system was used to capture sun and sky images supporting the identification of sunglint in the radiometer field of view. Quality control was applied at first using three flags based on meteorological conditions, to select non-evaluable incoming solar irradiance. Finally a novel sunglint flag was applied using computed water
leaving radiance or R_RS, derived from automated image analysis. The remaining unmasked R_RS spectra were transformed into discrete values based on the FoulÉ-Index (FUI) simplifying the optical comparison of water bodies. This quality control method as well as FUA scale can be adapted to automatically generate high quality data useful in the validation of satellite R_RS, optical classification of water bodies, and eventual estimation of optically active water constituents as an element of ocean observatories. (Abstract ID 11842)

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SPATIAL VARIATION IN MICROBIAL COMMUNITY FUNCTIONAL GROUP COMPOSITION IN SURFACE WATER AND SEDIMENTS IN DORCHESTER BAY OF BOSTON HARBOR

Boston Harbor restoration has been ongoing for 30 years and has improved water quality. The goal of this study was to compare surface water and sediment microbial communities from the mouth of the Neponset outfall at 3 locations in Dorchester Bay. We measured physico-chemical parameters and characterized the microbial communities of surface water and bottom water/sediments at the mouth of the Neponset River (NEP), Thompson Island (TI), and Spectacle Island (SI) in summer 2011. Surface and bottom water samples were measured for physico-chemical properties and analyzed using Principal Components Analysis (PCA) and sediment microbial communities will be analyzed using Fatty Acid Methyl Esters (FAMES) and statistically analyzed using PCA. PCA Axes 1 and 2 explained 100% of the variability in surface and sediment water physico-chemical parameters. Axis 1 separated TI from NEP and SI samples, and while Axis 2 separated all 3 sampling stations with TI being intermediate to NEP and SI. Based on PCA results, we expect microbial communities to be similar among the sediment samples and different among the surface water samples. (Abstract ID 9624)

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THE BROAD-SPECTRUM BENEFITS OF RESEARCH PARTNERSHIPS BETWEEN TEACHERS AND MARINE SCIENTISTS

Fostering partnerships between scientists and pre-college classrooms is a win-win scenario for both sides: Developing experiences in authentic research not only impacts the teacher and her students, but also has the potential to change thinking in the community. Co-authors Yager and Garay originally met through the Polar Trex program. Now in their 4th year of working together, the partnership has grown from co-authoring a classroom activity to developing a tri-state global ocean project that connects coastal students in Texas, Georgia, and Alabama! Partnerships like this expand the teacher/student's knowledge base and gives depth to learning by bridging the gap between real-time research and classroom studies. The direct, personal relationship allows students to see scientists as real people facing real challenges in their work. And, brings attention to different career disciplines and new technologies. For teachers, scientists provide background for new concepts and technical knowledge of equipment and procedures, as well as a stimulating exchange of ideas that meets STEM objectives. The scientist benefits from the educational outreach developed from their work, giving exposure to timely scientific topics. (Abstract ID 12038)

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CLIMATICALLY ACTIVE GASES IN THE EASTERN BOUNDARY UPWELLING AND OXYGEN MINIMUM ZONE (OMZ) SYSTEMS

The EBUS (Eastern Boundary Upwelling Systems) and OMZs (Oxygen Minimum Zone) contribute very significantly to the gas exchange between the ocean and the atmosphere, notably with respect to the greenhouse gases (hereafter GHG). From in-situ ocean measurements, the uncertainty of the net global oceans-atmosphere CO2 fluxes is between 20% and 30%, and could be much higher in the EBUS-OMZ. Off Peru, very few in-situ data are available presently, which justifies alternative approaches for assessing these fluxes. GHG air-sea fluxes determination can be inferred from inverse modeling applied to Vertical Column Densities (VCDs) from GOSAT, using state of the art modeling, at low spatial resolution. For accurately linking sources of GHGs to EBUS and OMZs, the resolution of the source regions needs to be increased. This task develops on new non-linear and multiscale processing methods for complex signals to infer a higher spatial resolution mapping of the fluxes and the associated sinks and sources between the atmosphere and the ocean. The use of coupled satellite data (e.g. SST and/or Ocean colour) that carry turbulence information associated to ocean dynamics is taken into account at unprecedented detail level to incorporate turbulence effects in the evaluation of the air-sea fluxes. We will present a framework as described above for determining sources and sinks of GHG from satellite remote sensing with the Peru OMZ as a test bed. (Abstract ID 11997)

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STRUCTURE OF SMALL-SCALE TURBULENCES AT THE FREE AIR-WATER INTERFACE

In this contribution we will present a new approach for analyzing interfacial shear induced turbulence at the free air-water interface. We use an infrared imager sensitive in the spectral range form 3-5 µm for visualizing the water sided turbulence from passive thermography. Due to a heat flux present at the interface, a temperature difference exists between the skin layer and the water bulk below the diffusive sub-layer. Turbulence disrupts the boundary layer, the temperature footprint of which can be seen in the images. Due to the shear at the interface, turbulences are not isotropic but exhibit elongated streaks in wind direction. We will present a novel image processing based approach for classifying and segmenting the streaks. From these segmentation, statistical distributions of streak spacings can be analyzed. As expected, a trend towards smaller streak spacings with increasing friction velocity is evident. Surprisingly, above a certain threshold friction velocity, streak spacings appear to remain constant. Besides small-scale structures, we also examine larger scale coherent structures, which can be associated with Langmuir circulations. We relate our findings to the Langmuir number for a first indication of the production processes of these structures. Results from laboratory and field measurements will be presented. (Abstract ID 10147)

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RESPONSES OF MARINE N, FIXATION TO INTERACTIVE GLOBAL CHANGE EFFECTS. TRICHODESMIUM AND CROCOSPHAERA COMPARED AND CONTRASTED

Within the past five years, new attention has focused on effects of global change on marine N2 fixation. In addition to Trichodesmium, unicellular N fixers like Crocosphaera watsonii are now recognized as major components of the diazotrophic community. Several recent studies suggest that elevated pCO2 has a positive effect on N2 fixation rates by both of these groups of N2 fixers. These cyanobacteria, and that light interacts with pCO2 in controlling cellular retention of N2 fixation. We will present a framework as described above for determining sources of GHG from satellite remote sensing with the Peru OMZ as a test bed. (Abstract ID 11907)

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EFFECTS: 2011 MISSISSIPPI RIVER FLOOD ON CO2 FLUXES IN THE LOUISIANA COASTAL ZONE: LINKAGES WITH RIVERINE DOM INPUTS

The flood of the Mississippi River basin and the opening of the Morganza spillway in the spring of 2011 provided a unique opportunity to study CO2 evasion from the coastal region when there is a large injection of terrestrial-derived DOC. As worldwide floods become more
frequent and severe, one possible effect is the accelerated release of terrestrial organic matter into the coastal zone. The liability of this terrestrial-derived DOC will determine how quickly it may be oxidized to CO₂ and released to the atmosphere. Characterizing the dissolved inorganic carbon and understanding the sea to air fluxes of CO₂ before, during and after the event allow us to examine the implications of such events for climate change and carbon sequestration. Here, we present the results of measurements of Dissolved Inorganic Carbon (DIC), Total Alkalinity (TA), Dissolved Organic Carbon (DOC), and pCO₂ levels from the inner shelf to the tidal freshwater portion of the Achafalaya River estuary. Discrete TA and DIC samples were collected and pCO₂ was measured continuously during pre-flood, flood and post-flood cruises. (Abstract ID 9931)

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REMOTE SENSING OVERVIEW OF BP OIL DISCHARGE FROM SATELLITE SAR DATA.

Satellite remote sensing played a crucial role for monitoring BP's oil spill in the Gulf of Mexico (GOM). Oil discharged from the wellhead started to be detected by satellites on 23 April 2010. and oil slicks associated to this event were observed until 15 July. To map the extent, location, and evolution of the spill, we used a previously developed image processing algorithm called TCNNA which processes satellite Synthetic Aperture Radar (SAR) data. Monitoring of this event by processing 37 SAR images collected during the event allowed us to detect rafts of oil in the coastal zone as they separate from the much larger main spill that is centered around the BP well site. These oil rafts were detected moving at a rate of 15 miles per day and making landfall progressively as winds and tides push them along the coast. In deeper waters, drifting oil moved up to 45 miles per day and as far as 300 km away from the well source. This happened when, oil was reached by the loop current which carried the floating layer of oil southeast from the wellhead. As shown in Figure 1, repeated observations of floating oil increased with proximity to the oil source. By normalizing oil detections by the frequency that each area was sampled, we estimate that oil covered a mean daily area of 10750 km². In total, oil covered a cumulative extent of 119,600 km² of the GOM surface waters. (Abstract ID 11622)

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DISTRIEBUTION AND ND ISOTOPES ALONG THE BONUS GOODHOPE SECTION IN THE SOUTHEAST ATLANTIC OCEAN

Dissolved and particulate concentrations of Rare Earth Elements (REEs) and dissolved neodymium isotopic composition (εNd) have been measured in seawater along the Bonus GoodHope (GEOTRACES/PlFA) section in the Atlantic sector of the Southern Ocean. Dissolved REE concentrations increase with depth (e.g., from 11 to 33 pmol·kg⁻¹ for Nd) and their normalized patterns evidence a clear enrichment of HREEs relative to LREEs, together with a pronounced negative Ce anomaly at all the stations (0.06-0.14). Overall, εNd range mainly from −17 to −14 for seawater, −15 to −14 for DIC samples and −17 to −14 for pCO₂ levels. The εNd values for DIC samples were consistently lower than those for pCO₂, which indicate that dissolution of continental crust-like PAAS-normalized patterns of particulate REEs, and remarkably negative εNd values (−17 to −15) for seawater suggest a strong contribution from reworked continental crust. We proposed the existence of a specific mutualism for these processes which would be important for both dissolved and particulate phases, suggesting equilibrium between them or that the particles are authigenic. A preliminary mixing model, assuming conservative εNd and salinity, evidences the dilution of NADW at southern latitudes: i.e. the εNd of modified NADW seems to be primarily controlled by water mass mixing. (Abstract ID 9693)

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THE ROLE OF PHOTOREACTIVE SIDEROPHORES IN ALGAE-BACTERIA INTERACTIONS IN SITU

Certain phytoplankton may have a symbiotic association with specific bacterial species driven by a mutualistic relationship of photosynthetically fixed organic carbon and heterotrophic remineralization of limiting nutrients. We proposed the existence of a specific mutualism between vibrioferrin (VF) producing Marinobacter and members of the dinoflagellate and coccolithophoridal algal lineages. This photosynthetically active siderophore VF provides an enhanced supply of Fe(III) to the algae and in return the bacteria would benefit from the release of photosynthate supporting their growth. To provide evidence for this bacterial-algal association we analyzed bacterial community structures with emphasis on the in situ abundance and succession of Marinobacter species inside and outside phytoplankton blooms. Using in situ fluorescence hybridization (FISH) and Marinobacter specific probes we could determine the correlation of certain Marinobacter species with dinoflagellate blooms. Furthermore we detected vibrioferrin biosynthetic genes using quantitative Real-Time PCR (qPCR) and analyzed the importance and abundance of other marine photoreactive siderophores like aerobactin and petrobactin. With this we hope to estimate the potential role of photoreactive siderophores in oceanic iron cycling and their contribution to bacteria-algal mutualism in correlation to phytoplankton blooms. (Abstract ID 12406)

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THIN SURFACE LAYER TRANSFER OF CHROMOPHORIC DISSOLVED ORGANIC MATTER (CDOM) IN ESTUARIES

Observations and modeling of transport processes in estuaries frequently under resolve the upper 50 cm of the water column. Instrument packages developed at UMass have allow us to effectively examine this region. We have frequently found low salinity water, and associated high CDOM concentrations, to be confined to a very thin surface layer, especially following rain events. While this layer may represent a small portion of the system and only occurs episodically, it may account for a significant loss of nutrients from the transport of dissolved constituents from land to the coastal ocean. We will present data from towed vehicles as well as from 5 buoys which have been deployed from near the head of the Neponset River Estuary to the mouth of Boston Harbor. The buoys support salinity and CDOM sensors at approximately 30 cm water depth. Output from a high resolution finite difference model will be compared with the field data and used to assess the importance of the thin surface layer for CDOM transport and in determining the residence time of fresh water in the harbor. (Abstract ID 12531)

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INCERTAINCE UNDER-REPRESENTED HIGH SCHOOL STUDENTS INCREASED AWARENESS AND KNOWLEDGE RESULTS OF LIBERTY SCIENCE CENTER'S APPROACH

From December 2010 through June 2011, Liberty Science Center offered a two-day Ocean Science program to 208 high-school students and their teachers from 10 Newark, NJ, high schools. Our goals were to show students the interdisciplinary nature of science, increase their ocean literacy, enhance their ability to interpret and manipulate data, and increase their understanding of how ocean scientists do their work. The program included four data-oriented lessons developed under COSEE-NOW using ocean observing systems to teach physical and chemical oceanography and tied to that other lessons emphasizing the carbon pump and associated organisms. To evaluate the program, students completed a survey at the beginning and end of the two days (pre-post test design). Teachers completed a post-program survey rating program quality, alignment to curriculum and appropriateness for students. Matched pre-post student survey results showed increases in awareness of and knowledge about the physical and chemical characteristics of the ocean, the ocean's impact on their daily lives and scientists' ability to conduct research remotely. The program was well received, and Newark schools requested additional sessions in the coming year. (Abstract ID 11247)

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UNTANGLING THE TIME-DEPENDENT MIXTURE OF FORCES GENERATING TURBULENCE IN SHALLOW SHELF SEAS

Turbulence within the water column of shallow shelf seas is produced by a mixture of forcings: wind stress, wave-induced Langmuir vortex force, and unstable buoyancy flux acting at the top, bottom stress associated with dominantly tidal flows at the bottom. In general, this mixture of forcings is highly time-dependent, varying on tidal, diurnal, storm, and seasonal scales. Because important characteristics of turbulence (vertical velocity variance, vertical fluxes and net horizontal transport of sediment and bioactive material) vary dramatically with forcing mechanism, it is of interest to be able to identify periods when a single forcing mechanism dominates. Using as a metric direct observations of turbulent vertical velocity variance taken over extended periods of time at two sites differing in water depth and tidal amplitude, I will present methods of determining when a single forcing mechanism dominates, either in time and or with depth in the water column. (Abstract ID 9620)
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TRACER MODELING WITH THE HYBRID COORDINATES OCEAN MODEL (HYCOM).

A series of tracer simulations are being conducted at NCEP/NWS for a variety of applications, from dispersion of radionuclide contaminants motivated by the Japanese nuclear accident near Fukushima, to nutrient estimations. The tracer capabilities of HYCOM are used, in regional domains, to test the ability to forecast fields from the 1/12° HYCOM (RTOPs-Global) model output. In this study, results are presented from the soon-to-be first operational ocean dispersion model at NCEP/NWS, addressing the Fukushima-Daiichi nuclear accident, March 11, 2011. Similar tracer simulations are intended for applications like oil spills, radionuclides, and for ecosystem modeling. (Abstract ID 9531)

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PYRITE NAPANPITICLES FROM HYDROTHERMAL VENTS ARE A POTENTIAL SOURCE OF IRON TO THE OCEAN

Recent calculations demonstrate that iron emitted from hydrothermal vents has an impact on the iron budget of the world ocean, and the pathways by which iron is transported from the immediate vent region to the larger ocean basin are being explored. We show TEM and SEM images of pyrite nanoparticles (collected from black smokers at Lau Basin in May 2009) as small as 4 nm, which are aggregated into larger ‘nano-frames’ of 50-300 nm in size. The mass balance analysis of vent samples collected on the same cruise demonstrated that up to 10% of the total iron emitted from black smokers was present as pyrite nanoparticles smaller than 0.2 µm. Kinetic experiments of synthesized pyrite nanoparticles suggest that these nanoparticles persist in oxygenated seawater solution and do not oxidize readily. The pyrite nanoparticles appear to behave as dissolved entities as the oxidation rate law shows first order dependence in pyrite nanoparticle concentration. We suggest these pyrite nanoparticles are a potential source of iron to the larger ocean. (Abstract ID 10428)

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BIOFILMS AND SIZE SORTING OF INTERTIDAL SEDIMENT DURING EROSION

Biofilms found at the sediment surface are known to limit sediment resuspension. It is thought that biofilms preferentially retain fine particles, but this hypothesis remains to be tested. The goal of this study was therefore to investigate size-specific grain retention by biofilms. Sediment cores were collected from an intertidal flat and eroded with a Gust microcosm erosion chamber at various shear stresses (0.08-0.60 Pa). Half of the cores were eroded without prior treatment, while sodium hypochlorite was added to the other cores to destroy biofilms. Disaggregated inorganic grain size (D10%) distributions were obtained for the resuspended sediment and each treated core was compared to its corresponding untreated core. At intermediate shear stresses, biofilms were found to preferentially retain large grains. (Abstract ID 9918)

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FEEDBACKS BETWEEN HIGH PHYTOPLANKTON BIOMASS AND THE IN SITU HEAT BUDGET

For the Long Term Ecological Research project, we have measured the inherent (IOP) and apparent (AOP) optical properties along the West Antarctic Peninsula. This region is characterized by large coastal diatom blooms that can be >30 mg chlorophyll /m^3. Such high phytoplankton concentrations suggest there is a potentially significant feedback between the algal biomass and the radiant heat budget in coastal waters. Using in situ measurements, optical closure was achieved between the IOPs and AOPs via HydroLight. This closure provided confidence in the in situ measurements. The 1% light levels ranged from 5-50 meters depth over the observed 10-fold changes of chlorophyll, suggesting that most of the radiant heat is trapped in the upper few meters of the water column. High surface temperatures (>4 degrees C) are observed in nearshore waters often in the high chlorophyll water. Using measured surface light and in situ optics, the calculated heating rates corroborate ship temperature measurements. These results emphasize the need to accurately model optical variability and feedbacks in Antarctic coastal waters to accurately resolve the surface radiant heat budget. (Abstract ID 10622)

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THE INFLUENCE OF NONLINEAR MESOSCALE EDDIES ON OCEANIC CHLOROPHYLL

High-resolution sea-surface height (SSH) fields constructed from altimeter data have revealed the ubiquity of nonlinear, coherent eddies with mesoscale radii of ~100 km throughout the World Ocean. We investigate the influence of these eddies on oceanic biology from 10 years of upper-ocean chlorophyll (CHL) estimates collocated to the eddies inferred from the SSH fields. The observed westward propagation of CHL and SSH previously attributed to linear Rossby waves is shown to be due to nonlinear eddies that were not resolvable in the SSH fields analyzed in past studies. At temporal scales of weeks to monthly and spatial scales greater than 100 km, the dominant mechanism is shown to be eddy-induced horizontal stirring of the ambient CHL field.

While the horizontal advection of CHL by the rotational velocities of eddies dominates the statistics of CHL variability globally, trapping of CHL within the cores of highly nonlinear eddies is found to be important in anticyclonic eddies in specific regions. From collocation of scatterometer wind fields to the eddies, it is shown that the interaction between the anticyclonic eddy surface currents and the background wind field results in a sustained cyclonic wind stress curl at the cores of anticyclonic eddies. This eddy-induced Ekman pumping injects nutrients into the euphotic zone and thus plays a critically important role in sustaining the ecosystems trapped within the nonlinear cores of anticyclonic eddies. (Abstract ID 9662)

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ON THE USE OF SUB-MESOSCALE TRACER INFORMATION AND MESOSCALE ALTIMETRIC FIELD FOR THE CONTROL OF OCEAN CIRCULATIONS

Ocean mesoscale eddies are essential components of the ocean circulation which is currently best observed by altimetric satellites. In addition, high resolution sensors of geo-chemical tracers such as Sea Surface Temperature or Ocean Color reveal even smaller structures at the sub-mesoscale, which are not detected by altimetric satellites. These two types of scales (mesoscale/sub-mesoscale) and their related products (altimetric field/tracer image) provide a representation of the same physical/bio-geochemical reality of the ocean.

In this study, the potential benefit of these two types of complementary observations is explored, with the aim of refining the estimation of the ocean circulation. More specifically, the Finite-Size Lyapunov Exponents (FSEs) are used to extract filaments from the turbulent mesoscale velocity field. Comparing the FSLEs and the tracer patterns, it is shown that image information can be inverted to retrieve the corresponding velocity.

This process yields an improved description of mesoscale currents from altimetry as well as the knowledge of vertical motions which are essential to biogeochemical modeling. The perspectives offered by this approach, combining altimetric mesoscale observations and sub-mesoscale tracer images, will conclude the presentation. (Abstract ID 9685)
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The hydrographic structure and flow over the continental shelf between Chesapeake Bay and Cape Hatteras is subject to a number of upstream influences. A short cruise to examine the distribution of fish schools in this region and their relation to known hydrographic features (Cold Pool and the shelfbreak front) was conducted from September 9-15, 2011 on the R/V HATTERAS: IMPACT FROM RECENT FLOODING

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AN EVALUATION OF THE PERFORMANCE OF SWAN WAVE PREDICTIONS USING OFFSHORE U.S. BUOYS

In order to evaluate the wave predictions of the U.S. Naval Oceanographic Office (NAVOCEANO), we have set up models using NAVOCEANO’s implementation of the Deltas Swan wave prediction model to generate wave spectra for nine locations around the United States that are coincident with wave buoys. We evaluate the model skill by comparison with the buoy data, comparing significant wave height, peak period, and mean wave direction. A year of twice-daily SWAN model runs with hourly predictions is evaluated. In addition to comparing the entire time-series with buoy observations, the data are stratified by season, as well as local wind strength and direction, to determine the conditions for optimal (and worst) model performance. The difference in geography of the locations (complexity of the adjacent coast and exposure to remotely-generated swell) is also considered. The results can be applied to estimate how well the model will perform in conditions analogous to those considered in this study. (Abstract ID 10288)

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UPPER OCEAN TURBULENCE RESULTING FROM THE INTERACTION OF AN INTERNAL WAVE BEAM WITH A PYCNOCLINE

Numerical simulations are performed to investigate the interaction of an internal wave beam with an upper ocean pycnocline. The focus is on turbulence in the pycnocline that may result owing to nonlinearities during transmission and reflection of the internal wave field. Linear inviscid solutions based on ray theory are also used to provide guidance on the reflection dynamics of the internal wave beam. At low values of the Froude number, $Fr$, linear theory and numerics show excellent agreement. At moderate values of $Fr$, solitary wave like features form at the interface. Furthermore, higher harmonics in the reflected wave response, affected by multiple reflections by the turning points inside the pycnocline, are trapped. The simulations reveal the major role of convective instability in initiating turbulence during the tunnelling of the internal wave beam through the upper ocean pycnocline. The energetics and the phasing of internal wave energy conversion to upper layer turbulence will be quantified. (Abstract ID 10810)

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ISOLATION AND CHARACTERIZATION OF BACTERIALSAMPLES FROM ASSATEAGUE ISLAND MARYLAND

Methods for the classification and identification of bacterial organisms are constantly changing due to advances in the knowledge of molecular biology tools available for such processes. Methods used today can range from simple staining techniques that reveal morphology to more complex molecular techniques such as metagenomics that allow characterization of unculturable microorganisms. In this study, soil and water samples from Assateague Island Maryland were collected and used to inoculate Salt water and Nutrient agar media for microbial isolation and characterization. Gram staining confirmed the presence of Gram positive and Gram negative bacteria. Biochemical characterization with TSI and MacConkey agar media confirmed acid production but no lactose fermentation. We performed molecular characterization on three bacteria isolates using universal 16s rDNA primers to identify the family and genus of the organisms but unsuccessful. The three isolates included bioluminescent bacteria, an antibiotic producing bacteria and lawn forming bacteria. Future work will attempt to repeat the molecular characterization approach. (Abstract ID 9491)

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DISTRIBUTION OF THE HOLOCENE-AGE PEARL RIVER-DERIVED SEDIMENT ON THE DELTA AND CONTINENTAL SHELF

High-resolution Chirp profiling and coring reveals an elongated (~ 400 km) Holocene Pearl River- derived mud area (thickness ~ 30 m) extending from the Pearl River delta plain southwestward off the Guangdong coast to the Leizhou Peninsula. On the continental shelf off the west Guangdong Province, the mud is deposited in water depth shallower than 50 m, while to the southeast of the Pearl River estuary, the mud area can extend to the ~ 120 m isobath. Through analyzing the terrigenous sedimentary sequences from other continental shelves of the Western Pacific marginal seas, we find the initiation of the mud area can be further divided into two stages: before the mid-Holocene sea-level highstand (MHSH), the distal mud was deposited between 11.2 and 9.8 cal ka BP when the sea-level rose slowly after the meltwater pulse (MWP) -1B. The proximal mud was deposited after 9.8 cal ka BP when the sea-level rose slowly after the MWP-1C. On the MHSH, clinoform developed on the continental shelf off the west Guangdong Province, extending ~ 150 km from the Pearl River estuary. (Abstract ID 9672)

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A GLOBAL ESTIMATE OF OCEAN AGE AND TRANSIT TIMES INFERRED FROM RADIOCARBON OBSERVATIONS

A number of previous observational studies have found that the waters of the deep Pacific Ocean have an age, or elapsed time since contact with the surface, of 700 to 1,000 years. Numerical models suggest ages twice as old. Here we present an inverse framework to determine the mean age and its upper and lower bounds given GLODAP radiocarbon observations, and we show that the potential range of ages increases with the number of constituents or sources that are included in the analysis. The inversion requires decomposing the world ocean into source waters, here obtained using the Total Matrix Intercomparison method at up to 2 by 2 degree horizontal resolution with 11,113 surface sources. We find that the North Pacific at 2,500 meters depth can be no younger than 1,100 years old, which is older than some previous observational estimates. A best estimate of mean age is also presented using the mixing history along circulation pathways. Subject to the caveat that the estimate would benefit from further observations and that radiocarbon cannot rule out the presence of extremely old waters from exotic sources, the deep North Pacific waters are 1,200 to 1,500 years old, which is more in line with existing numerical model results. (Abstract ID 10004)

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TRANSPORT VARIABILITY OF THE ACC AND TELECONNECTION WITH THE SOUTHERN ANNUAL MODE (SAM) SOUTH OF AFRICA

To study the Antarctic Circumpolar Current (ACC) volume transport several cruises have taken place. The results of these cruises show snapshots without information about the time variability. To investigate the time variability of the ACC the Alfred Wegener Institute operates an array of Pressure Inverted Echo Sounders (PIES) along a satellite altimeter ground track south of Africa. PIES monitor ocean bottom pressure and acoustic travel time across the water column. A Gravest Empirical Mode (GEM, Meinen and Watts 1998) was applied to determine the geostrophic transport between the PIES. These time series were used to compute a transfer function between satellite derived transport and geostrophic transport. Satellite altimetry offers the possibility to calculate ACC transport between 1992 and 2010. A mean transport of 115 Sv and a variability of 7 Sv were derived for the Topex/Poseidon, Jason 1 and Jason 2 time period. A wavelet analysis shows that the ACC transport highly correlates with the winter and spring SAM index, whereas a direct correlation on a monthly scale could not be shown. (Abstract ID 11016)
While evidence for impacts of ocean acidification on surface water ecosystems is accumulating, little is known on the timing and the amplitude of chemical changes in the deep-sea. In contrast to shallow water organisms, which are adapted to large changes in temperature and water chemistry, the deep-sea fauna has evolved under stable environmental conditions and might be highly vulnerable to small changes in seawater chemistry. We quantified the extent of changes in deepwater pH in 5 fully-coupled climate-carbon-cycle models in the North Atlantic under a “business-as-usual” emission scenario. All models project decreases in pH exceeding 0.2 units by the year 2100 regionally reaching down to 3000 m. Typical habitats of this depth range include hotspots of North Atlantic biodiversity. Reductions in pH beyond this threshold have been reported to be detrimental to deep-sea benthic organisms. Moreover, these pH reductions exceed the natural variability of pH in North Atlantic bottom waters. Chemical changes of this amplitude are much larger than any variability that organisms have experienced during at least the last 650,000 years. (Abstract ID 12458)

INTEGRATING RESEARCH AND EDUCATION FOR BROADER IMPACTS:

Community colleges are an important pathway for students intending to complete a baccalaureate degree, particularly for groups underrepresented in science. Students at these institutions have few opportunities to engage in research and even fewer opportunities in ocean sciences. To address this need, the NSF-funded Center for Ocean Sciences Education Excellence (COSEE) Pacific Partnerships developed an internship program for community college students. Promoting Research Investigation in the Marine Environment (PRIME) is an intensive, multi-site program that over the past four years has placed 31 interns with 25 scientist mentors for 8-10 week summer research experiences in Oregon, Washington, and Hawaii. Our evaluation demonstrates that the program is a successful, replicable, and rewarding model for engaging scientists in broader impacts activities, increasing ocean literacy, and broadening participation in science. PRIME scientist mentors value the program and in working with community students. Several mentors continued supporting students to work in their labs after the internship ended. PRIME provides valuable research experience for students that can further their careers. PRIME builds partnerships between scientists, community colleges and informal science education institutions. (Abstract ID 10730)
BENTHIC OSTRACODE ASSEMBLAGES IN THE BERING SEA FROM 1976 TO 2010

To further our understanding of recent climate and oceanographic changes affecting the Bering Sea ecosystem, we are analyzing living ostracode assemblages from the Northern Bering Sea collected during research cruises on the Polar Sea (2010), the Healy (2006, 2007, 2009), Alpha Helix (1990, 1994, 1999), Karluk (1978), and the Sea Sounder (1976, 1977, 1978). Many ostracode species have a geographic distribution limited by survival/reproductive temperatures, so they are useful monitors of climatic and oceanographic change. A total of 11 species were identified from 180 Bering Sea surface samples. Temporal patterns suggest the Bering Sea assemblage composition has responded to short-term temperature changes. For example, the abundance of Pseudopunctatilla, a predominantly Arctic species, decreased from 18-19% in the 1970s to 1% by 2009. This decrease coincided with changes in the PDO and higher Bering SSTs through the mid-2000s. In contrast, Pectocythere, a temperate genus, made up ~4% of the assemblage in 1990 but increased to 14% by 2006, as SSTs rose. Lower SSTs in the late 2000s may have caused this species’ decline to 2% in 2010. Our results support that recent ocean temperature changes in the Bering Sea region are affecting benthic ecosystems. However, because many factors influence biological responses, uncertainty about the impacts of climate change on marine ecosystems and interpretations remain. (Abstract ID 11574)

OCEAN-ICE SHELF INTERACTIONS IN THE EASTERN ROSS SEA

The narrow shelf between the Amundsen and Ross Seas shows nearly freezing and low salinity surface water carried westward by the Antarctic Slope and Coastal Currents. Around Cape Crocket the coastal flow turns north and subsurface waters offshore have direct access to the Ross Ice Shelf along the Little America Trough (LAT). Undetected in summer data are intrusions of warmer Circumpolar Deep Water available at the slope. To investigate the year-long transport along this path, and the ensuing ocean ice-shelf interactions in the eastern Ross Sea, an array of moored subsurface temperature, salinity and current recorders was deployed during February 2010-March 2011 near the outer and mid portions of the LAT. We will characterize currents and water mass properties revealed by these records and two short CTD transects spanning the moorings occupied during their recoveries on the CLIVAR Repeat Section cruise. Active ocean-ice interactions are indicated by intermediate meltwater outflow in early winter, preceded by relatively warm subsurface influences throughout the summer, and followed by a weakly stratified water column that persisted during the rest of the year. (Abstract ID 12905)

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CANTON OCEAN EDDY EFFECTS BE PARAMETERIZED IN CLIMATE MODELS?

Eddy effects in the Antarctic Circumpolar Current are of leading order importance, where they oppose the meridional overturning of the mean flow. Results from control and 1% year increasing carbon dioxide runs of the CCSM using eddy-resolving resolution of 1/10 degree in the ocean and sea ice components will be compared to results using 1 degree resolution in these components. How well the eddy parameterization in the 1 degree runs performs will be evaluated by comparison with the 1/10 degree runs, where the mesoscale eddies are resolved. (Abstract ID 9308)

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SPATIAL VARIABILITY OF DIURNAL WARMING FROM SATELLITE MEASUREMENTS OF SST

Diurnal warming events between 5 and 7 K, spatially coherent over large areas (~1000 km), are observed in independent satellite measurements of ocean surface temperature. A global study of these diurnal events show that the majority of the large events occurred in the extratropics. Given sufficient heating (from solar radiation), the location and magnitude of these events appears to be primarily determined by large-scale wind patterns. The amplitude of the measured diurnal heating scales inversely with the spatial resolution of the different sensors used in this study. Validation of diurnal warming using satellite data, must consider the spatial resolution of the sensor. These results indicate that predictions of peak diurnal warming using wind speeds with a 25 km spatial resolution available from satellite sensors and those with 50-100 km resolution from Numerical Weather Prediction models may have underestimated warming. Thus, the use of these winds in modeling diurnal effects will be limited in accuracy by both the temporal and spatial resolution of the wind fields. (Abstract ID 10427)
High temperature venting occurs in all oceans at all spreading rates and the ocean residence time for cycling through hydrothermal plumes is comparable to that for thermo-haline circulation. What impact, then, might high-temperature venting have on ocean biogeochemistry? I will discuss two threads of relevant research. First, recent Mid-Atlantic Ridge studies have determined export fluxes for heat, mass, and a range of trace elements and isotopes from a single vent-site to the ocean. While that study focused exclusively on high-temperature fluxes, it can serve as a template for future work. What is required next is an integrated study of diffuse and focused axial hydrothermal flow from a basal-hosted system at a medium- to fast-spreading ridge over the decadal timescale from one volcanic eruption to the next. Second, recent work has shown that hydrothermal systems may play a significant, previously overlooked role in exporting stabilized dissolved colloidal Fe to the deep ocean and that the fate of this essential micronutrient may be intimately coupled with the organic carbon cycle, even within the first few seconds following vent discharge from the seabed. Who knows what else might be revealed from a more thorough investigation of the fate of dissolved and particulate major and trace elements and their isotopes in a dispersing hydrothermal plume?

The next section of the US GEOTRACES program, provisionally scheduled for late 2013, will be well placed to address that. (Abstract ID 9065)
The role of non-breaking wind-generated surface waves in the turbulent mixing of the upper ocean has been mostly overlooked, but recent research suggests that the effect could be strong enough to significantly alter local climates, and introducing this effect into climate models could lead to improvements in seasonal climate prediction. Surface waves, particularly those on the ocean, are normally presumed to be irrotational and to have little or no interaction with near-surface turbulence giving rise to through-surface injection of turbulent kinetic energy and distortion of turbulence by the Stokes drift. However, no real waves are irrotational, and it has been known for at least half a century that they can generate turbulence; furthermore, the turbulence is unstable to the irrotational orbital motion of the waves which leads to growth of the turbulence. By modelling the turbulence generation in a large eddy simulation we have developed a parameterisation which we then introduced into an ocean mixing model. The results show that a decrease in surface temperature of around two degrees can occur quickly under large enough waves. (Abstract ID 9674)

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TEST OF COMPOUND SPECIFIC STABLE ISOTOPE ANALYSIS FOR DETERMINING TROPHIC POSITION IN FRESHWATER ECOSYSTEMS

Compound specific stable isotope analysis (CSIA) of source and trophic amino acids is a novel technique for determining trophic position of organisms that has been employed over the past decade in marine and estuarine foodwebs. However, few studies have applied this approach in freshwater systems. To investigate the efficacy of this approach for use in floodplain rivers, controlled laboratory experiments were conducted using model organisms (Clamydomonas sp. as producer and Daphnia magna as consumer). The algae were maintained in continuous culture using defined media with ammonium chloride and calcium nitrate as nitrogen sources. Daphnia were maintained in continuous culture with the algae culture effluent serving as the Daphnia culture media. Algae were collected from the effluent and Daphnia were harvested after completion of two generations. Nitrogen salts, algae and Daphnia were analyzed for δ15N ratios. Amino acids were recovered from algae and Daphnia by acid hydrolysis and purification by ion exchange and their triﬂuoroacetyl/isopropanol ester derivatives formed. Trophic positions, calculated from whole-organism and amino acid CSIA δ15N ratios were compared to demonstrate the efficacy of the CSIA approach in freshwater systems. (Abstract ID 10611)

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IDENTIFICATION OF THE TWO ACARTIA TONSA POPULATIONS LOCATED IN NARRAGANSETT BAY AND ANALYSIS OF THE BIOLOGICAL DIFFERENCES PRESENT BETWEEN THEM

Genetically distinct clades of the estuarine copepod, Acartia tonsa, have been identified. It is hypothesized that each may have specific habitat or culturing requirements. A. tonsa resting eggs were collected from Narragansett Bay, RI, sediment in early spring and hatched out at a series of increasing temperatures. These were raised in the laboratory and adult females fixed for DNA extraction and sequencing using the rRNA and small subunit rRNA genes. Two clades were identified from eggs hatched from the same sediment sample. These were present in approximately equal proportions and these proportions remained the same at the different hatching temperatures. Separate cultures of each clade were established and mating experiments were set up where unmated adults of the same and opposite clades were placed together. Eggs produced by females crossed with males of the opposite clade were not viable. These findings support the suggestion that these populations represent reproductively isolated cryptic species. (Abstract ID 10861)

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PREDICTING THE IMPACTS OF CHANGING ENVIRONMENTAL CONDITIONS ON LOWER TROPHIC LEVEL ECOSYSTEM DYNAMICS IN THE BERING SEA

Despite frequently being ice covered until March the continental shelf of the eastern Bering Sea is one of the world’s most productive marine ecosystems, with its fisheries representing half of the marine harvest in United States waters. Large changes in lower trophic level ecosystem dynamics have been observed on inter-annual and inter-decadal time scales, although the mechanisms giving rise to these changes are not well understood. We present a lower trophic level ecosystem model for the Bering Sea that has been developed to explore relationship between climate, ocean conditions, productivity and flow of energy through the food web. The core of the ecosystem model is a Nutrient-Phytoplankton-Zooplankton model which has been coupled to an ice-biology module and to a benthic sub-model. This modeling effort is a major advancement in our understanding of the Bering Sea’s role in the global carbon cycle and thus its capacity for regulating climate feedbacks. Model predictions of the influence of future climate change on the ecosystem of the Bering Sea will be discussed and model predictions of the influence of changing environmental conditions on lower trophic level ecosystem dynamics in the Bering Sea presented. (Abstract ID 9430)

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ENHANCEMENT OF REVERSE ESTUARINE CIRCULATION EVENTS AND COASTAL CONNECTIVITY DUE TO PLUME INTRUSIONS FROM AN ALONGSHORE ESTUARY

Connectivity between the coastal ocean and estuaries as well as between adjacent estuaries along a coastline can impact both the physics as well as the biology of these systems. Realistic hindcast ROMS simulations of the Pacific Northwest including the Salish Sea and Columbia River estuaries and the coastal ocean off Washington and Oregon show these connections. The Columbia River plume downwelling favorable winds can intrude into the Salish Sea via the Strait of Juan de Fuca. These frequent events reverse estuarine circulation in the Strait and create an important transport pathway between the nearshore coastal ocean and the Salish Sea. While observations of these interactions have been made previously, particle tracking, model dye releases, numerical experiments, and a detailed examination of the total exchange flow allow us to quantify the extent of the interaction between these two estuaries. In particular we find that wind alone can create these reversals, however the presence of the Columbia River plume strengthens the reverse estuarine circulation allowing for enhanced connectivity between the nearshore coastal ocean, the Columbia River and the Salish Sea. (Abstract ID 12465)

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BIOPHYSICAL RESPONSE TO ENSO DIVERSITY IN THE EASTERN TROPICAL PACIFIC OCEAN

ENSO significantly influences atmospheric and ocean circulations in the Pacific sector, which it turn affect biological production and ecosystem characteristics. Much of our existing knowledge about the relationship between ENSO and biology is with respect to the classic El Niño, which has maximum warming in the eastern equatorial Pacific (EP). However, since the 1990s, there have been frequent occurrences of a new type of El Niño that has maximum warming in the equatorial central Pacific (CP). The impact of the latter on biology is not well understood. Biophysical responses in the eastern tropical Pacific to the 1997-98 and 2009-10 El Niño (i.e., the strongest EP- and CP-El Niño event in the last three decades, respectively) are analyed using satellite observations and reanalysis products. Significant differences in chlorophyll-a concentration are found between the two events associated with different patterns of anomalies for the physical variables. An adjoint tracer analysis is used to examine the difference in the origin and pathway of water masses in the upper eastern tropical Pacific that control the difference in nutrient supply and thus chlorophyll-a concentration. (Abstract ID 10511)

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OXYGEN TRENDS IN THE GLOBAL OCEAN

Global ocean models predict that, for realistic CO2 emission scenarios, the oceanic oxygen inventory should decrease about 3 times faster than what we would expect solely from the decreased oxygen solubility of warmer temperature. In addition, the need to produce ever greater quantities of food for a growing world population has driven to the widespread use of fertilizers in agriculture. This caused increased nutrient fluxes to the coastal ocean, where ensuing increases in primary productivity and in the vertical flux of organic matter are presumably the primary cause of decreasing oxygen near the bottom in several coastal settings. Yet it is often difficult to detect significant oxygen trends in the global ocean due to the lack of historical oxygen data and shortness of time series. Using a global ocean database, calculations reveal that median oxygen decline rates are more severe in a 30 km band near the coast than in the open ocean (>100 km from the coast). Percentages of oxygen time series with negative oxygen trends are also greater in the coastal ocean than in the open ocean. (Abstract ID 10869)

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DYNAMIC CO2 ERRORS AS ESTIMATED FROM SHIP-BASED CTD CASTS, AND SOME MODELING

Near slack tide in the Saguennay fjord, three CTD casts with two optode 3830 sensors and one SBE43 sensor were performed at vertical descent and ascent speeds of 0.14, 0.30 and 1.0 m s-1 respectively. Winkler titrations were performed at ten depths immediately before and after this set of CTD casts. The difference in oxygen measurements between upcasts and downcasts was...
BIDIRECTIONAL REFLECTANCE DISTRIBUTION CORRECTION OF ABOVE-WATER AND SATELLITE WATER-LEAVING RADIANCE IN COASTAL WATERS

Water-leaving radiances, retrieved from in situ or satellite measurements, need to be corrected for the bidirectional properties of the measured light in order to make them comparable with each other. The current satellite operational algorithm for this correction is optimized for typical oceanic waters. In order to analyze the bidirectional reflectance distribution function (BRDF) of case 2 waters a dataset of typical remote sensing reflectances was generated through radiative transfer simulations for a range of viewing geometries. A case 2 water focused remote sensing reflectance model is proposed based on this dataset to correct above-water and satellite water-leaving radiance data for bidirectional effects. The proposed model is first validated with a year-long time series of in situ above-water measurements acquired by colocated multi- and hyperspectral radiometers with different viewing geometries installed at the Long Island Sound Coastal Observatory (LISCO) and then on MODIS data for the LISCO site. Following successful validation original dataset simulated for moderate case 2 waters a dataset of typical remote sensing reflectances was generated through radiative transfer simulations for a range of viewing geometries. A case 2 water focused remote sensing reflectance model is proposed based on this dataset to correct above-water and satellite water-leaving radiance data for bidirectional effects. The proposed model is first validated with a year-long time series of in situ above-water measurements acquired by colocated multi- and hyperspectral radiometers with different viewing geometries installed at the Long IslandSound Coastal Observatory (LISCO) and then on MODIS data for the LISCO site. Following successful validation original dataset simulated for moderate case 2 waters is expanded for a broader range of open ocean and coastal water parameters. (Abstract ID 10343)

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NITROGEN ISOTOPES IN THE ORGANIC MATRIX OF BIVALVE SHELLS: A RECORDER OF ANTHROPOGENIC NITROGEN POLLUTION.

Stable nitrogen isotopes (δ15N) in organic tissues have been extensively used to detect anthropogenic nitrogen inputs into aquatic systems, as waste-water is typically enriched in 15N. However, it has been difficult to extend records of anthropogenic nitrogen input back through time. δ15N signatures in the organic matrix of bivalve shells offer the potential to extend such records to the past using museum collections or fossil specimens. Mytilus edulis shells from the highly polluted Scheldt estuary in the Netherlands were more enriched in 15N (δ15N = +13.3±0.5‰ n= 17) compared with Chlamys uniserialis shells from the less impacted Ouargueli River in the Central African Republic (4.4±0.5‰ n= 3). Pecten maximus shells from the French coast ranged from +8.3±0.6‰ in the Bay of Brest to +3.1±1.2% at 200m depth. Average δ15N shell and tissue 15N values were highly correlated along this depth gradient (shell=0.82*tissue+1.46, R2=0.94, n=4). These preliminary data suggest that the organic matrix of bivalve shells record environmental 15N values from rivers to estuaries to the ocean and can record anthropogenic nitrogen pollution across a large ecological gradient. (Abstract ID 10402)

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OCEAN SURFACE SALINITY TEXTURE WITHIN THE SUBTROPICAL REGIME

The climatic view of the ocean surface salinity (OSS) constructed from over 50 years of ship-based observations depicts a smooth field of salty water delineating the subtropical regime. In contrast, model output; satellite derived sea surface height and ocean surface temperature; ship-based underway measurements of SST, OSS and hull mounted Acoustical Doppler Current Profiler, reveal an abundance of mesoscale and sub-mesoscale structures. The meltane of ~100 km diameter eddies of salty and fresher components, along with larger scale circulation and Ekman convection, are fundamental in compensating the regional net evaporation. The OSS in situ data are limited in spatial and temporal coverage. Aquarius now provides data that reveal the source and evolution of the mesoscale OSS features, allowing improved understanding of their role in balancing the subtropical hydrological cycle. (Abstract ID 10493)

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THE IMPORTANCE OF NONLINEAR POPULATION DYNAMICS TO EARLY LIFE HISTORY STAGES OF MARINE FISHES

Long-term scientific surveys of the fish communities in the California Current System and the Northeast U.S. Continental Shelf System reveal striking differences between the dynamics underlying larval, recruitment, and adult life history stages. We use time series forecasting models to explore the temporal dynamics of over 100 fish stocks on Georges Bank and in the Southern California Bight. We demonstrate that, for larval fishes, exploited species are...
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SMALL-SCALE HYDRODYNAMICS IN TIDAL RIVER JUNCTIONS IN THE SACRAMENTO-SAN JOAQUIN RIVER DELTA

In branching channel networks, such as might be found in estuaries, channel junction flow dynamics may dominate large-scale dispersion. We focus on the Sacramento-San Joaquin River Delta, the complex of tidal channels upstream of San Francisco Bay, analyzing the structure and variability of several junction flow features. Observations made in August 2011 at three junctions display complex small-scale hydrodynamics. A boat mounted Acoustic Doppler Current Profile transacted along the perimeter of each junction for seven to eight hours. With the acquired water column velocity and local temperature data, we examine time variability of small-scale flow features at tidal river junctions. Also, nine Android phone drifters were released throughout one day to survey how tidal river junctions may affect near-field dispersion. Inner junction dynamics seem highly variable over a few hours with the formation and decay of bores and separation, recirculation, and subduction zones. Although small relative to the total distance traversed by the drifters, these flow features may significantly impact drifter trajectories and large-scale dispersion. Small-scale junction flow features appear to be linked mostly to plan-form geometry and depth variations. (Abstract ID 12139)

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IN SITU ELECTROCHEMISTRY IN EXTREME ENVIRONMENTS: FROM SEAFLOOR HYDROTHERMAL VENTS TO THE DEEP SUBSURFACE BIOSPHERE

Numerous recent advances in ocean science research have been enabled by the development of technological engineering capabilities coupled to the adaptation of cutting edge sensor methodology. Electrochemical methods have often been used to study environmental processes, and in recent years there have been significant advances allowing for real time geochemical measurements with high temporal and/or spatial resolution. One such powerful technique is that of in situ voltammetry, where current is measured while scanning an entire voltage range of the solid-state mercury/gold electrode, allowing the simultaneous measurement of more than one species at a given time. Voltammetry is particularly useful for addressing questions of reductive species distribution and transformation rates at seafloor hydrothermal systems, however significant engineering and methodological challenges exist. Presented here are recent results and lessons learned from a series of deployments of a multi-parameter in situ electrochemical analyzer on DSV Jason-II and DSV Alvin at active vent sites on Loihi Seamount, Hawaii, and CORK Subseafloor Observatories located atIODP boreholes on the Juan de Fuca Ridge Flanks. (Abstract ID 12733)

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THREE YEAR TIME-SERIES OF CARBONATE CHEMISTRY DYNAMICS AND BIOGEOCHEMICAL PROCESSES WITHIN A TROPICAL ATLANTIC CORAL REEF ENVIRONMENT

A three-year time-series of autonomous observations of air-sea pCO2 temperature, salinity and oxygen have been acquired within the La Parguera Marine Reserve, Puerto Rico at the Atlantic Ocean Acidification Test-bed. These observations, obtained using a MAPCO2 system, are coupled with autonomous meteorological (wind, rain), and light (PAR) measurements acquired at the near-by ICON/CREWS station. Together with weekly discrete carbonate chemistry sampling, we apply this time-series to explore the temporal dynamics and primary controls on carbonate system within a shallow water Atlantic tropical reef environment and consider how such dynamics might change as a consequence of continued ocean acidification. (Abstract ID 11924)

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TIME SERIES OF VERTICAL FLUX OF ZOOPLANKTON Fecal PELLETS ON THE CONTINENTAL SHELF OF THE WESTERN ANTARCTIC PENINSULA

We investigated the contribution of zooplankton fecal pellets to particulate organic carbon (POC) flux over the continental shelf of the Western Antarctic Peninsula to better understand the possible effects of changes in zooplankton community structure, due to climate change, on fecal pellet export. Fecal pellets were collected at 170 m depth in a moored sediment trap from the possible effects of changes in zooplankton community structure, due to climate change, on

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IN THE UNDERGRADUATE CLASSROOM

New participatory courses in Marine Sciences are now a central component of the Rutgers undergraduate Marine Science curriculum. The courses use new datasets enabled by ocean observations, in particular, the interactive exploratory capabilities of underwater gliders. The overall program is designed to increase repeated contact with students similar to the graduate experience. The main sequence is a 1.5 credit research course with changing topics that can be taken multiple times throughout the undergraduate career. Three levels of participation have been documented, starting with a "watch-one" phase, where students are learning to be part of a research team, a "do-one" phase, where students are active researchers, and a "teach-one" phase, where senior-level students act as mentors to the younger students. Initial feeder courses are used to involve students as early as their freshman year, with topics ranging from introductory overviews to initial skills building courses for research. A capstone course is Communicating Ocean Science, where students learn and have participatory experience in communication to informal audiences. Results include a 10-fold increase in undergraduate participation in the research lab. (Abstract ID 12386)

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IMPACT OF OCEAN OBSERVATIONS ON HURRICANE IRENE INTENSITY FORECASTS

Hurricane Irene followed a track that curved northward over the Bahamas and ran directly over the U.S. east coast from Cape Hatteras to New England, causing severe storm surges and intense inland flooding. While the ensemble of atmospheric forecast models accurately forecast the track, intensity was consistently over predicted. IOOS data are used to better understand the intensity forecast. The highly stratified Mid Atlantic waters were monitored with a pair of gliders during the hurricane, documenting the rapid cooling and mixing of the warm surface layer with the cold pool, resulting a deeper thermocline and cooler surface waters. Satellite imagery revealed the greatest cooling at midshelf, where the availability of cold pool water is greatest. Atmospheric hindcasts of Hurricane Irene using the observed variation in sea surface temperature reduce the intensity of the storm, in some cases by 15 knots, bringing the hindcasts in line with buoys observations. Beyond the initial wind forcing, HF Radar surface current and drifter observations indicate the inertial tail of the storm lasted for several days, and was most intense over the mid shelf region. (Abstract ID 12310)

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THE USE OF REAL-TIME DATA FROM GLOBALLY-DISTRIBUTED GLIDER MISSIONS IN THE UNDERGRADUATE CLASSROOM

New participatory courses in Marine Sciences are now a central component of the Rutgers undergraduate Marine Science curriculum. The courses use new datasets enabled by ocean observations, in particular, the interactive exploratory capabilities of underwater gliders. The overall program is designed to increase repeated contact with students similar to the graduate experience. The main sequence is a 1.5 credit research course with changing topics that can be taken multiple times throughout the undergraduate career. Three levels of participation have been documented, starting with a "watch-one" phase, where students are learning to be part of a research team, a "do-one" phase, where students are active researchers, and a "teach-one" phase, where senior-level students act as mentors to the younger students. Initial feeder courses are used to involve students as early as their freshman year, with topics ranging from introductory overviews to initial skills building courses for research. A capstone course is Communicating Ocean Science, where students learn and have participatory experience in communication to informal audiences. Results include a 10-fold increase in undergraduate participation in the research lab. (Abstract ID 12386)
Increased freshwater input into the Nordic Seas could ultimately lead to changes in the Atlantic Meridional Overturning Circulation. Freshwater anomalies in the Nordic Seas are often more strongly influenced as connected to the inflow from the Arctic, which is modulated by anomalous Arctic-river runoff as well as by net melting of Arctic sea ice and Greenland ice cover, and hence strongly influenced by global warming. We investigate Nordic Seas’ freshwater anomalies in a hydrographic dataset collected within the NISE project and show that those anomalies are mainly located in the Norwegian Sea. This location suggests a connection with the Arctic rather than the Arctic inflow. The routing of freshwater deduced from the observations is compared with that of a multi-century Bergen Climate Model simulation. Here, preliminary results show that the Arctic inflow dominates the Nordic Seas’ freshwater budget. The implications for the role of Arctic vs. Atlantic inflow on Nordic Seas freshwater anomalies both in predictions and future climate change are discussed. (Abstract ID 10952)

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EFFECTS OF NUTRIENTS FORMS, RATIOS AND STOICHIOMETRY ON PELAGIC AND BENTHIC PROCRoccus spp.

The genus Procroccus includes six planktonic species that form high-biomass blooms, and at least nine predominantly benthic toxogenic species. Four of the planktonic, including P. minimum, the only plankton reported to be toxogenic, are among the most commonly recognized harmful algae that are increasing in frequency, duration, and magnitude globally. Growth studies suggest a species group that generally grows maximally at inorganic nutrient N:P ratios just below Redfield proportions. However, field studies indicate that planktonic Procroccus species bloom when nutrients are at high N:P ratios relative to Redfield proportions. In the benthic species P. lima complex, toxin production has been shown to be inversely related to nutrient limitation, increasing when nutrient ratios are above Redfield proportions. Mixotrophy and allelopathy can play an important role in the interactions among planktonic Procroccus species, diatoms and other dinoflagellates, but little information is available for benthic taxa. Given the projection for increasing land-based nutrient export to continue, it is expected that there will be further expansion of planktonic harmful Procroccus spp, and globally more intensive or more toxic benthic occurrences in the future. (Abstract ID 9869)

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REEF BUILDING CORALS RELY ON SYMBIOTs FOR ENERGY AND NUTRIENTS OVER A LARGE DEPTH RANGE

Corals living in shallow waters typically acquire their nutrients and energy from their photosynthetic symbiotic zooxanthellae, whereas deeper corals may rely to a lesser extent on photosynthetic derived materials due to lower light levels. Whether these deeper corals feed to a greater extent is hotly debated within the community. We separately measured the stable carbon and nitrogen isotope signatures of the coral host and symbiotic zooxanthellae of three species of reef building corals (Porites astreoides, Montastraea cavernosa, and Montastraea faveolata) along a depth gradient (3–40 m) of the Florida Reef Tract. The δ13C and δ15N values of the zooxanthellae and host tissue of all three species became progressively more depleted in 13C and 15N with depth. The lower δ15N values at depth suggest that feeding is actually less important at depth. Further, we found a strong correlation between the δ13C values of the host and their zooxanthellae at all depths, suggesting that even as photosynthetic rates decrease with depth, hosts continue to acquire most of their carbon from their symbionts and do not rely to any greater extent on feeding heterotrophically. (Abstract ID 10436)

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ASSESSING THE IMPACT OF OCEAN ACIDIFICATION ON MARINE PLANKTONIC CALCIFICATION USING SATELLITE ANALYSIS AND EARTH SYSTEM MODELING

Marine planktonic calcifiers such as coccolithophores, foraminifera, and pteropods play a fundamental role in the ocean carbon system, a role that may be modified substantially by rising atmospheric CO2, and climate change. We will present results from the initial phase of this study to better constrain the magnitude of ocean acidification and climate change impacts on marine inorganic carbon dynamics. In particular we will present improvements to our primary numerical tool, the new Community Earth System Model, version 1 (CESM v1), a variant of the widely used Community Climate System Model (CCSM) that includes fully interactive marine ecosystem and global carbon modules. Comparisons will be made to the earlier version (CCSM v3.0) coccolithophore fields as well as to historical satellite remote sensing (SeaWIFS, MODIS). Characterization of the biogeographic niche for marine calcifiers; i.e., the temperature, circulation and seawater chemistry `phase-space` for calcifiers will be shown. (Abstract ID 9542)

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BOTTOM-UP EFFECTS ON INTERANNUAL VARIABILITY

Differences in surface area-to-volume ratio as a function of phytoplankton size are often reflected as different half-saturation constants for nutrient uptake. We consider the impacts of this difference for the interannual variability of different size classes of phytoplankton. We compare two models with allometric grazing of different size classes. In one model (described in Galbraith et al., Biogeosciences 2010) the growth rates of large and small plankton are set equal to each other. In the other different nutrient limitation is allowed. We examine the impacts of the differing formulations on interannual variability, showing that the bottom-up effects enhance interannual variability in large plankton during the spring, but suppress it during the fall. We examine the reasons for this difference, paying particular attention to the difference in the light-driven spring bloom versus the nutrient-driven fall bloom. (Abstract ID 11280)

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DEFINING THE NICHE OF HARMFUL ALGAE VIA ECOGENOMICS AND TRANSCRIPTOMICS

Despite considerable efforts, a comprehensive understanding of the factors that promote these harmful algal blooms has been lacking because the biochemical pathways that allow their dominance relative to other phytoplankton within specific environments have not been identified. We sequenced the first HAB genome (A. apophagophernes) and compared its gene complement to those of six competing phytoplankton species identified via metaproteomics. Using an ecogenomic approach, we specifically focused on the genes that may facilitate dominance within the environmental conditions present during blooms (high levels of organic matter, metals, and turbidity). A. apophagophernes possesses a larger genome (56 mbp) and more genes involved in light harvesting, organic carbon and nitrogen utilization, and encoding siderophore- and metal-requiring enzymes than competing phytoplankton. Collectively, these findings suggest that anthropogenic activities resulting in elevated levels of turbidity, organic matter, and metals have opened a niche within coastal ecosystems that ideally suits the unique genetic capacity of A. apophagophernes and thus has facilitated the proliferation of this and potentially other HABs. Testing of this hypothesis via transcriptomics will also be discussed. (Abstract ID 11690)

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A NEW TYPE OF WAVE MOTION IN INHOMOGENEOUS, COMPRESSIBLE FLUIDS IN A GRAVITY FIELD

We consider a particular class of wave motions in fluids, in which pressure remains constant in each moving fluid parcel. An exact, analytic solution of linearized hydrodynamics equations obtained is described that describes the wave motion in inhomogeneous, compressible, rotating fluids with piece-wise continuous parameters in a uniform gravity field. The solution is valid under surprisingly general assumptions about the environment and reduces to some classical wave types in appropriate limiting cases. Free waves in bounded and unbounded domains as well as excitation of wave fields by a point source are considered. Edge waves propagating along vertical and inclined rigid boundaries are found in rotating and non-rotating fluids. Allowance for three-dimensional variation of the sound speed and for arbitrary density stratification, including density discontinuities, makes the exact solution an attractive model of acoustic-gravity waves in a coupled ocean-atmosphere system. The new wave type complements classical exact solutions known as the Rossby, Lamb, Kelvin, and Poincare waves, which provide much of the conceptual foundation of modern geophysical fluid dynamics. (Abstract ID 9320)

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LINKING PHYTOPLANKTON BIODIVERSITY AND PRODUCTIVITY IN AN ECOSYSTEM MODEL OF THE CALIFORNIA CURRENT SYSTEM
A self-emergent ecosystem model that strives to represent phytoplankton diversity of the California Coastal System (CCS) is utilized in order to resolve the relationship between primary productivity and species richness. In a numerical experiment, biomass and rates of productivity were calculated for a series of model runs that included monoucultures or polycultures of individuals drawn from the top 10 phytoplankton that emerged from a complete model run (n=78 phytoplankton). More than one phytoplankton type was necessary to maximize modeled resource use and productivity, as evidenced by over yielding in the polyculture. As a result, we identify a minimum of four phytoplankton types necessary to adequately capture modeled primary productivity in the CCS, and discuss the ecological mechanisms (e.g., complementarity, facilitation, selection) that structure the modeled phytoplankton community. (Abstract ID 10719)

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A SHIP-BASED INSTRUMENT FOR THE DISCRIMINATION OF PHYTOPLANKTON TAXA USING SPECTRAL FLUORESCENCE SIGNATURES AND IMAGING MULTIVARIATE OPTICAL COMPUTING (IMOC)

Research continues on the development of an instrument for the in situ discrimination of phytoplankton size and community composition that is simple, relatively inexpensive, and has a low power requirement. A ship-based version has been constructed and tested in the field at Martha’s Vineyard Coastal Observatory (MVCO). The key components of the instrument are interference filters (called multivariate optical elements; MVEs) that are based on the principle of spectral fluorescence combined with multivariate optical computing for pattern recognition. These have been designed, constructed, and used to classify Synechococcus spp. (a PE-containing cyanobacterium), Thalassiosira pseudonana and T. weissflogii (diatoms), Emiliana huxleyi (a coccolithophore), and a Tripedella genotype. Data collected at MVCO are consistent with those from the Imaging FlowCytob and with respect to cell concentrations and approximate cell sizes. Work continues on background and flat-field corrections to improve our detection of the smallest cells (e.g., Synechococcus). (Abstract ID 11881)

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INCREASED ABUNDANCE AND ECOLOGICAL IMPLICATIONS OF PLASTIC MICRODEBRIS IN THE NORTH PACIFIC SUBTROPICAL GYRE

Reports of plastic debris in the North Pacific Subtropical Gyre (NPSG), particularly microdebris less than 5 mm in diameter, have been cause for significant public concern. However, the distribution, abundance, and ecological effects of pelagic plastic debris remain largely unknown. We compared neat samples from 1972-3 to those collected in 2009-2010. The median concentration of neutrionic plastic microdebris increased from 0.001 particles m^{-2} in 1972-3 to 0.310 particles m^{-2} in 2009-2010. Microdebris particles were inhabited by a subset of the North Pacific Subtropical rafting community, and associated with increased abundance of the pelagic insect Halobates sericeus. In a series of 24-hour incubation experiments, neutrionic zooplankton ingested polyethylene spheres 25-35 μm in diameter. These results are a first step to understanding the ecological implications of microdebris in the NPSG. (Abstract ID 10407)

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LIMITS TO DISPERAL FOR MARINE PLANKTON

Distributional range shifts are one of the primary biological responses to climate change expected and observed among marine plankton species. However, plankton must have sufficiently high dispersal potential to be able to track spatial changes in their ocean habitat. Here we examine the genetic-geographic structure of a cosmopolitan planktonic copepod, Haloptilus longicornis, across a basin-scale longitudinal transect in the Atlantic Ocean (48° N – 44° S), in order to evaluate the dispersal capacity of this species across a number of environmental gradients. We find that although the species is present throughout subtropical and tropical waters in the Atlantic, a region of low abundance in equatorial latitudes corresponds to a population genetic break in this species (Fst = 0.17, P < 0.005). Our results imply limited dispersal across the tropics, and the genetically intermediate population in this region must contribute few migrants to populations in the northern and southern subtropical gyres. We conclude with the suggestion that regions of sub.visual, in which the species consistently occurs in lower abundance, may serve as important dispersal barriers for holoplankton species. (Abstract ID 10065)

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TRANSITION IN THE GLOBAL GEOMETRY OF ARCTIC MELT PONDS

During the Arctic melt season, the surface of the ice cover undergoes a remarkable transformation from vast expanses of snow covered ice to complex mosaics of ice and melt ponds. Sea ice albedo, a key parameter in climate and ecosystem modeling, is determined by these configurations. We have found that melt pond evolution exhibits a critical transition from simple Euclidean shapes to self-similar regions with boundaries similar to space filling curves of fractal dimension 2. The critical length scale in terms of area is around a hundred square meters. Our findings demonstrate that there are universal features of Arctic melt pond evolution which are similar to phase transitions in statistical physics, and provide a novel path to simplify the treatment of melting sea ice in climate models. (Abstract ID 12818)

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SHRINKING SNOW CAPS AND RISING TIDES - RESPONSE OF THE ARABIAN SEA ECOSYSTEM TO CLIMATE CHANGE

Over the past 10 years the Arabian Sea ecosystem has witnessed rapid changes linked to the warming trend over Eurasia. Since 1998, the warming trend has led to intensification of wind-driven upwelling along the coasts of Somalia, Oman and Yemen and record increases in...
phytoplankton blooms over the entire western Arabian Sea. The impacts of the warming trend have not been limited to the southwest monsoon. Since 1998, winter convective mixing during the northeast monsoon (NEM) has been weakening, but despite this trend, Chl concentrations in the Arabian Sea have been on the rise due to unprecedented blooms of the green heterotrophic dinoflagellate Noctiluca scintillans. Thick blooms of Noctiluca have become a regular feature of the Arabian Sea during the NEM, replacing diatoms as the dominant winter-bloom forming phytoplankton. Here we present eco-physiological data from several cruises to the Arabian Sea which suggests that the appearance of this organism may be tied to the shoaling of oxygen deficient waters in the northern Arabian Sea. The implications of this organism for food chain are also discussed. (Abstract ID 9924)

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TIDAL WAVE REFLECTANCE AND NON-LINEAR TRANSFER IN THE ELKHORN SLOUGH, CA

Elkhorn Sough is a shallow, tidally-forced estuary directly connected to Monterey Bay. The short slough length and significant tidal storage due to flats and marshes create an ebb-dominated slough. Analysis of 10 days of co-located velocity and pressure observations measured in the Elkhorn Sough, CA, in 2009 revealed a 20% energy loss between the incoming and outgoing tidal wave. It was found that, energy from primary tidal constituents was transferred to higher harmonics making the outgoing wave different from the incoming wave. Owing to a lack of statistical confidence for the 10-day data set, four longitudinally placed co-located velocity and pressure sensors throughout the slough for 60 days in September to October of 2011. The new time series are separated into incoming and outgoing tidal waves by using the cross-spectral analysis of co-located pressure and velocity data. Tidal wave reflectance, as a function of frequency for the tidal constituents and corresponding overtides, dissipation rates between each station, and non-linear transfers using a bi-spectral analysis will be presented. (Abstract ID 9758)

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WIND INDUCED CHANGES ON THE AGULHAS SYSTEM

The connection between Indian Ocean and South Atlantic at the Agulhas retroflection area is limited to the south by the Subtropical Front, and is largely controlled by the location of the zero wind stress curl. Since the late 1960s, the circumpolar westerlies have been showing a poleward shift in response to the positive trend of the southern annular mode (SAM). To access the impact of these changes of the atmospheric forcing on the Agulhas region, an implementation of the HFCOM, forced with monthly means of NCEP/Reanalysis since 1948 was run. The results show a positive trend in sea surface height, salinity and temperature from 1970 to 2010. The model results also show a poleward shift of the Subtropical Front. The positive trend of these fields in the Agulhas System region and the displacement of the Subtropical Front follow the positive trend of the SAM index, with higher values during austral summer months. These changes reflect a southward drift of the wind forced ocean gyres, and a widening of the connection between the two basins. (Abstract ID 10608)

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OBSERVATIONS OF CIRCULATION AND WATER MASS TRANSFORMATION IN THE EASTERN CHUKCHI SEA

Pacific water enters the Chukchi Sea through Bering Strait and progresses northward, impacting aspects of the western Arctic Ocean including ice-melt and ventilation of the upper halocline. In summertime the Alaska Coastal Current (ACC) is the major conduit for warm and fresh Pacific Water. However, to date there have been limited direct observations of the current. Here we use hydrographic and velocity data from multiple summertime surveys to investigate the circulation and intra-seasonal variability of water masses in the Chukchi Sea, with emphasis on the ACC. Contrary to earlier thinking, we demonstrate that the ACC is at times weakly baroclinic, highly variable along the shelf, and can transport multiple water masses that can be objectively defined based on their physical properties. We argue that, in early summer, mixing between surface ACC water penetrating the Chukchi Sea and winter water already on the shelf leads to the formation of a new water mass. This Chukchi Summer Water has the correct density to ventilate the upper halocline, potentially weakening its ability to insulate the deeper warm Arctic water. (Abstract ID 10755)

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PHOTOSYNTHESIS-IRRADIANCE RELATIONSHIPS IN SEAWATER OF THE EAST CHINA SEA IN THE CONTRAST SEASON (WINTER AND SUMMER)

Photosynthesis-irradiance relationship (P-E curve) of marine phytoplankton is the key factors for the estimation water column primary production based on satellite ocean color information. P-E curve can be described by an equation with two parameters, the maximum rate of photosynthesis (Pm) and the initial slope (α). On board incubation of P-E curves were carried out from January and July cruises of 2008 in the East China Sea. The January and July cruises were designated to represent the winter and summer conditions, respectively. In winter, only little variation of (Pm,α) were found due to the well-mixed conditions in the euphotic layer. In summer, very high variation of (Pm,α) were found due to the strong stratified conditions in the euphotic layer. The shelf-averaged values of (Pm,α) in the shallow mixed layer were in general higher than the values below the mixed layer. The shelf-averaged values of water column primary production calculated based on the photosynthesis-irradiance relationships were 186±117 and 775±677 mgC·m⁻²·d⁻¹ in winter and summer, respectively. The results further demonstrated the overestimation of standard products of satellite-based primary production. In addition, the spatial distribution of measured primary production was counter to the satellite-based primary production in winter. (Abstract ID 9697)

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NUMERICAL INVESTIGATION OF COASTAL CIRCULATION DYNAMICS NEAR CAPE HATTERAS, NORTH CAROLINA

Coastal circulation near Cape Hatteras (CH), North Carolina is highly complex due to the convergence of the shelf currents, presence of several ocean fronts and influence of the Gulf Stream. While the interaction of shelf flows with the Gulf Stream is of tremendous importance as it often results in significant export of coastal water to the deep ocean, the dynamics of this interaction are not well understood. In this study, we used a nested regional ocean model to hindcast circulation states in summer (August, 2004) and winter (January 2005) periods, when extensive coastal sea level, in situ temperature, salinity and velocity observations are available. Model-data comparisons show major features in the observations are reasonably well simulated, allowing us to perform detailed analyses on along- and cross-shelf transport, momentum and kinetic energy balances to further quantify complex circulation variability and shelf water entrainment processes near CH during these two periods. In this presentation, we will describe our model setup and model skill assessments, and discuss major findings derived from these model diagnoses. (Abstract ID 11637)

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DELIVERY AND ACCUMULATION OF PARTICULATE ORGANIC MATTER ALONG THE WEST COAST OF NORTH AMERICA: THE IMPORTANCE OF SMALL MOUNTAINOUS RIVERS

We investigate the concentration and biogeochemical composition of particulate organic matter (POM) in the suspended load of three small mountainous rivers from the west coast of the United States (Umpqua, Eel and Salinas) and in surface sediments from their associated depositional rivers located adjacent to the shelf. Samples collected at different fluvial discharges, including several flood events, and at different locations and water depths along the shelf were analyzed for a variety of parameters to evaluate POM provenance and composition. Measurements include carbon and nitrogen contents, stable carbon and nitrogen isotopic compositions, radiocarbon compositions and yields of organic compounds derived from
distinct biologic (e.g., biomarkers such as lignin phenols, cutin acids, amino acid products) and combustion (e.g., pyromarkers such as polycarboxylated benzenes) sources. These data are used to compare and contrast the source, age, and biochemical make-up of POM transported and deposited by each river system. Because the river systems have distinct hydrodynamic, geomorphology, hydrology and land use patterns, and their associated shelves display significant contrasts in oceanographic characteristics such as wave energy, currents, productivity and bathymetry; we use the observed trends to gain insights on the factors that control the delivery, transformation and fate of organic matter across this continental margin. (Abstract ID 10251)

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CARBON DIOXIDE FLUXES IN THE EASTERN NORTH ATLANTIC DURING SUMMER AND AUTUMN: A COMPARISON BETWEEN 2006 AND 2011

In the framework of the CARBOCHANGE Project, the variability of fugacity of CO₂ in the Eastern North Atlantic region is being studied using a voluntary observing ship. The QUIMA

CONTROL PROCEDURE TO ESTIMATE ERROR COVARAINCES

The error variance of an analysis is an important piece of information that is often required by users. However, accurate calculation of this usually relies on good knowledge of the error covariances of the background field and observations that were combined to make the analysis. These may not be available for all locations. We outline an approach to obtaining analysis uncertainty that does not depend on knowledge of these error covariances. The approach uses a special analysis that indicates the influence of observations at each analysis grid point. This is then converted to analysis error variance using coefficients that are estimated from the data that formed the analyses. The approach is demonstrated for the objective analyses of the EN3 dataset. These are monthly estimates of the temperature and salinity of the ocean running from 1950 to present. However, the method would be applicable to other variables and other spatial and temporal scales. It is also shown that the approach has the benefit of highlighting areas where there may be problems in the analyses. (Abstract ID 9686)

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IMPACTS OF TEMPORAL CO₂ AND CLIMATE TRENDS ON THE DETECTION OF OCEAN ANTHROPOGENIC CO₂ ACCUMULATION

While the oceanic CO₂ sink is estimated to be 25% of annual emissions, this is likely to decrease over the next 100 years as ocean temperatures increase and the ocean becomes saturated with CO₂. Currently oceanic anthropogenic carbon dioxide (AnthroCO₂) is approximated by linear relationships between dissolved inorganic carbon (DIC) and a suite of physical and biological ocean parameters. This technique depends on stable regression residuals through time. However, non-linear increases in DIC due to long-term trends in the physical and biological state of the ocean may result in an unstable relationship. In our study, the validity of these assumptions over the 21st century is tested using the Climate Community Systems Model, to simulate natural and anthropogenic DIC. Our results indicate that at sampling intervals of 3 decades this method should be used to predict AnthroCO₂ as errors will have reached ~20%. As we approach the 30th anniversary of WOCE occupations, it is imperative that we continue to pursue field measurements to detect changes in AnthroCO₂ in the ocean and that we continue at regular intervals of no less than 10 years if the error is to remain below 20% for many regions in the ocean, including the Southern Ocean, tropical Atlantic Ocean, tropical Pacific Ocean, and North Atlantic Ocean. (Abstract ID 10815)

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SUBMESOSCALPE SPATIAL VARIABILITY OF OCEAN TURBULENCE

As a part of the June 2011 ONR Scalable Lateral Mixing and Coherent Turbulence (LatMix) experiment, a detailed characterization of the spatial structure (both vertical and horizontal) of velocity and temperature turbulence (microstructure) was obtained. The experiment took place in the Sargasso Sea, approximately 300 km SW of Cape Hatteras. The approach was to use the T(turbulent)- REMUS Autonomous Underwater Vehicle navigating in a box pattern around a drifting drogued Gateway communication buoy. The vehicle was employed in a yoyo mode spanning depths of 20 to 45 m using a 30o descent/ascent angle. This configuration allowed the AUV based measurements to be both along and across prescribed isopycnals and to be taken in an approximate Lagrangian coordinate system with respect to the mean flow at the center depth of the drogue. An intrusion of cold fresh water was observed on the sigma theta = -25.1 kg/m³ surface and tracked for 14 km. Sporadic regions of intense turbulence were found at the vertical edges of the intrusion suggesting a shear driven source of the turbulence. Turbulence patches within the cold plume were much less intense and less intense. A discussion of processes involved in both cross and along isopycnal mixing will be presented. (Abstract ID 9343)

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EASY ELECTRONICS FOR TEACHING OCEAN SCIENCE

Modern ocean science depends heavily upon electronic devices, such as multibeam sonar, CTD instrumentation, remotely operated vehicles, and broadband satellite communications. While such sophisticated devices are often operated and maintained by skilled electronics technicians, it is useful for ocean scientists to have a working acquaintance with the basic principles and methods on which these devices are based, since such knowledge may suggest novel ways of approaching a wide variety of research problems. This presentation demonstrates a number of simple and relatively inexpensive devices that can be acquired by ocean scientists to complement existing undergraduate ocean science courses, as well as in student projects or actual fieldwork. (Abstract ID 10192)

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STATE ESTIMATES AND FORECASTS IN THE GULF OF MEXICO

An adjoint method analysis has been developed for the Gulf of Mexico (GoM) and has been tested by forecasting Loop Current (LC) and eddy shedding. State estimation (also called four-dimensional variational (4D-VAR)) was used to match the model evolution to satellite-derived along-track sea surface height (SSH) anomalies and gridded sea surface temperature (SST) data by adjusting model temperature and salinity initial conditions, open boundary conditions, and surface forcing fields. The model fits observations during the assimilation period and forecasts ocean state using monthly climatological open boundary conditions and surface forcing. Forecasts provide a cross-validation test of the state estimate by comparing its evolution to independent observations. The model forecast was tested for several ring separation events, including Eddy Franklin (Eddy-F) in May 2010, during the Deepwater Horizon (DWH) oil spill in the GoM. The model skill has been assessed by computing model-observation root-mean-square (rms) differences during both the hindcast and forecast periods. The model forecast skill metrics generally outperform persistence, reference (unadjusted) model runs, and climatology during a LC ring-shedding event for a period of 1 – 2 months. (Abstract ID 12660)

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MECHANISMS OF NON-PHOTOCHEMICAL QUENCHING OF FLUORESCENCE IN CYANOBACTERIA

Quantum yields of chlorophyll fluorescence recorded under ambient irradiance, including solar-induced fluorescence, are controlled by the process of non-photochemical quenching (NPQ), a photoprotective mechanism that dissipates excess absorbed energy as heat. All plants, eukaryotic algae, and many cyanobacteria evolved NPQ but the molecular mechanisms differ between taxa. The NPQ in cyanobacteria has only recently been discovered. Here we present a new model of NPQ in cyanobacteria and determine bio-optical, kinetic, and thermodynamic characteristics of this process. Our kinetic analysis revealed that NPQ is a multi-step process that includes both light and dark reactions. The NPQ is triggered by an orange carotenoid protein (OCP) that acts as a blue-green photoreceptor. Formation of the quenched state involves photoactivation of the OCP carotenoid, conformational change in the protein, and its attachment to phycochlorins. NPQ activates a pathway of thermal dissipation from allophycocyanin, thus reducing the flux of absorbed energy from phycochlorins to reaction centers. We compare the NPQ mechanisms in cyanobacteria with that in other phytoplankton taxa and discuss implications for interpretation of the irradiance-driven variability in fluorescence yields in the ocean. (Abstract ID 11945)

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SEASONAL AND INTERANNUAL FLUCTUATIONS OF BOTTOM WATER EXPORT FROM THE WESTERN ROSS SEA

Long time series of ocean properties are increasingly important in assessing the ocean coupling and feedback to global climate change. The polar regions are particularly sensitive to climate change, including Southern Ocean deep ocean overturning. Export of AABW from the western Ross Sea was observed during the Cape Adare Long Term Mooring (CALM) program, February 2007 to January 2011. The CALM time series exhibits pronounced seasonal periodicity similar to that observed in Weddell Sea AABW export. The bottom maximum speeds and coldest temperature occur in March-April, suggesting austral summer/early fall export of shelf from the western Ross. Seasonally is also apparent in salinity, with the saltiest bottom water coinciding with the coldest bottom water. The warmest, freshest bottom water occurs in July-January, with a secondary cold period in October-November, which is not coupled to high salinity, suggesting an origin from the eastern Ross Sea lower salinity shelf water. Interannual decrease in bottom salinity is evident, reflecting a decadal decrease in regional shelf salinity and/or reduced contribution of western Ross Sea high salinity shelf water. (Abstract ID 9390)

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SEISMIC IMAGING OF WATER MASS MIXING PROCESSES ASSOCIATED WITH THE SUBTROPICAL FRONT SOUTHEAST OF NEW ZEALAND

Water mixing processes across the Subtropical Front (STF) southeast of New Zealand’s South Island are poorly understood. However, such processes are readily apparent in this region due to observations of significant micro-nutrient transport (particularly iron) from subtropical to subantarctic water masses. Modern petroleum industry multi-channel seismic reflection data acquired near and across this front provide an opportunity to study such processes in two dimensions and at length scales of tens of metres. In particular, the structures of eddies that rotate off the front (locally manifested as the northeastward-travelling Southland Current) into subantarctic waters have been imaged on several seismic lines. A comparison has been made of two roughly coincident petroleum industry data sets collected across the front during the summers of 2005-2006 and 2007-2008. Distinctive eddy-shaped features have been imaged at a variety of sizes and with different amounts of internal reflectivity. The characteristics of the outer edges of these features provide some constraint on how the eddies interact with the surrounding water masses. (Abstract ID 10781)

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SST-WIND COUPLED MODES IN THE BENGUELA CURRENT SYSTEM AT INTRASEASONAL TIME SCALES FROM SATELLITE OBSERVATIONS (2000-2008)

In this study a combination of reanalysis and satellite data is used to document the intraseasonal upwelling variability of the Benguela current system and its forcing mechanisms. A covariance analysis between winds (QuikSCAT) and SST (TMI) allows first documenting the spatial extent, seasonal modulation and intensity of the upwelling cells in two regions of peak variability of upwelling-favorable winds, namely the regions around Cape Frio (18°S) and Luderitz (27°S). The analysis reveals that dominant wind-SST covariability modes are associated with two distinct regimes: a high-frequency regime corresponding to the local atmospheric forcing of synoptic variability related to the extra-tropical storms activity and a low-frequency regime related to the propagation of equatorial Kelvin waves. The remote atmospheric and oceanic forcings are documented from the NCEP and SODA reanalyses. Results are discussed and compared to the characteristics of the intraseasonal upwelling variability in the Humboldt upwelling system (Peru/Chile region). (Abstract ID 11976)

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HIGH-RESOLUTION PALEO-ENVIRONMENTAL CHANGES OBSERVED BY DETAILED XRF CORE SCANNING IN HOLOCENE (0-16 KA CAL. BP) SEDIMENTS FROM THE CENTRAL MEDITERRANEAN

The Mediterranean area is a sensitive recorder of climate change, as it is located on the boundary of the subtropical pressure fields and the mid latitude westerlies. This sensitivity makes it an ideal region for climate studies. Previous work in the Gulf of Taranto, (Central Mediterranean) has shown the prominent presence of millennial - decadal variability during the past 2000 years (e.g. Castagnoli, 1992). In this study, we present high resolution records of environmental change based on XRF core scan data and proxy data from a range of cores from the same region spanning different water depths and covering the last 16 kyr. We demonstrate significant changes in the hydrological cycle from glacial to interglacial times and on sub-millennial scale which are attributed to changes in river run-off as a result of changes in global atmospheric circulation patterns. (Abstract ID 13202)

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ENSEMBLE APPROACH TO FORECAST SATELLITE BIO-OPTICAL PROPERTIES AND UNCERTAINTIES

We apply an ensemble approach to produce short-term (1-3 day) forecasts and associated confidence in the forecast. We developed ensembles for two types of models, hydrodynamic and/or initial field), the ensemble spread (variance) provides an indication of uncertainty, or community to propagate initialization, forcing, and algorithm error sources through the numerical models. Ensemble techniques have been used by the environmental modeling community to propagate initialization, forcing, and algorithm error sources through the simulation process. When each ensemble member uses a different realization (e.g., forcing and/or initial field), the ensemble spread (variance) provides an indication of uncertainty, or confidence in the forecast. We developed ensembles for two types of models, hydrodynamic only (no biology) and coupled bio-physical models, to assess the importance of including biogeochemical biology in the simulations (i.e., whether the particles can be treated as conservative tracers or whether inclusion of growth and grazing is required). We compare the forecast distributions to the corresponding satellite ocean color image products and calculate spread-skill statistics.
to assess the skill of the model forecasts, and how well the ensemble variance represents forecast uncertainty (whether the largest ensemble variances correspond to the largest forecast-observation mismatches). This methodology enables us to quantify errors and produce uncertainty maps for bio-optical forecasts. (Abstract ID 10272)
DO SOUTHERN OCEAN FRONTS FOLLOW MERIDIONAL SHIFTS IN THE SOUTHERN HEMISPHERE WESTERLY WINDS?

The detectability of Southern Ocean fronts and their response to climate change is analyzed in a 100 year CO2-induced climate change simulation using the high resolution coupled climate model HIRHAM.1. Fronts are identified as local maxima in the surface sea height and sea temperature (SST) gradient, and zonal transport. These methods agree well, except for regions near Antarctica where background SST gradients weaken and north of the Antarctic Circumpolar Current (ACC) where SST gradients can be density compensated by salinity gradients. As the climate warms, the maximum wind stress increases by a zonal average of 13 percent and shifts south by up to 10 degrees locally. The Subtropical Front shifts south accordingly, even over steep topographic ridges. However, no displacement of fronts in the ACC is found and the current contracts and weakens despite the increased wind stress. Front location and intensity appear strongly controlled by topography. While the position of ACC fronts remains fixed there are changes to the properties of water-masses between frontal zones. The implication for the detection of frontal shifts in paleo records is discussed. (Abstract ID 11279)

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LAST DECADES SEA SURFACE TEMPERATURE CHANGES AND TRENDS IN SOUTHWESTERN OF SOUTH ATLANTIC OCEAN USING AVHRR SATELLITE DATA AND MODEL SIMULATION

The understanding of the South Atlantic Ocean has become very useful since its circulation compounds the upper path of Meridional overturning circulation, playing an important role on global climate system. Recent researches show that Southwestern South Atlantic is becoming warmer and saltier during past decades (Curry & Mauritzen, 2005; Sato & Polito, 2008). Using model simulation, this work investigated this warming and its influence on Southeast Brazilian Coast, specially on Brazil Current (BC) retroflexion, where it separates from the coast to flow eastward, compounding the lower boundary of South Atlantic Subtropical Gyre. The model used is HYCOM and reproduces South Atlantic Ocean conditions from 1960 to 2010, forced by NCEP Reanalysis. In this study we also compare sea surface temperature of satellite data (AVHRR Pathfinder v.5) with model results. At first, satellite data from 1980 to 2010 seem very similar to model results for the same period. Trends in latitude of the BC retroflexion are approximately 0.015° and 0.025° per year southwest, to model and satellite, respectively. With this result is possible to estimate that the South Atlantic Subtropical Gyre is transcribing its south limit, so do the influence of warm water transported by BC at upper levels. (Abstract ID 12554)

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AN INNOVATIVE METHOD FOR THE DETERMINATION OF TRACE ZINC IN SEAWATER USING MICRO-SEQUENTIAL INJECTION AND A NOVEL FLUORESCENT PROBE

Flow Injection (FI) technology has been considerably improved over the last two decades notably with the development of miniaturized, single channel discontinuous flow systems. This presentation will describe the principles and attributes of micro-Sequential Injection lab-on-valve (µSI-LOV), the latest development in FI methodology, and its application to the determination of trace Zn in seawater samples. The technique exploits the selectivity and sensitivity of RuO2-Zn-3, a novel fluorescent probe that is used in a seawater matrix for the first time. The optimized reaction conditions and flow protocol yield a detection limit of 0.3nM Zn, high precision (RSD ≤ 2.5%) and a linear quantification range up to 40nM Zn. This is achieved without preconcentration using 50µL of indicator and 75µL of sample, an analytical cycle of 1min per sample and instrumentation that is simple, compact, fully automated and requires minimal maintenance. The applicability of µSI-LOV to open ocean determinations will be demonstrated using SAFE standards and open ocean Zn profiles collected in the Southern Ocean. The potential of µSI-LOV to shipboard and eventually in situ determinations of trace elements will also be discussed. (Abstract ID 10845)

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DISTINCTION OF ATLANTIC VS. PACIFIC NITRATE IN THE BEAUFORT SEA FROM THE COUPLED N AND O ISOPTIE RATIOS OF NITRATE

We present the first measurements of the natural abundance nitrogen (N) and oxygen (O) isotope ratios of nitrate (15N/14N and 18O/16O) from water-column depth profiles collected along a transect in the Beaufort Sea, during the Canadian IYP-GEOTRACES cruise aboard the Admiration in August-September 2009. The data show a clear distinction of nitrate from Atlantic vs. Pacific provenance. Nitrate isotope ratios below the halocline are analogous to those measured by others in the North Atlantic. A substantial increase in nitrate 15N/14N is evident from the bottom of the halocline toward the surface, paralleled by a comparable decrease in nitrate 18O/16O at these depths. But the record of 15N/14N shows that the 15N-enriched nitrate observed in the upper open ocean is confirmed to nitrate exported to the Arctic at Bering Strait due to benthic denitrification on the Bering shelf; Evidenced of this is afforded by previous observations of progressive 15N-enrichment of fixed N on the eastern Bering shelf in association with the N deficit (Granger et al. JGR in press). The decrease in nitrate 18O/16O in the Beaufort halocline toward the surface indicates that nitrate is newly nitrified toward the surface, such that 100% at the nitrate at the concentration maximum was assimilated then remineralized directly in the Arctic. The nitrate isotope ratios thus provide a unique tracer of Pacific-derived N into the Arctic, and provide insight of N biogeochemical transformations that occurred on the Bering shelf and downstream in the Arctic. (Abstract ID 11377)

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CHANGES IN TERRESTRIAL CDOM ABSORPTION SPECTRAL SLOPES WITH MIXING AND REMOVAL (HUDSON BAY, CANADA)

We examine the changes in absorption spectral slopes of colored dissolved organic matter (CDOM) using a data set of salinity, δ15N and δ18O and CDOM absorption in Hudson Bay (Canada). CDOM in Hudson Bay is controlled by terrestrial inputs, in contrast to adjacent Hudson Strait. By following the fraction of river water (determined with salinity and δ15N/δ16N) we track the changes in terrestrial CDOM optical properties with mixing and removal. CDOM absorption is removed to a significant degree likely due to photochemical oxidation, and indicates that terrestrial inputs of DOM are labile. There was no negligible indication of absorption removal during initial estuarine mixing. Of the many absorption spectral slope (S) parameters used as proxies for CDOM dynamics, the ones at shorter wavelengths proved the best indicators for absorption removal. Increase in absorption spectral slopes at 275 to 295 (S275-295) and 290 to 350 nm (S290-350) are strongly correlated with removal of CDOM absorption. (Abstract ID 9389)

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COHERENT MEASUREMENTS OF OCEAN SURFACE WAVES AND WIND FOR HIGH WIND AND WAVE CONDITIONS.

Current wind-wave numerical models are largely based on a statistical description of the marine atmospheric boundary layer (MABL) and do not resolve the phase of the waves nor the modulation of the wind by the waves, but the next generation of LES models will provide wave-resolved dynamics, kinematics and the coherent associated air-flow. We present a coherent analysis of winds and waves from data collected during the ONR HiReS program from R/P FLIP off California, and from the Kvitebjorn platform in the Norwegian Sea. One aspect of these experiments is the strong conditions encountered with wind speeds up to 25m/s and significant wave heights up to 11m. A suite of wind and wave measuring systems were deployed allowing the resolution of the modulation of the wind by the waves. In particular, wave- and wind-scanning LIDARs ensured non-intrusive space-time measurements of the dynamics and kinematics of the MABL. We examine the effect of the statistical and deterministic properties of the wind and wave fields on the momentum fluxes and on the vertical and horizontal profiles of the wind velocity. (Abstract ID 1147)

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COMPARISON BETWEEN SILICON AND NITRATE ISOTOPE RATIOS IN THE UPWELLING AREA OFF PERU

In this study we present the first direct comparison between dissolved stable silicon (δ30Si(OH)₄) and nitrogen (δ15N) isotopes in the upwelling area off Peru to investigate biogeochemical processes and nutrient cycling in one of the globally largest Oxygen Minimum Zones (OMZ). Silicon and nitrogen isotopes in the euphotic zone of the open ocean are mainly influenced by utilization in the way that diatoms preferentially incorporate the lighter isotopes, whereas in regions with prevailing anoxic waters the nitrate isotope composition is also altered by other processes. Silicic acid limitation offshore is indicated by high δ15N-Si(OH)₄ ratios (~15) leading to the highest δ30Si(OH)₄ values (3.7‰) accompanied by high δ15N-N₂ values (16‰). Due to upwelling and intense recycling of silicic acid on the shelf, surface samples show low δ30Si(OH)₄ values around 2‰. Nitrate isotope compositions in surface waters differ from values expected from δ30Si(OH)₄ suggesting that either N-loss (denitrification and/
these ideas to two ocean models indicates that global oceanic CO2 uptake over 1990-2007 was
then examined oceanic 14C dynamics for 1950-2007 using observations and two ocean general
sink. (Abstract ID 10017)

The turbulent kinetic energy (TKE) budget is key to many process-oriented numerical models in
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CHANGING CONTROLS ON OCEANIC RADIOCARBON: NEW INSIGHTS ON SHALLOW-TO-DEEP OCEAN EXCHANGE AND ANTHROPOGENIC CO2 UPTAKE

The propagation of perturbations to the atmospheric 13C/12C ratio (Δ13C) from nuclear weapons
test and fossil fuel combustion into and through the oceanic reservoir is of interest because
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MICROBIAL COMMUNITY DISTRIBUTION IN METHANE-BEARING SEDIMENTS FROM THE ULLEUNG BASIN
Microbial communities present in methane-bearing sediments from the Ulleung Basin were examined using FISH chip microarray analysis. Non-metric multidimensional scaling (NMS) and multi-response permutation procedures (MRPP) were used to determine whether microbial community compositions were significantly different according to whether communities were found in sulfate-methane transition zone (SMTZ) sediments, gas hydrate occurrence zone (GHOZ) sediments, or bottom-simulating reflector (BSR) sediments, and to correlate samples with abiotic characteristics of the sediments. This analysis indicated that communities from each zone were distinct from one another, and that depth, sulfate concentration, and alkalinity were the abiotic variables most correlated to the axis separating communities from each zone. In addition, two distinct community groups were found within the GHOZ; this may be explained by the proximity of certain communities to methane hydrate-bearing sediments. SMTZ communities were distinct between coring sites; this distinction is correlated with sediment concentrations of barium and manganese. These results suggest that microbial community composition in the Ulleung Basin may be determined by the presence of sulfate in the SMTZ and the proximity of communities to methane hydrate in the GHOZ. (Abstract ID 10320)
NOAA's Test and Evaluation of Conductivity/Temperature Sensors for Monitoring Salinity at Long Term Coastal Observatories

NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) maintains a suite of conductivity/temperature (CT) sensors on a select number of its National Water Level Observation Network (NWLON) and Physical Oceanographic Real-Time System (PORTS) stations. All CT sensors currently in operation at these stations are manufactured by Falmouth Scientific, Inc. (FSI). In a continued effort to explore evolving technology, and to expand the arsenal of instruments available for operational use in CO-OPS observatories, the Greenspan EC3000 CT sensor was selected for test and evaluation. A series of laboratory tests was conducted in which both brands of sensor were compared against conductivity calibration standard solutions, then tested concurrently in CO-OPS seawater test bath facility. In two separate field tests, Greenspan sensors were compared to an operational FSI sensor at an NWLON station, and to a Sea-Bird SBE-32 on a NOAA Chesapeake Bay Intertidal Buoy System (CIBS) platform. A summary of laboratory and field tests will be presented, preliminary analysis of which indicates that the Greenspan EC3000 CT sensor compares favorably to the FSI CT sensor. (Abstract ID 12046)

Benthic Carbon Cycling in the Chukchi Sea: Status and Trends in a Changing Ecosystem

Sea ice retreat in the Chukchi Sea influences the timing and extent of organic carbon production and subsequent export to the underlying sediments. Multiple national and international studies in the Chukchi Sea over the last decade have investigated pelagic-benthic coupling, benthic carbon cycling and macrofaunal community composition and biomass. The northern Chukchi Sea is characterized by heterogenous sediments and more diverse benthic communities relative to the southern Chukchi Sea. High concentrations of surface sediment chlorophyll a and total organic carbon, along with high rates of sediment oxygen demand indicate relatively high export of organic carbon to the benthos in offshore waters of the SE Chukchi Sea, northern Chukchi Sea and in upper Barrow Canyon. By comparison, lower values of these parameters occur in nearshore Alaska coastal waters and the central offshore Chukchi Sea. Statistical analyses indicate that water mass type, depth, sediment grain size and food quality are the most significant variables driving benthic macrofaunal abundance and biomass. These findings will be discussed in relation to the international Distributed Biological Observatory effort to track biological response to this changing ecosystem. (Abstract ID 12580)

The Evolving Science of Ecosystem Modeling in the Gulf of Mexico: From Circulation to Populations

An integrated approach to the modeling of marine ecosystems requires consideration of biogeochemical processes, food-web interactions, and physical forcing mechanisms. Over the last 30 years, circulation and ecosystem concepts and observational and modeling programs have evolved in the Gulf of Mexico (U.S. and Mexican waters) with a steady convergence toward synergy. The majority of circulation models applied to the Gulf presently, generally do well in simulating Loop Current intrusion-separation cycles, eddy propagation, flow patterns through the Yucatan Channel, and deep cyclones under the Loop Current. However, there are unsettled issues, such as with modeling deep flows below ~1,000 m and the mechanism of energy transfer to the deep Gulf. Regional ecosystem models that couple 3D physical fields with biogeochemical processes (e.g., nutrient-phytoplankton-zooplankton-detritus, NPZD, or Lagrangian particle models) are in various states of development in the Gulf. A coordinated and integrated effort is required to build basin-wide ecosystem models that can address key questions, including variability in nutrient and gas fluxes, larval transport pathways, vertical organic matter flux, and ecosystem response to perturbations (e.g., storms, oil spills, climate variability, etc.). (Abstract ID 11398)
Eliciting linkages between human activity and coastal processes are paramount to estuarine preservation and management. For example, land use patterns can profoundly influence nutrient loading, primary productivity, and overall trophic status. This contribution summarizes results from a 3-year study (2008-2011) examining the effects of land use patterns on phytoplankton growth, community composition, biogeochemical cycling, and water quality within the Ashepoo-Combahee-Edisto (ACE) Basin (South Carolina, USA). A combined field and experimental approach was used. This included seasonal surveys of physical parameters, nutrients, phytoplankton, and bacterial indicators from several systems within the ACE Basin representing multiple land uses (forest, agriculture, agriculture, residences, waterfowl impoundments, and others). Seasonal in situ nutrient addition bioassays were performed over a two-year period (2009-2011), and both field and experimental results suggested a limitation of inorganic-N relative to it. Organic nutrients were likely the key drivers of overall productivity. In addition, correlations were found between water quality, nutrient levels, phytoplankton, and bacteria with land usage. Finally, evidence suggests that local hydrography may play an important role in the distribution of bacteria within the water column. (Abstract ID 11646)

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SMALL SCALE CHANGES IN GELATINOUS ZOOPLANKTON COMMUNITY DURING UPWELLING AND RELAXATION EVENTS

Gelatinous zooplankton represent a poorly understood component of marine food webs in part because of difficulties estimating abundance using traditional net sampling techniques. The degree of vertical patchiness can influence the trophic impact of jellies, and the biophysical part because of difficulties estimating abundance using traditional net sampling techniques. During recent observations to understand how the internal tide propagates through Monterey Bay, CA, we found that sampling began at the end of a 12 d stretch of upwelling favorable winds. The first day of sampling was marked by a thin layer of high chlorophyll fluorescence and intense water column density stratification, with jellies, including large (> 8 cm bell diameter) scyphomedusae, most abundant at the strongest vertical density gradient. Subsequent sampling days were characterized by decreasing chlorophyll fluorescence and reduced water column density stratification, along with an abundance of Pleurobrachia spp. and the hydromedusa Eutonina indicans. Surface-associated thin layers of copepods occurred during and after the relaxation event. These layers were surprisingly devoid of gelatinous zooplankton and did not overlap spatially with the subsurface chlorophyll layer. (Abstract ID 10868)

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MIXING AND FLOW IN ASCENSION, A STEEP NARROW CANYON

During recent observations to understand how the internal tide propagates through Monterey Canyon, we took limited measurements in nearby Ascension Canyon. Short, narrow, and straight, Ascension is opposite to Monterey in its physical characteristics, and there is no apparent internal tidal flux being steered by bathymetry into the canyon. Nevertheless, turbulence was only slightly less than in Monterey, and diapycnal diffusivity was larger, owing to weaker stratification. In addition to evidence of internal tides, mixing appeared to be also generated by flow along the continental slope dipping into the canyon. (Abstract ID 9314)

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MODELING AND ASSIMILATING OCEAN COLOR RADIANCES

Radiances are the source of information from ocean color sensors to produce estimates of biological and geochemical constituents. They potentially provide information on various other aspects of global biological and chemical systems, and there is considerable work involved in deriving new information from these signals. Each derived product, however, contains errors that are derived from the application of the radiances, above and beyond the radiance errors. A global biogeochemical model with an explicit spectral radiative transfer model is used to investigate the potential of assimilating radiances. The results indicate gaps in our understanding of radiative processes in the oceans and their relationships with biogeochemical variables. Most important, detritus optical properties are not well characterized and produce important effects of the simulated radiances. Specifically, there does not appear to be a relationship between detrital biomass and its optical properties, as there is for chlorophyll. Approximations are necessary to get beyond this problem. In this report we will discuss the challenges in modeling and assimilation water-leaving radiances and the prospects for improving our understanding of biogeochemical process by utilizing these signals. (Abstract ID 9834)

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DO WARM YEARS PROMOTE GREATER GROWTH AND SURVIVAL OF LARVAL COD ON GEORGES BANK?

A major shift in the zooplankton community on Georges Bank observed between the 1980s and 1990s has implications for the recruitment of marine fish. Warmer years promoted earlier spring blooms and the production of zooplankton prey for larval cod (Gadus morhua) across the Georges Bank region. Average daily growth was estimated by applying a static grid of stations at 10x10 km resolution covering the Georges Bank region. The larvae were constrained vertically at the thermocline at 20 m depth. Larvae were able to feed and grow through the day using bi-monthly observations of zooplankton and temperature observations as input to the IBM. Growth patterns were estimated for January-February, March-April, and May-June for the years 1977-2006. Extreme cold and warm years were identified and compared to address variation in growth rates related to annual and inter-annual variation in zooplankton and temperature conditions. Warmer temperatures and higher prey abundance promote higher potential growth and survival, an important component of recruitment. (Abstract ID 12403)

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USING TOWED SENSOR OBSERVATIONS TO MODEL THE DISTRIBUTIONS OF TOTAL SUSPENDED SOLIDS IN HUMBOLDT BAY, CALIFORNIA DURING THE SPRING-SUMMER TRANSITION

End-member mixing models of bay and estuarine ecosystems are often used to predict temporal and spatial variations in sediments distribution and water chemistry. In Humboldt Bay, CA the factors controlling sediment and water chemistry are not currently understood to the degree required to develop appropriate mixing models. Here we present recent observations on two time series of suspended sediment distribution. A CDI with attached transmissometer was towed through the bay during three tidal conditions. Sensors collected TSS concentration, temperature, salinity, fluorescence and dissolved oxygen concentration. Data suggest that TSS is strongly sensitive to a threshold current velocity but that hydrographic and chemical parameters are not correlated to tidal data. Parameter distributions seem to result from mixing between two or three, variable end members that change significantly over the course of the spring-summer transition. Tow data and ancillary results from concurrently collected bay transects are used in constructing a complex mixing model that better explains observed trends and may also assist with the predictions of Humboldt Bay sediments distribution and water chemistry. (Abstract ID 10409)

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DOPPELMEASUREMENTS OF TURBULENT KINETIC ENERGY DISSIPATION RATES NEAR THE OCEAN SURFACE

Turbulent Kinetic Energy dissipation rates (TKEDR) were obtained in the Labrador Sea during summer 2004, with instrumentation on an ASIS buoy equipped with meteorological...
and oceanographic sensors. The novelty of this data set consists in being obtained in the open ocean, and during a phytoplankton bloom. Using a coherent pulse-to-pulse Doppler sonar we obtained velocity fluctuation measurements at 150 densely spaced (0.8 cm) range bins, allowing us to calculate wavenumber spectra. The TKEDR were then calculated by means of the Kolmogorov theory, avoiding the use of Taylor's hypothesis. The analysis of these TKEDR in different wind regimes confirmed the fundamental role of wave effects together with the wind, as an essential factor to parameterize the TKEDR. Near surface TKEDRs were found to be enhanced above classical low-of-the-wall estimates at moderate to high wind speeds, and also to be independent of the wave phase, even at high winds. This is contrary to recent observations showing TKEDR beneath wave crests to be significantly enhanced over those beneath wave troughs, and helps resolve a recent controversy in the literature. (Abstract ID 10550)

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GLOBAL AND LOCAL MODELING OF INTERNAL AND BAROTROPIC TIDES

As barotropic tides flow over submarine topography, internal tides are generated in the density-stratified ocean interior. These internal tides lead to an important energy transfer from the barotropic tide to the ocean interior, and play a role in determining barotropic tidal amplitudes on a global scale. Here, high-resolution numerical modeling is used to understand and quantify these processes. A linear internal tide generation model, valid for flow over large amplitude topography, is solved on a set of patches covering the entire ocean, using prescribed barotropic forcing and realistic continuous stratification. The implied global multi-constituent estimates of the associated energy transfer from the barotropic tide are consistent with observationally derived estimates. When these local models are coupled to a lower resolution global model of the barotropic tide, one obtains a global model of barotropic and internal tides, with no data assimilation or parameterized internal tide drag. These solutions are found efficiently by working in the frequency domain (rather than time-stepping the equations of motion), via direct inversion of large sparse matrices. (Abstract ID 11535)

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SEX-SPECIFIC ZOOPLANKTON PHENOLOGY, PROTANDROUS DIAPAUSE EMERGENCE AND MIGRATION IN CALANUS SP.

Sex-specific life history strategies are an important but poorly researched area of copepod biology. Here we report on a literature study and subsequent analyses of two such strategies in Calanus: protandrous diapause emergence and protandrous migration. Abundance data were collected from the literature for males and females Calanus finmarchicus, C. glacialis, C. hyperboreus and C. helgolandicus across their distributions. Data were used to measure a) the time gap between peak male and peak female abundance, and b) the relative vertical distributions of the sexes around the reproductive season. Across all species, the date of peak male abundance preceded that of females in 90 of 105 discrete time series. We observed differences in the degree of protandrous emergence between species. Protandrous emergence may be advantageous to males in ensuring that they are ready to mate before female arrival. This study opens up a line of enquiry to a mostly unexplored area of zooplankton science. A focus on sex-specific phenotype is needed to improve our understanding of Calanus population dynamics and to predict how this important zooplankton group may respond to climate change. (Abstract ID 10797)

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LINKING ACTIVITY AND COMMUNITY STRUCTURE OF BACTERIAL ASSEMBLAGES IN THE SARGASSO SEA AND MID-ATLANTIC BIGHT

In this study we evaluated the relationship between abundance and activity levels of marine bacterial communities. Activity of microbial communities from the Mid-Atlantic Bight and Sargasso Sea in spring and summer over two years was assessed using 5-bromo-2’-deoxyuridine (BrdU) incorporation into synthesized DNA. Phylogenetic profiles of active (BrdU-labeled) and total (untreated) bacterial populations were obtained with 454 tag pyrosequencing, and statistical tests were conducted on relative abundance and activity levels. In both environments, a majority of observed bacterial groups were as active as expected based on their abundances. However, 2% of all bacterial groups in each environment had significantly different activity levels than abundances would indicate. In 80% of the communities, the rare bacterial fraction (1% or less of the total community) was more active than abundances would indicate. Additionally, the abundant bacterial fraction (5% or more of the total community) was less active than expected in 85% of the communities. By profiling differential activity levels of bacterial taxa, this study provided insight into the complex linkage between community structure and activity of bacterial assemblages. (Abstract ID 10566)
OCEANIC MEAN FLOWS FORCED BY TOPOGRAPHICALLY GENERATED INTERNAL WAVES

Generation of large-scale flows by dissipative internal waves as the main manifestation of wave drag is a well-known fact in atmospheric dynamics. However, it has been harder to apply to the ocean due to more complicated basin shapes or the random nature of the forcing. Unfortunately, our knowledge of the ocean circulation depends on such processes, namely internal wave generation, propagation and dissipation that global numerical models can’t resolve. In order to motivate future oceanic wave drag parametrizations, we propose to model balanced analytically balanced flows arising from the dissipation of topographically-generated internal waves. In a three-dimensional domain with constant buoyancy and Coriolis frequencies, a linear model for the radiation of dissipative Boussinesq waves by a barotropic tide flowing over small-amplitude topography is first derived. A non-linear forcing term acting on the phase-averaged vorticity equation is next derived using a generalized Lagrangian mean approach. This forcing resonates with the balanced mode, which then grows in time. Finally, important qualitative differences between rectilinear and rotary tides, as well as between various shapes of topographies, are highlighted. (Abstract ID 12431)

LOCAL GENERATION OF INTERNAL SOLITARY WAVES IN A PYCNOCLINE

Oceanic observations have provided evidence of the generation of internal solitary waves due to a tidal internal barb impinging on a seasonal pycnocline from below. The purpose of this talk is to present direct numerical simulations of such a generation process with the fully nonlinear and non-hydrostatic MIT-gcm model. An academic two-dimensional configuration in a vertical plane is first considered. We shall show that, depending on the parameters, different modes of internal solitary waves can be excited in the pycnocline and we shall provide examples of internal solitary waves as first, second and third modes, trapped in the pycnocline. The mechanism for the generation of internal solitary waves will then be put forward. This mechanism relies upon the matching of the horizontal phase speeds of the incoming wave beam and of an excited interface wave trapped in the thermocline. Application to the Bay of Biscay will then be considered. (Abstract ID 12265)

TROPICAL ATLANTIC INSTABILITIES IN CCSM4

We focus on the tropical Atlantic instabilities in the 20-th century CCSM4 run. The biases appear in both atmospheric and oceanic components. Mean sea level pressure (MSLP) is too high by a few mbar in the sub-tropical highs and too low in the polar lows. As a result, surface winds in the tropics are ~1ms/s too strong that causes excess evaporation and depressed SSTs north of the equator. However, south of the equator SST is too warm due to the evaporative cooling being outweighed by the warming by other factors. The highest SST bias is close to the coast Biscay will then be considered. (Abstract ID 12426)

ECOLOGICAL RISKS OF ANTHROPOGENIC NOISE ON FRESHWATER FISHERY RESOURCES

With the rise in global demand for natural resources, the development, exploration, and extraction using new and traditional energy technologies in the United States is a priority. With recently discovered regions of oil and gas reserves from inland sources, particularly throughout the upper Missouri River basin, there has been increased interest in surveying freshwater ecosystems such as lakes and riverbeds. In accessing these new resources it is critical to better identify the ecological ramifications of expanding traditional methods into new environments as significant challenges may be placed on ecological patterns and distributions of fishery resources not present in the marine environment. Of growing concern are the effects of anthropogenic noise on fishes. Research on the effects of anthropogenic noise has primarily been directed at mitigating impacts to marine mammals while few peer-reviewed studies characterize the effects of these noise sources on fishes. This presentation will discuss the risks of increased use of seismic air guns, piling driving, and wind farms to fishery resources. (Abstract ID 12426)

SHIFT IN NUTRIENT LIMITATION AFFECTS BIOCHEMICAL COMPOSITION OF NORTH SEA PHYTOPLANKTON

Coastal waters of the North Sea have been affected by eutrophication over the past decades and subsequent efforts to reduce nitrogen nutrient loads resulted in a major shift in N/P Si nutrient ratios. The consequent changes in the limiting resource can alter the biochemical composition of phytoplankton. As phytoplankton presents the base of the food web, its biochemical composition also affects the structure and functioning of food webs and subsequently the carrying capacity of the ecosystem. Novel approaches using liquid chromatography and gas chromatography in combination with isotope ratio mass spectrometry make it possible to trace stable isotope incorporation into major cellular components such as carbohydrates, amino acids and fatty acids. The work presented here investigates synthesis rates of these different understanding of the diffusive and advective processes that contribute to the modification of water masses and the MOC is needed. The vertical mixing coefficient, D, and along-isopycnal mixing coefficient, K, is thought to strongly control the MOC and climate sensitivity. Inverse methods are tools used to diagnose the ocean circulation from hydrographic data. Inverse models have so far, been unable to resolve the spatial structure of D and K. Recently an over-determined tracer-contour Inverse Method (TCIM) is established, which is less sensitive to error than existing inverse methods and has the potential to resolve the magnitude and vertical distribution of D, K, and the geostrophic flow directly from hydrographic data. Recent progress on the TCIM now allow for multiple ‘communicating’ boxes. This, and replacing K with simply the isopycnal heat flux (from which K can be determined), is expected to increase accuracy of the TCIM and finally allow for a ‘global inversion’ resulting in a global spatial distribution of K, D and the geostrophic flow. (Abstract ID 9811)
biochemical components in natural phytoplankton communities of the North Sea and in cultures grown under different nutrient limitations. Though still preliminary, this work will make it possible to infer changes in phytoplankton stoichiometry and consequent food web changes based on knowledge of prevailing resource conditions. (Abstract ID 11283)

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DEMESIAL FISH ASSEMBLAGES ASSOCIATED WITH DESOTO CANYON AND THE CONTINENTAL SLOSE OF THE EASTERN GULF OF MEXICO RELATIVE TO THE DEEWPWATER HORIZON OIL SPILL

Edge habitats typically have high biodiversity and biomass regardless of ecosystem, but such deep-sea habitats (e.g. continental slopes, submarine canyons, seamounts) remain relatively unexplored. DeSoto Canyon and adjacent continental slope habitats of the eastern Gulf of Mexico were the first affected by the Deepwater Horizon oil spill (DWH). Deep-water fishes have slow life histories and are among the most sensitive taxa to environmental perturbations yet in the Gulf of Mexico these taxa are poorly documented, many taxonomies are unresolved and new species undoubtedly exist. We used fishery-independent longline and trap surveys to describe the deep-water assemblages of large demersal fishes in this region. We also examined dominant species for exposure to polycyclic aromatic hydrocarbons (PAHs), petroleum-derived toxins that may affect fish health. During 2011, 73 stations (199-2,014 m deep) yielded 626 fishes including two species of hagfishes, 15 species of elasmobranchs and 21 species of teleosts. Fish assemblages and abundances were similar among regions and mediated by depth and temperature (85%) were captured <600 m deep). Detected exposure to PAHs was a function of proximity to the DWH site. (Abstract ID 12271)

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OCEAN DEOXYGENATION - STATUS AND TRENDS

Theoretical consideration as well as ocean biogeochemistry models robustly predict that global warming will lead to a substantial decrease in the ocean’s oxygen content. The main drivers of this ocean deoxygenation are well understood, i.e., reduced solubility of oxygen in seawater and increased stratification, but the spatial distribution of the expected changes in oxygen as well as the potential impact of these changes are not well established. Few places exist that not only permit the estimation of long-term trends, but also allow for a proper assessment of such trends against shorter-term variability. Notable exceptions are the North Atlantic and the North Pacific, where the data to date suggest a complex pattern of changes that likely reflect as much (natural) climate vacillations as it represents a response to (anthropogenic) ocean warming. Even weaker is our current ability to understand and model the impact of ocean deoxygenation on open ocean regions with hypoxic or even anoxic conditions. In this presentation, the current status in our understanding will be reviewed and recent trends discussed. (Abstract ID 11085)

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TOWARD A GLOBAL DATA-BASED ESTIMATE OF THE OCEANIC ACCUMULATION OF ANTHROPOGENIC CO2 SINCE THE WOCE ERA

Model simulation predict that the ocean has accumulated approximately 20 to 30 Pg C between the WOCE era (mid-1990) and the CLIVAR era (mid-2000), which represents roughly a 20% increase in the amount of anthropogenic CO2 stored in the ocean. In the last decade, a series of repeat hydrographic cruises have been undertaken with the goal to document and quantify this accumulation. More recently, international synthesis activities have quality controlled and homogenized the data on a basin-scale, opening the opportunity to estimate the anthropogenic CO2 accumulation in the ocean since the WOCE era with a high-quality data set. We will report on our first attempts to estimate this increase on a global-scale, using a range of methods, including the eMLR, ΔTIce, isoprell ΔCT0, and TTD methods. This will permit us to assess the uncertainties associated with the separation of the changes in total inorganic carbon from those associated with the uptake of anthropogenic CO2. We will also address the challenges associated with the temporal and spatial interpolation required to arrive at a global integrated number given the relatively sparse data sets. Good knowledge of the global oceanic uptake of anthropogenic CO2 between the mid-1990s and the mid-2000s will provide much needed constraints for the global carbon budget over this period. (Abstract ID 11454)

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MACROFAUNAL COLONIZATION AND TROPHIC DYNAMICS AT TWO EAST PACIFIC METHANE SEEPES (HYDRATE RIDGE AND COSTA RICA)

Methane seeps, including those at Hydrate Ridge on the Cascadia margin and Mound 12 off Costa Rica, are characterized by diverse microbial consortia that fix inorganic carbon and precipitate authigenic carbonates. By placing results of in situ substrate colonization experiments and ex situ isotopic tracer experiments within an isotopically-defined food web, we were able to test the hypothesis that fluid flow and substrate type and availability structure communities at deep-sea methane seeps. Fluid flow was more important than substrate type in defining communities, except for a few substrate specialists (e.g. Xyloplax on wood). Though 10- and 13-month deployments were insufficient for community recovery, macrofaunal densities and biomass were higher on substrates placed in active seepage, while taxonomic richness was greater at inactive reference sites. Similar taxa characterized substrates in areas of active seepage at sites separated by 6000km (e.g. ampharetid and dorvilleid polychaetes, the gastropods Proswana laevis and Pyrgopelta coronula). Stable isotopic ratios suggest a dependence on multiple chemosynthetic pathways in both active and inactive settings, and tracer experiments identified specific metabolic pathways that contribute carbon and nitrogen to macrofauna. (Abstract ID 12674)

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COST-MINIMIZATION STRATEGIES OF MARINE MICROBES AND THEIR POTENTIAL IMPACTS ON NP CYCLING IN THE UPPER OCEAN

High throughput sequencing increased our ability to resolve distributions and functions of marine microbes. While diversity of microbes found in any one sample can be staggering a few phytophyle types consistently dominate communities in oligotrophic oceans. Recent work reports that high-latitude oceans and the mesopelagic ocean support chemolithotrophic sulfur and ammonia oxidation in diverse lines of bacteria and marine group I archaea. The impacts of these processes on the global carbon and nitrogen cycles are only beginning to be detailed. Based on analyses of nitrogen requirements of dominant oligotrophic microorganisms and their potential for non-Redfield C:N:P stoichiometry we hypothesized that deviations from Redfield N:P in areas of the surface ocean not dominated by nitrogen fixation can be explained by impacts these highly optimized microorganisms have on inorganic N dynamics. In the Southern Ocean, for example, positive N values observed in the upper ocean cannot adequately be explained by nitrogen fixation nor advecive processes. In these waters 15-30% of surface ocean microbes have the potential to perform nitratification during winter. Using a simplified box model we show the impact these organisms and their vertical distribution have on surface ocean N:P ratios. We hypothesize that in the modern ocean, over geologic time scales, biogeochemical processes occurring in the surface ocean will favor organisms that are cost minimized for nitrogen and iron. (Abstract ID 10230)

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IN SITU MEASUREMENTS OF SKIN SST FOR SATELLITE SST CLIMATE DATA RECORD

Sea Surface Temperature (SST) is an essential indicator for climate change. High accuracy and stability of the satellite SST products are required for long-term climate data record of global SST. It is important to routinely collect in situ SST measurements for the evaluation and improvement of the quality of satellite SST products. The infrared SST autonomous radiometer (ISAR), made by the University of Southampton, has been deployed on the research vessel Dong Fang Hong II of Ocean University of China since September 2009. The R/V Dong Fang Hong II operates mainly in the China Seas including Bohai Sea, the Yellow Sea, the East China Sea and the South China Sea, for about 300 days per year. The ISAR was installed on the top of the research vessel, around 13 m above the sea surface. The skin SST measurements were collected during eighteen cruises in this area from 2009 to 2011. These in situ SST products are compared with shipboard measurements of skin SST. The results will be presented and
discussed. (Abstract ID 10153)

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This study investigates the relationship between the South China Sea summer monsoon and the first tropical cyclone (TC) of the season to make landfall over mainland China (in short, the first-landfall TC) using the South China Sea summer monsoon index, NCEP/NCAR reanalysis monthly average data, and best-track TC data from Joint Typhoon Warning Center (JTWC) for 1948–2009. The results show that the characteristics of the first-landfall TC are closely associated with the frequency, active stage, and strength of subsequent landfall TCs in the same year. In detail, a stronger (weaker) South China Sea summer monsoon index year corresponds to more (fewer) landfall TCs over Mainland China, a later (earlier) date of the first-landfall TC, a lower (higher)-latitude landing point of the first-landfall TC, and a stronger (weaker) monsoon trough. The anomalous wind field and the track of the first-landfall TC are also significantly related to the strength of the index. The location of the first-landfall TC has shown a gradual trend toward higher latitudes over the analysis period, and there is a decreasing trend in the variability of the South China Sea summer monsoon index. (Abstract ID 9462)

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THE FIRST-LANDFALL TROPICAL CYCLONE OVER MAINLAND CHINA

The North Atlantic Ocean is an important oceanic region with a high variability in tropical cyclone formation and development. Understanding the factors that influence the first-landfall TC over mainland China is crucial for improving hindcast and short-term forecasts of TCs. This study investigates the relationship between the South China Sea summer monsoon and the first-landfall TC over mainland China using NCEP/NCAR reanalysis monthly average data and best-track TC data from JTWC for 1948–2009. The results show that the characteristics of the first-landfall TC are closely associated with the frequency, active stage, and strength of subsequent landfall TCs in the same year. In detail, a stronger (weaker) South China Sea summer monsoon index year corresponds to more (fewer) landfall TCs over Mainland China, a later (earlier) date of the first-landfall TC, a lower (higher)-latitude landing point of the first-landfall TC, and a stronger (weaker) monsoon trough. The anomalous wind field and the track of the first-landfall TC are also significantly related to the strength of the index. The location of the first-landfall TC has shown a gradual trend toward higher latitudes over the analysis period, and there is a decreasing trend in the variability of the South China Sea summer monsoon index. (Abstract ID 10153)

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PRINCIPAL COMPONENT CHARACTERIZATION OF FLUORESCENCE SPECTRA FROM SEAWATER SAMPLES COLLECTED DURING THE DEEP WATER HORIZON OIL SPILL

In 2010 more than 300 water samples were taken in the deep waters of the Gulf of Mexico on
several cruises aboard the R/V Walton Smith (Joye et al. 2011) and R/V Pelican, and one cruise aboard the R/V Weatherbird. The first Pelican cruise in May 2010 collected samples in the sub-surface plume from the Deep Water Horizon incident (Diercks et al. 2010). Samples taken on the later Pelican and Weatherbird cruises in May and June of 2010 were taken in the Loop Current and its associated Warm Core Ring ( Wade et al. 2011a, 2011b). We report analysis of a combined excitation-emission data set by Principal Components Analysis (PCA). The scanning fluorometer produces a 31 by 31 matrix of excitation-emission values. The significant excitation emission values can be put into a linear vector with 237 values and assembled into a large matrix with each row representing the 237 results from each sample. The matrix was decomposed into principal components and scores using standard methods. About 90 percent of the variance in the matrix can be explained by the first 5 principal components. Most samples in the plume have principal components are distinct from most samples taken in the loop current and ring. The plume samples have principal components similar to the NIST DWH standard oil and to the principal components of a surface oil slick sample collected during the spill. (Abstract ID 12138)

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EXTREME TURBULENT HEAT FLUXES IN WESTERN BOUNDARY CURRENTS: A NEW FRAMEWORK FOR QUANTIFICATION AND ANALYSIS

We analyze the probability density distributions of surface turbulent heat fluxes, applying the two parametric modified Fisher–Tippett (MFT) to air–sea flux estimates derived from reanalyses state variables and from the Voluntary Observing Ship (VOS) data. Extreme turbulent heat fluxes amount to 1500–2000 W/m² (for the 99th percentile) and can exceed 2000 W/m² for higher percentiles in the western boundary current extension (WBCE) regions. Analysis of linear trends and interannual variability in the mean and extreme fluxes shows that the strongest trends in extreme fluxes (more than 15 W/m² per decade) in the western boundary current regions are associated with the changes in the shape of distribution. In many WBCE regions changes in extreme fluxes are different from those for the means at interannual and decadal time scales. In particular, the correlation between interannual variability of the mean and extreme fluxes is relatively in the Southern Ocean and the Kuroshio Extension region. Newly derived probability distributions have also been used in assessing the impact of sampling errors in the VOS-based surface fluxes. Although sampling does not have a visible systematic effect on mean fluxes including WBCE regions, sampling uncertainties may result in the strong underestimation of extreme flux values exceeding 100 W/m². New framework allowed to derive the requirements to the observational and modelling platforms for the successful replication of extreme turbulent fluxes. (Abstract ID 10378)

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CRITICAL BEHAVIOR OF FLUID AND ELECTRICAL TRANSPORT IN SEA ICE

The fluid transport properties of sea ice mediate melt pond evolution and ice pack reflectance, snow–ice formation, nutrient replenishment for microbial communities, and the evolution of salinity profiles. Electromagnetic monitoring of these processes relies on some knowledge of the effective electrical properties of sea ice. Columnar sea ice is effectively impermeable to fluid flow below a 5% brine volume fraction, yet is permeable for brine volume fractions above this threshold value. In two different experiments conducted in the Arctic and Antarctic, we have found that this critical transition in fluid flow at the brine connectivity threshold displays a strong electrical signature, laying the foundation for electromagnetic monitoring of transport phenomena in sea ice. Here we also modify traditional percolation models for columnar sea ice, hypothesizing that granular sea ice has a percolation threshold near a 10% brine volume fraction. This modified percolation model is then in excellent agreement with our field data taken in Antarctica, where granular ice is a significant component of the ice cover. (Abstract ID 12882)

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RIVER DISCHARGE, STRATIFICATION AND SHELF WATER HYPOXIA IN THE MISSISSIPPI BIGHT

Ecosystem metabolism, driven by available organic and inorganic nutrients, is an important end-point indicator for water quality and health of estuarine systems. When community consumption of dissolved oxygen (DO) exceeds the rate of production, hypoxia (<2mg DO/L) or even anoxia (no oxygen) may develop. Sources of inorganic and organic nutrients in estuaries are derived from rivers and terrestrial runoff. The regional summer stratification in the Mississippi Bight is strengthened by offshore advection of fresh surface waters and onshore advection of high density bottom waters. Our monthly Northern Gulf Institute (NGI-NOAA) surveys of the Mississippi Bight show that hypoxia is a regional phenomenon that can extend as far as 10m above bottom and last through the entire summer (4 months). In the fall, hypoxia is interrupted by episodic wind events (hurricanes) and vertical mixing will reintroduce DO to the bottom waters. Results from the 4-year monitoring program suggest that, in addition to tidal nutrient inputs, physical processes such as river discharge, advection, mixing, and air-sea interactions, exert important controls on the net outcome of DO in the ecosystem. (Abstract ID 12337)

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REDOX CONTROL OF THE PARTITIONING AND SCAVENGING OF Fe(III) AND Pa(V ) IN SEAWATER: ROLE OF NATURAL ORGANIC MATTER

Controlled laboratory radiotracer experiments were carried out to examine the phase partitioning of Fe(III, III), Pa(V, IV) and Th(IV) in seawater in the presence or absence of macromolecular organic matter, including humic substances (HS) and exopolymers (EPS), and to examine the role of natural organic matter in controlling the biogeochemical cycling of trace elements. The partitioning of $^{55}$Fe, $^{233}$Pa and $^{234}$Th between dissolved, colloidal and particulate phases showed that while values of their particle- or colloid-water distribution coefficients (logKd or logKc) are consistently high (5.7-7.3), their colloidal size spectra and apparent solubilities were significantly different. The particle-reactivity followed the general order of Th(IV)>Fe(III)>Pa(V) in low DOM seawater, with the highest apparent solubility (~1 kDa) observed for Pa(V). In the presence of EPS or HA, however, the apparent solubility followed the order of Fe(III)>Th(IV), Pa(V). We hypothesize that, while the reactivity of Th(IV) remained unchanged, Fe(III) and Pa(V) can be reduced to Fe(II) and Pa(IV) by macromolecular organic matter on particulate surfaces, resulting in higher solubility for Fe(III) and promoting reductive scavenging of Pa(V) in marine environments. (Abstract ID 12303)

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NUMERICAL STUDY OF THE INFLUENCE OF SURFACE WAVES ON TURBULENCE IN THE UPPER OCEAN

To understand the dynamics of the interaction between upper ocean turbulence and surface waves, we perform direct numerical simulation for turbulence in the presence of a progressive wave. The simulation provides an instantaneous, three-dimensional description of the flow field for a detailed examination of turbulence structure under the distortion of surface wave. The periodic and accumulative effects of the wave on the turbulence are studied in Eulerian and Lagrangian frames, respectively. In the Eulerian frame, turbulence is found to be wave-phase dependent. Turbulent vortices are turned, stretched, and compressed periodically, leading to a phase-dependent distribution of enstrophy. The variation of Reynolds normal stress is explained by the analysis of their budget. In the Lagrangian frame, the wave dissipation due to wave-turbulence interaction is quantified through the Reynolds shear stress and the Lagrangian property of the wave. Vertical vortices are shown to tilt towards the wave propagation direction due to both the Stokes drift and the correlation between wave strain rate and turbulence vorticity, which yields a potential mechanism for the initial development of small-scale Langmuir cells. (Abstract ID 12394)

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THE KUROSHIO NUTRIENT STREAM AND ITS TEMPORAL VARIATION IN THE EAST CHINA SEA

Using in situ data from 88 cruises from 1987 to 2009 in the East China Sea, downstream nutrient flux (the product of velocity and nutrient concentration) and nutrient transport...
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DETERMINATION OF THE OCEAN INTERNAL WAVE PROPERTIES FROM NAUTICAL X-BAND RADAR OBSERVATIONS

Nautical X-Band radar is generally equipped on ship for navigation purposes. It can detect the sea surface roughness with high temporal and spatial resolution. In this paper, an approach is proposed to retrieve the properties of ocean internal wave from ship-borne X-band radar observations. First of all, the nonlinear velocity of internal wave is derived from radar images based on R adon Transform technique. The second, given the vertical distributions of backscattering data, the Thomson-Haskell method is used to solve the Taylor-Golstein boundary value problem (eigenvalue problem). Then, the amplitude of internal soliton can be retrieved from the data acquired in June 2009 in the South China Sea based on the Korteweg-de Vries (KdV) equation for continuous stratified finite depth system. The retrieval amplitudes are consistent with these observed by towed thermistor chain. Finally, the uncertainty of the method is also discussed. (Abstract ID 9502)

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MIXING IN THE CENTRAL ARCTIC OCEAN IN RECENT YEARS

Since 2007, the North Pole Environmental Observatory has launched expendable current probes (XCP) as part of annual springtime airborne hydrographic surveys in the central Arctic Ocean. Mixing is estimated from 10-meter shear and CTD-derived Brunt-Väisälä frequency for comparison with Arctic Ocean mixing in the 1980’s estimated using the same method. Mixing estimates from simultaneous XCP and microstructure profiles provide consistent results. The present, survey-averaged mixing estimates for the deep Arctic Ocean are an order of magnitude higher than those found during the 1980s. Our observations have mainly been made under a complete springtime ice cover, so the decline in ice extent is not the cause of the mixing increase. Possible explanations include increased near-inertial ice motion due to decreases in thickness and enhanced generation associated with changes in circulation and stratification. One 2008 CTD-XCP station over the Lomonosov Ridge is intriguing in the latter regard. It suggests a significant eddy-like feature in the Atlantic Water layer with abnormally high temperatures and several well-mixed layers 50-100 meters thick. The XCP data indicate high mixing rates below this feature. (Abstract ID 10548)

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MOLECULAR AND ECOLOGICAL DIVERSITY OF PICOCYANOBACTERIAL POPULATIONS IN THE COSTA RICA DOME

The Costa Rica Dome (CRD) is an offshore mesoscale feature that develops seasonally in the eastern Tropical Pacific. Despite its upwelling nature, picocyanobacterial populations dominate the surface mixed layer. The present study investigated the abundance and diversity of Synechococcus and Prochlorococcus across the nutrient-rich CRD and surrounding oligotrophic waters. Depth-resolved sampling for flow cytometry and DNA analysis of picocyanobacteria assemblages was accompanied by physico-chemical characterization of the water masses harboring them. Phylogenetic analysis based on the rpoC1 gene marker revealed various populations of Synechococcus and Prochlorococcus with different distributional patterns. Most of the Synechococcus-like sequences from surface waters fell into one cluster with no closely related known isolates, while a few sequences clustered together with Synechococcus Clade II. Cytoskeletal composition shifted dramatically below the mixed layer. Most of the sequences within the dome were closely related to Prochlorococcus MIT9303 and MIT9313 and were distinct from Prochlorococcus sequences outside, which were more similar to the NATL2 isolate. Overall, we observed a strong shift in community composition above and below the pycnocline, while changes along the horizontal scale were less pronounced. (Abstract ID 12460)
results underline the nascent state of coccolithophore cell physiology and the importance of a mechanistic understanding of inter- and intraspecies sensitivity differences to predict future changes in calcification of natural coccolithophore assemblages. (Abstract ID 12019)

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THE EFFECT ON RUNUP OF INCIDENT WAVE DIRECTIONAL AND FREQUENCY BANDWIDTH

Shoreline runup during storms is dominated by infragravity waves (periods ~ 100sec). Infragravity waves are driven by shoaling incident sea swell waves (periods ~ 10-sec), and are reflected partially at the shoreline. Observation-based empirical formulas suggest infragravity energy generally increases with increasing incident wave energy and period. However, runup observed and predicted (with these formulae) is scattered, suggesting other variables may be important. We investigate numerically the infragravity energy dependence on incident wave frequency and directional bandwidth. The numerical model, a phase-resolving Boussinesq formulation fumwaveC (similar to FUNWAVE and COULWAVE) simulates wave breaking at the front face of steep waves with an eddy viscosity term. Preliminary results show that, on a planar beach with normally incident waves with fixed energy and peak period, runup levels can differ substantially with varying directional and frequency bandwidths. The role of wave breaking and energy transfer to sea swell waves on infragravity energy levels is also investigated. (Abstract ID 9914)

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COUPLED-OCEAN-ATMOSPHERE-WAVE MODELING OF WEATHER FRONTS

A five day nearshore field experiment in December 2003 near Myrtle Beach, SC, provided concurrent measurements of waves, currents and bathymetry within the surfzone and offshore inner shelf. To investigate the connection between nearshore, inner shelf and atmospheric processes that drive the coastal flows we use a newly developed Coupled Ocean – Atmosphere – Wave – Sediment Transport (COAWST) Modeling System using the Model Coupling Toolkit to exchange prognostic variables between the ocean model ROMS, atmosphere model WRF and wave model SWAN. The modeling system allows seamless resolution from the North Atlantic Ocean (regional scale) to the inner continental shelf to the surf zone (local scale). The first two weeks of December were simulated, including the passage of two weather fronts. The first storm generated waves from the south driving a moderate northerly longshore current. The second front generated waves with a large angle of incidence from the north, driving southerly longshore currents approaching 2m/s. Results from the model system are utilized to understand the connections between the large-scale weather patterns and the observed wind driven offshore and wave driven surfzone flows. (Abstract ID 10841)

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IMPORTANCE OF MESOSCALE FEATURES IN THE GULF OF MEXICO ON LARVAL PELAGIC FISH ABUNDANCE

The management of fisheries requires accurate estimates of spawning stock biomass, preferably through the use of accurate fishery independent indices. Better understanding of environmental variables that influence larval distributions in the Gulf of Mexico will help improve fisheries-related indices. This research investigated whether larval abundance of a variety of pelagic fish species (Thunnus thynnus, Auxis spp., Euthynnus alletteratus, Katsuwonus pelamis, Coryphaena spp, Istiophorids, Other thunnus spp., and Xiphias gladius) collected during annual NOAA SEAMAP spring ichthyoplankton surveys in the Gulf of Mexico were related to mesoscale circulation features. Visual and automated methods of classifying the features were compared, and variability in larval abundances and species diversity was assessed using a variety of non-parametric multivariate statistics. (Abstract ID 11489)

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COMPARISON OF DOPPLER- AND RADAR CROSS SECTION-BASED WAVE HEIGHT SPECTRA FOR LOW SEA STATES

Using radar as a remote sensing technique for measuring ocean surface waves presents several advantages over conventional point sensors. Although our understanding of the scatterers contributing to the backscattered signal as well as the methods used to extract wave field information from these signals have progressed over the last several decades, many questions still remain. Measurements of wave fields using dual-polarized high-resolution X-band pulse-Doppler radar at low grazing angles along with two independent measurements of the surface waves using conventional sensors were performed offshore of the Scripps Institution of Oceanography pier. These data were taken in low sea states so effects associated with breaking waves are minimized. Cross-correlation functions between radar cross section (RCS) and Doppler signals are used to contrast and characterize signal modulations in the spatiotemporal domain. Doppler and RCS measurements are also used to compute wave height spectra, and comparisons between them are examined for both vertical-transmit and vertical-receive, and horizontal-transmit and horizontal-receive polarizations. Wave height spectra and associated wave statistics computed from the conventional sensor data are compared with those obtained from the radar measurements. (Abstract ID 10385)

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HUMAN INFLUENCES ON THE CHEMICAL COMPOSITION OF ORGANIC MATTER IN STREAMS AND LAKES OF THE HIMALAYAS

This study focused on quantifying human influences on the water systems of Nepal, specifically in the cities of Kathmandu and Pokhara, the Langtang Valley region and the Khumbu (Everest) region. Water samples were collected from surface sources and one well. Sampling sites were chosen for their proximity to local population and tourism centers. Solid phase extraction followed by gas chromatography time-of-flight (GC-TOF) mass spectrometry was used. Plasticizers were found to be some of the most abundant identifiable compounds in the samples. Diethylhexyl Phthalate (DEHP) was found in all (n=13) samples, with concentrations up to 5 ug/L. Diethylene Phthalate (DCHP) was found in most samples, with a concentration <170 ug/L. Dibutyl Phthalate (DBP) and Bisphenol A (BPA) were found in some samples. The highest concentrations DCHP and DBP were in samples taken in city regions. The highest concentrations of DEHP were also from city regions, but concentrations of more than half the maximum were also found in remote headwater regions. (Abstract ID 12436)

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INFLUENCES OF HYDROTHERMAL PLUME FALLOUT AND MINERALOGY ON MICROBIAL COMMUNITIES: INSIGHTS FROM IN SITU EXPERIMENTS AT THE LOIHI SEAMOUNT, HAWAII

The Loihi Seamount is the newest volcano in the Hawaiian chain and is very hydrothermally active. The hydrothermal fluids are rich in iron and poor in H2S and offer the ideal environment to study biotic iron cycling. Polished panels of various iron-bearing minerals were placed at the seafloor near the hydrothermal vent and on the flanks of the Loihi Seamount for up to three years and upon retrieval, the panels were found to be colonized by microorganisms. The cells were enumerated via fluorescent microscopy and the communities were characterized via 16S Sanger sequencing. Here, we present preliminary results and discuss the implications for any mineralogical and hydrothermal influences on microbial communities. (Abstract ID 12627)

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CLASSROOM CONNECTION: A SHIP-TO-SHORE INITIATIVE TO ENGAGE SPECIAL EDUCATION STUDENTS IN OCEANOGRAPHIC RESEARCH

In July - September 2010, scientists on board the research vessel JOIDES Resolution (the "JR")
during the Integrated Ocean Drilling Program (IODP) Expedition 327 interacted with one elementary ‘special education’ classroom in the Phoenix metro area via blogs and Q&A. The excitement and enthusiasm generated by this interaction inspired the “Classroom Connection” initiative, a 10 week ship-to-shore project aimed at teaching federally- and Arizona state- mandated curriculum standards using ship-to-classroom interaction. The project was implemented during IODP Expedition 336 (fall of 2011) and included hands-on classroom activities, web-based lessons, blogs, Q&A and an interview series with personnel on the JR.

Four elementary ‘special education’ and ‘special needs’ classrooms in the Phoenix metro area participated for all 10 weeks. We present the successes and challenges of this project and what implications they may have for ‘special education’ curriculum. (Abstract ID 12642)

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CANNOT SOUTHERN OCEAN PROCESSES MAINTAIN STRATIFICATION, OVERTURNING, AND HEAT TRANSPORT IN AN OCEAN WITH AN ADIABATIC INTERIOR?

We use a novel Lagrangian ocean model to explore the role of Southern Ocean processes in maintaining ocean stratification, the meridional overturning circulation, and poleward heat transport in an ocean with an adiabatic interior. This model is perfectly suited for simulations in the limit of zero diffusivity, since it produces no spurious mixing, and it does not require the Gent-McWilliams parametrization to generate oceanic bolus transports. When our idealized zero-diffusion ocean with a circumpolar channel is exposed to a realistic zonal wind stress and surface density restoring, the resulting ocean stratification, meridional overturning and poleward heat transport resemble those observed in the Atlantic. We test sensitivities of these features to variations in key dynamical factors, including the depth of the circumpolar channel, the strength of northern and southern hemispheric westerlies, and the imposed density in the North. The deep overturning cell, the mid-depth stratification, and the northward penetration of Antarctic Intermediate Water depend strongly on the co-existence of the circumpolar channel, southern hemispheric westerlies and density surfaces that outcrop in both the channel region and the northern high-latitudes. (Abstract ID 12073)

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REAL TIME MODELING AND OBSERVATIONS OF THE 2011 TSUNAMI DEBRIS FROM JAPAN

SCUD (Surface CURRENTs from Diagnostics) model is used to simulate motion of debris from the 11 March, 2011 tsunami in Japan. The SCUD utilizes near-real time AVISO altimetry data along with real-time ASCAT ocean surface winds to assess ocean surface currents, consistent with trajectories of drifting buoys, used in the Global Drifter Program. The result is a daily map of surface currents on 1/4 degree lat/long grid. These ocean surface current fields are applied to model the transport of tsunami debris. The debris is represented in the model by 678,000 tracers released on the day of tsunami near the east coast of Japan. The daily-updated maps of the debris field are public at http://iprc.soest.hawaii.edu/users/hafner/PU/SCUD/TSUNAMI_DEBRIS/tsunami_tracers_no_vector_large.html Reports on sightings of debris at sea ocean have been used to validate and improve the model. Practical applications of the modeled field of tsunami debris include the assistance for maritime safety and coordination of coastal clean-up operations. (Abstract ID 12648)

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RESPONSES OF MONTASTRAEA FAVELOLATA CALCIFICATION, RESPIRATION AND PHOTOSYNTHESIS TO SEAWATER CHEMISTRY CHANGES SIMULATING THE EFFECTS OF OCEAN ACIDIFICATION

Zooxanthellate coral calcification rates (CR) are generally 2-4 times higher in the light than in the dark. Ocean acidification reduces seawater pH and has been documented to reduce coral CR, presumably because photosynthesis cannot raise the pH enough to overcome the negative effects of the decrease in seawater pH. We used a Tris buffer to stabilize seawater pH during incubations to measure coral CR under a range of pH values spanning pre-industrial to predicted 2100 values. Results show that at a Tris stabilized pH of 8.2 or 8.6, there was no difference between light and dark CR due to enhanced dark CR, while at pH 7.5 or 7.9, light CR was 2-fold that in the dark due to reduced dark CR. Respiration rates remained relatively constant over the pH range examined; however, photosynthetic rates tended to decrease with higher pH which resulted in a trend of lower P/R ratios with increasing pH. This may indicate a small stimulation of photosynthesis due to higher PCO2. Further experiments are examining the relationships of calcification, photosynthesis and respiration to seawater pH. (Abstract ID 12023)

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TEMPORAL TRENDS OF BENTHIC FAUNA IN THE NORTHEASTERN CHUKCHI SEA, 2008-2010

An interdisciplinary study evaluated benthic communities near three proposed oil and gas exploration areas (Burger, Klaudtik, and Statoil) in the northeastern Chukchi Sea annually in 2008-2010. This study was sponsored by ConocoPhillips, Shell Exploration and Production Company, and Statoil USA E & P to collect biological and environmental information in these areas prior to exploration and provide data useful for permit applications and post- exploration comparisons. Benthic macrofauna and megafauna populations were surveyed and trends in abundance and biomass analyzed. Dominant benthic taxa exhibited temporal trends associated with oceanographic conditions that reflected climate variability. Macrofaunal abundance and the number of taxa increased with higher water temperatures and declined with colder temperatures while megafaunal responses were less clear. While trends were associated with water temperature, variations were found for both macrofauna and megafauna. Individual taxa responded to the inter-annual variability of oceanographic conditions to varying degrees, illustrating differing tolerances to a changing environment. (Abstract ID 12533)

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FUKUSHIMA RADIOACTIVITY FOUND IN THE MARINE SNOW AT THE DEEP LAYER IN THE WESTERN NORTH PACIFIC

We carried out the sediment trap experiments in the western North Pacific during autumn, 2010 and summer, 2011. The sinking particles were collected in the area before and after the accident of Fukushima nuclear power plant. Fission-product nuclides Cs-137 and Cs-134 were detected in the sinking particles at 5000 m depth about a month after the accident. The radioisotopes originated from Fukushima were transported to the deep ocean with marine snow immediately. (Abstract ID 9562)

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COHERENT MULTIDECADAL ATMOSPHERIC AND OCEANIC VARIABILITY IN THE NORTH ATLANTIC: BLOCKING CORRESPONDS WITH WARM SUBPOLAR OCEAN Winters with frequent atmospheric blocking, in a band of latitudes from Greenland to Western Europe, are found to persist over several decades and correspond to a warm North Atlantic Ocean. This is evident in atmospheric reanalysis data, both modern and for the full 20th century. Blocking is approximately in phase with Atlantic multi-decadal ocean variability (AMV). Wintertime atmospheric blocking involves a highly distorted jetstream, isolating large regions of air from the westerly circulation. It influences the ocean through windstress-curl and associated air/sea heat flux. While blocking is a relatively high-frequency phenomenon, it is strongly modulated over decadal timescales. The blocked regime (weaker ocean gyres, weaker air-sea heat flux, paradoxically increased transport of warm subtropical waters poleward) contributes to the warm phase of AMV. Atmospheric blocking better describes the early 20thC warming and 1996-2010 warm period than does the NAO index. It has roots in the hemispheric circulation and jet stream dynamics. Subpolar Atlantic variability correlates with distant AMOC fields: both these connections may express the global influence of the subpolar North Atlantic ocean on the global climate system. (Abstract ID 10280)

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ANNUAL TRENDS IN SEDIMENT FLUX ON THE WAIPOA RIVER MARGIN, NZ

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The east coast of New Zealand’s north island presents ideal geologic and oceanographic conditions for studying coastal sediment transport in a source-to-sink setting. The region features (-3000 m) mountains, erodible rock, and a vigorous maritime climate, which combine to generate and export ~15 Mt of sediment from the Waipaoa River each year. This study employs three bottom-boundary-layer tripods outfitted with a suite of acoustic and optical sensors designed to evaluate the mechanisms of water and sediment flux along and across the continental shelf for one year. The annual trend for sediment flux is across-shelf with little along-shelf component, driven by small to moderate wave events throughout the year. The notable exception to this rule involved the largest event of our record (July 2010), when the combination of waves (>3.5 m) and discharge (>2000 m³ s⁻¹) resulted in ~40% of the annual across-shelf transport at the near-shelf location, as well as significant along-shelf transport to the north. In this event, the combination of waves and discharge generated a gravity-driven flow, which was influenced by persistent, strong, along-shelf currents. (Abstract ID 11723)

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Tidal range changes in the Delaware Bay: past conditions and future scenarios

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A HIGH-RESOLUTION STUDY OF TIDAL RANGE CHANGES IN THE DELAWARE BAY: PAST CONDITIONS AND FUTURE SCENARIOS

Throughout the Holocene, appreciable changes in coastal and deep-ocean bathymetry are hypothesized to have resulted in large changes in tidal datums. An understanding of these changes is an important contribution to understanding relative sea-level change and to future coastal planning. To test this hypothesis, the Advanced Circulation (ADCIRC) model was used, with paleobathymetry and estimated future bathymetry, in order to model the time-varying tidal behavior of the Delaware Bay. Model runs were conducted on high-resolution grids at various time slices between 15,000 years before present and 1000 years into the future. Open boundary forcing at each time slice was obtained from global model runs. The most significant finding is that tidal ranges have increased by 60-80% in the upper Delaware Bay from 4000 years ago to present day. Additionally, the increase in tidal range shows significant spatial variability.
spatial variability, with the upper bay increasing at a faster rate than the lower bay. The results are consistent with field measurements of relative sea level change over the same time period. (Abstract ID 12217)

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SENSITIVITY OF TIDAL BAROTROPIC-TO-BAROCLINIC ENERGY CONVERSION TO DOMAIN SIZE IN A REGION MODEL

M₄ tides in the region around Monterey Submarine Canyon are simulated using a modified version of the Princeton Ocean Model. Barotropic-to-baroclinic energy conversion, (p ′ H′), is diagnosed. Most baroclinic energy entering the canyon originates on S Stope, but there are other, more remote sources within the model domain. Re-running the model with a smaller domain that excludes these remote generation sites decreases baroclinic energy flux in the canyon, but also changes energy conversion throughout the area common to both domains. The remote pressure perturbation (p ′ remote), from internal waves generated outside the common area, enhance or suppresses energy conversion inside the common area depending on its phase relative to the local pressure perturbation (p ′ local). This has three implications: (1) local internal wave generation is modulated by remote generation sites; (2) the internal wave field in regional models may be highly sensitive to domain size; and (3) if p ′ remote > p ′ local and the phase difference is ~180°, negative energy conversion will occur. (Abstract ID 12579)

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DEVELOPMENT AND EVALUATION OF AN OCEAN OSSE SYSTEM FOR THE GULF OF MEXICO

A prototype fraternal twin ocean OSSE system has been developed based on two different configurations of the HyBridge Coordinate Ocean Model (HYCOM). Development, evaluation, and calibration of this system is being conducted in the Gulf of Mexico. Goals include designing observing system improvements and enhancements to optimize GoM analyses used to initialize ocean forecasts and provide initial and boundary conditions to nested coastal ocean nowcast/forecast systems, and evaluating the performance of different data assimilation techniques. Errors between the two model configurations used for the nature run and the data assimilation system must have similar magnitudes and properties as the errors between present-day ocean models and the true ocean, and the nature run must also possess a climatology and ocean features that agree with observed properties within pre-specified limits. Analysis of both models demonstrates that these basic criteria are met. Our initial effort will be to determine the impact of targeted ocean observations on ocean analyses used to initialize the ocean component of hurricane forecast models. The goals of this application will be described and initial results will be presented. (Abstract ID 11800)

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SURFZONE AND INNER-SHELF TRACER EXCHANGE

During the IB09 field experiment (fall 2009), Rhodamine dye tracer was continuously released near the shoreline at the approximately alongshore- uniform Imperial Beach. A cross-shore array of six frames from the shoreline to 4 m depth measured waves, currents, dye, turbidity, and temperature. Offshore of the surfzone (z ~ 4-6 m depth), vertical and alongshore tracer structure was observed with co-located measurements of dye, turbidity, and temperature using a boat-towed vertical instrument array spanning 1-3 m below the surface and boat-borne CTD casts to the bed. Within the surfzone (~2 m deep at seaward edge), tracer was depth-uniform. Offshore, tracer was patchy in 50-100 m alongshore bands, and dye variability was correlated with turbidity and temperature variability, consistent with ejection by rip current events. The offshore tracer was approximately depth-uniform in the upper 3 m, but very low dye concentrations were observed in limited near-bed measurements in 6 m depth. Weak stratification was observed in the upper 3 m of the water column, while a strong thermocline generally below 3 m may have inhibited vertical tracer mixing seaward of the surfzone. (Abstract ID 10346)

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COMMUNICATING OCEAN SCIENCES COLLEGE COURSES: SCIENCE FACULTY AND EDUCATORS WORKING AND LEARNING TOGETHER

As the relationship between science and society evolves, the need for scientists to engage and effectively communicate with the public has become increasingly urgent. Leaders in the scientific community argue that research training programs need to also give future scientists the knowledge and skills to communicate. To address this, Communicating Ocean Sciences (COS) was developed to teach science undergraduate and graduate students how to communicate their scientific knowledge more effectively, and to build the capacity of science faculty to apply education research to their teaching and communicate more effectively with the public. Courses are co-facilitated by a faculty scientist and an educator. Scientists contribute their science knowledge and teaching experience, and educators bring their knowledge of learning theory regarding how students and the public make meaning from, and understand, science. Approximately 25 universities teach COS. The courses incorporate learning theory and provide outreach opportunities for students to apply that theory. Evaluation findings show the courses can be an effective mechanism to introduce scientists to education research and improve post-secondary science instruction, and help future scientists to become more effective communicators. (Abstract ID 9572)

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RECENT CIRCULATION STUDIES IN PRINCE WILLIAM SOUND, A FJORD-LIKE SYSTEM IN THE NORTHERN GULF OF ALASKA

Prince William Sound (PWS) is a semi-enclosed embayment in the northern Gulf of Alaska. It receives a substantial amount of freshwater from rain, rivers, and glaciers, and its main basin is significantly deeper than the shelf. Consequently, one might expect its circulation to resemble that of a classical fjord. Observations show this is only partly true. In this talk, recent field studies are presented to explore how several unique features of PWS impact circulation. The first notable difference is that PWS has two significant passages connecting it to the shelf. This means that the subtidal transport in each passage can be largely barotropic, and observations show this occurs in winter. Second, the main sill guarding PWS from deep water exchange is relatively deep and seaward of the largest channel, which allows a vigorous and predictable annual flushing of deep waters when downwelling winds relax. Finally, the interior of PWS is wide compared to both its length and the deformation radius. This creates space for lateral flow, which at times can even develop into a closed-core recirculation. (Abstract ID 10553)

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Recent studies have indicated that both small-scale Langmuir turbulence and submesoscale climate variables. (Abstract ID 11427)

Gross Oxygen Primary (GOP) and Net Oxygen Community Production (NOP) were sampled from ocean depths ranging between 60 and 3000 m. Sediment fluxes of MMHg were measured using intact sediment cores and overlying water for use in shipboard benthic flux chambers (SBFCs).

Production of monomethylmercury (MMHg) in sediments on the continental shelf and slope of the northwest Atlantic Ocean during three comprehensive Hg focused oceanographic cruises. We also use scale-decomposed fields to reveal a system far from steady-state. We also use scale-decomposed fields to reveal a system far from steady-state. The effects of Langmuir turbulence, in particular, are examined through comparisons with mixed layer simulations in the absence of Stokes drift. We also use scale-decomposed fields to construct maps of non-dimensional parameters and multiscale couplings. (Abstract ID 11987)

Hammer, R. C., University of Victoria, Victoria, BC, Canada, rhammer@uvic.ca
Circulation and thermal regime in green bay, lake michigan

This project aims to improve our understanding of hypoxia in green bay and the Fox River. Hypoxia has been a problem for decades, and evidence suggests that it may be worsening. Project tasks include: a) development of a hydrodynamic model for Lake Michigan, including Green Bay; b) collection of field data to validate the model and improve predictions of circulation and thermal regime. Initial analysis of modeling results reported by Beletsky and Schwab (2008) revealed low thermocline and thin epilimnion in summer of 2005. Kump and Waples measured severe hypoxia during that period. The model - data agreement suggests that hypoxia in lower Green Bay results from small initial mass of oxygen available for consumption by sediment oxygen demand. The spectrum estimate for Beletsky and Schwab’s (2008) summer temperatures showed a high-energy peak at a period of approximately 8 days. That peak coincides with an oscillation in currents and isotherms measured in summer of 1989 by Gotlib et al. (1990). Field data and model suggest that the cause of oscillation is exchange of water between Green Bay and Lake Michigan. (Abstract ID 12287)

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determined within the ETSP mixed layer during El Niño (Jan-Feb 2010) and La Niña conditions (Mar-Apr 2011). Continuous measurements of O2/Ar ratios were made along 105° and 205° between 80°W and 100°W using an Equalized Inlet Mass Spectrometer. Also, O2/Ar ratios and oxygen triple isotope composition were determined on a series of vertical profiles along these transects. Mixed layer O2/Ar ratios, based on O2/Ar ratios converted to C fluxes, ranged from slightly negative to 10 mmol/m2-d. GOP rates calculated from U/234-Th excess indicated 30 to 130 mmol C/m2-d. In both years, higher GOP and NOP rates, as well as NOP/GOP ratios were seen along the northern transect. When the influence of the upwelling on the oxygen mass balances is taken into account, both northern and southern transects indicated significantly higher productivity to the east. Higher GOP and NOP were observed during La Niña conditions in 2011. These estimates of net production will be compared to other approaches, including 234-Th deficiency and floating trap measurements. (Abstract ID 12489)

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PROJECT DYNAMO: INVESTIGATING GLOBAL WEATHER AND CLIMATE SYSTEMS IN THE INDIAN OCEAN

This presentation will highlight the participation of NOAA Teacher-at-Sea, Jacquelyn Hans, in a study of ocean-atmosphere interactions in the equatorial Indian Ocean involving meteorologists, oceanographers, and climate scientists from 13 countries in an investigation called Project DYNAMO (Dynamics of the Madden-Julian Oscillation). The Madden-Julian Oscillation (MJO) is a 30-90 day tropical weather cycle that starts over the equatorial Indian Ocean and moves eastward into the western Pacific Ocean where it impacts other global weather and climate patterns such as El Nino-Southern Oscillation (ENSO), Asian monsoons, tropical storm development in the Pacific and Atlantic oceans, and Pineapple Express events. Specialized instruments were deployed and operated on ships, aircraft, and islands in the Southern Indian Ocean, Maldives Islands, Diego Garcia British Indian Ocean Territory, and the Eastern Indian Ocean to collect data and study the MJO at its source. Jacquelyn joined Leg 3 of the research cruise aboard the R/V Roger Revelle in the Eastern Indian Ocean where she worked as part of the profiling operation and deployed a drifter buoy, while teaching her community college class from the ship. (Abstract ID 10791)

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THE APPLICATION OF LME CONCEPT FOR ECOSYSTEM-BASED MANAGEMENT IN THE BENGUELA CURRENT LARGE MARINE ECOSYSTEM

The Benguela Current Large Marine Ecosystem is one of the richest aquatic ecosystems on earth; it spans some 30 degrees of latitude, from northern Angola to the eastern shores of South Africa. This ecosystem has high primary productivity (~300 gCm2yr-1) which supports an important global reservoir of biodiversity and biomass of zooplankton, fish, seabirds and marine mammals. In 2007, after over a decade of political negotiations, practical cooperation and research, The Benguela Current Commission (BCC) was formed joining Angola, Namibia and South Africa in a multi-sectoral and inter-governmental approach to ensure sound governance of this aquatic region. The Commission provides a vehicle for the three countries to introduce an ecosystem approach to ocean governance. In recent times, BCC has adopted an LME concept for ecosystem-based management and its five-module approach (productivity, fish and fisheries, pollution and ecosystem health, socioeconomics and governance). This paper describes practical implementation of ecosystem approach in respect of lessons learnt and best practices as well as constraints encountered and measures taken to address them. (Abstract ID 11522)

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THE SIGNIFICANCE OF ULTRA-REFRACTED SWELL WAVES TO COASTAL PROCESSES IN SHELTERED AREAS: WITH APPLICATION TO CRISPY FIELD MARSH, SAN FRANCISCO

Deep water surface gravity waves propagating into shallow water may undergo significant changes in their direction due to refraction and other processes. Sometimes the direction of wave propagation can differ from the deep water direction by more than 90 degrees, in which case we refer to the waves as Ultra-Refracted Swell Waves (URSW). URSW can propagate onto sections of coastline that otherwise appear to be sheltered from ocean waves, and in these cases the highly refracted waves can significantly influence coastal processes. For example, Crispy Field Marsh is a small, restored tidal wetland located in the entrance to San Francisco Bay just east of the Golden Gate. The entrance channel to the marsh sometimes closes completely, which effectively blocks the tidal connection to the ocean and disrupts the hydraulics and ecology of the marsh. The most important factor found to bring about the entrance channel closure is the occurrence of large, offshore ocean waves. However, there were also some closure events during times with relatively small offshore waves. Examination of the deep water directional wave spectra during these times indicates the presence of a small secondary peak corresponding to long period swell from the southern hemisphere, indicating that Crispy Field Marsh and San Francisco Bay in general may be more susceptible to long period swell emanating from the south or southwest. A numerical modeling investigation was conducted and confirmed this phenomenon. (Abstract ID 9721)

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HURRICANE WAKE RESTRATIFICATION MECHANISMS

As a hurricane passes over the ocean, the intense cycloonic winds draw cold water up from the deep ocean, and make the surface mixed layer much deeper than normal. The result after the hurricane passes is a deep, cold wake which restratifies over time. We analyze the restratification of the cold wakes of Hurricanes Frances, Katrina, and Iggy based on scalings for different processes that can restore the hurricane wake to near the pre-hurricane conditions. The scalings are derived from model results and well-known parameterizations of air-sea heat fluxes, Ekman boundary fluxes, and mixed layer eddies. To obtain realistic scalings, we used satellite observations for temperatures inside the wakes, and climatological data from drifters for temperatures outside the wake and to calculate mixed layer depths. We find that the dominant mechanism for restoration of the surface is the Ekman transport of warmer water adjacent to the cold wake, while sub-mesoscale eddy bolus fluxes have the dominant subsurface effect. The resulting restratification timescales will be compared to approximate restratification times inferred from satellite SST data. (Abstract ID 9987)

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"OCEAN DISCOVERY" CRUISES: AT-SEA RESEARCH OPPORTUNITIES FOR THE NEXT GENERATION OF SCIENTISTS.

NOAA’s Cooperative Institute for Ocean Exploration, Research and Technology (CIOERT) explores and studies ocean frontiers with innovation and cutting edge technologies and is committed to bringing “science at sea” experiences to university students. Multidisciplinary “Ocean Discovery” cruises that communicate the excitement of research and discovery to students at a critical stage of their career decision-making have been incorporated into CIOERT’s Florida Shelf Edge Exploration expeditions, including use of the Johnson-Sea-Link submersible (2010) and UConn’s K2 ROV (2011). These high-quality experiences engage students in ocean research via complete research projects from shipboard data collection through presentations. Student research questions are created in association with CIOERT research projects and result in written papers and poster presentations. Students increase their understanding of the scientific process and observe, study, and characterize ocean conditions and benthic and pelagic habitats along the continental shelf. These experiences are transferred to the public, college students, pre-college teachers, and their students via presentations and web-based resources. These “Ocean Discovery” students will likely become tomorrow’s marine scientists, educators, and managers, all working, directly or indirectly, in support of NOAA’s mission. (Abstract ID 12198)

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CONSIDERING THE NON-CONSERVATIVE BEHAVIOR OF REFRACTORY DOC IN THE MODERN DEEP OCEAN: OPENING WINDOWS TO ITS DYNAMICS IN ANCIENT OCEANS

Marine refractory dissolved organic carbon (RDOC), holding 660 PgC, has a mean lifetime of thousands of years, with removal considered very slow and steady but incomplete during deep ocean circulation. But unlike RDOC in today’s ocean, this vast reservoir has been suggested as a relatively rigid carbon sink involved in Earth’s past climate changes. Accordingly, RDOC in ancient oceans had to be at times a much larger reservoir than it is today, and that
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OBSERVATIONS OF PRESSURE-GRADIENT DOMINATED ALONGSHORE CIRCULATION AT AN EXPOSED OCEAN BEACH

Surfzone dynamics onshore of an ebb-tidal delta and adjacent to a tidal inlet are investigated using measurements collected by an array of pressure sensors and current meters. The instrument array consisted of nine sites, six inside the surfzone extending over 600 m in the alongshore and three wave-current sensors extending over 1.2 km along the ~11 m depth contour outside the surfzone. Alongshore gradients in incident wave height (~10% difference at the 11 m sites), induced by refraction of waves over the ebb-tidal delta, resulted in alongshore wave set-up differences (O(10 cm)) over the 600 m extent of the surfzone instruments. Despite the moderate wave height gradients (O(10°)), alongshore pressure gradients inside the surfzone were often an order of magnitude larger than the radiation stress gradient force, and acting in the opposite direction. As a result, during the week-long deployment, alongshore wave-currents in the surfzone were driven by the pressure gradient. These findings demonstrate that alongshore pressure gradients associated with wave-induced set-up variations can be an important force driving nearshore flows, even in the presence of moderate wave height gradients. (Abstract ID 10727)

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IN SITU δ13C OF DISTINCT MARINE PLANKTON POPULATIONS USING FACS AND SWIM-IRMS

Elucidating pathways of carbon flow is critical for understanding carbon cycling and biogeochemistry in the marine environment. Variations in carbon isotopic ratios (δ13C values) of marine particulates can be used to trace sources of organic matter through the ecosystem. While whole-core δ13C differences between specific phytoplankton species have been observed in laboratory cultures under varying nutrient and growth conditions, field measurements have typically been restricted to mixed assemblages differentiated only by size. With fluorescence-activated cell sorting (FACS), specific plankton populations (e.g., diatoms, cyanobacteria) are separated and collected on the basis of either their natural autofluorescence or group-specific fluorescent stains. The δ13C content of sorted cells are then analyzed using a specialized microcombustion interface attached to an isotope-ratio mass spectrometer (SWIM-IRMS). Using this approach we measure an enrichment in diatom δ13C values compared to other measured groups. In situ differences in δ13C among different plankton populations can be exploited to follow carbon flow through successive trophic levels, and throughout organic matter remineralization, sinking, and preservation. (Abstract ID 10955)

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PLANKTVOROUS FISH LINK OCEANIC AND CORAL REEF FOODwebs

The food available to planktivorous coral reef fish includes oceanic zooplankton as well as zooplankton groups that originate from and reside within the reef. Using gut content and stable isotope (C, N) analyses, we quantify the relative contribution of reef versus oceanic zooplankton to the diet of nine planktivorous fish species sampled from three distinct reef habitats. Though fish in all habitats consume both oceanic and reef zooplankton, fish diet is habitat-dependent. Oceanic zooplankton comprise 60 to 86% of the diet of fish inhabiting the deep fore reef and 26 to 42% of the diet of fish from nearshore reefs. The dominance of oceanic zooplankton in the guts of forereef fish is paralleled by muscle tissue C isotopes that on average are depleted approximately 2% relative to fish inhabiting nearshore reefs. This study provides direct evidence of significant allochthonous (oceanic) input supporting secondary production in planktivorous reef fish. The role of planktivorous fish as trophic links between oceanic and coral reef food webs is influenced both by reef habitat and by feeding behavior. (Abstract ID 12795)

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IMPACTS OF HURRICANE IRENE AT FIRE ISLAND, NEW YORK: A BEACH BUILDING EVENT

The remnants of Hurricane Irene made landfall as a tropical storm on western Long Island, New York on 28 August 2011. Impacts to the barrier beaches of Long Island were expected to be significant, as this area was located within the northeast quadrant of the approaching storm. To assess the impacts of Tropical Storm Irene on Fire Island, a topographic lidar survey was collected after the storm made landfall. In contrast to initial expectations, comparisons of beach volumes with earlier data, in addition to field reconnaissance, indicate that a significant amount of cross-shore transport and infiltration of the beach occurred. Wave conditions from a six day period bracketing Irene were examined and it was found that the wave characteristics during Hurricane Irene were notably different than other severe storms of recent decades. Peak significant wave height values reached nearly 10 m. Long-period waves (17 s) from a southerly direction persisted prior to, during and following the peak of the storm. In contrast, northeaster storms are typically characterized by short period waves prior to the storm peak and long-period waves after the wave height has diminished. These data suggest that the substantial accretion on Fire Island following Irene resulted from the unusually long duration of long period swell throughout the storm, which appears to have resulted in an upward rotation of the shoreface. (Abstract ID 11098)

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OBSERVING THE UPPER OCEAN RESPONSE TO GLOBAL TROPICAL CYCLES USING ARGO FLOATS

Tropical cyclones are extreme atmospheric phenomena with implications for the structure and heat transport of the oceans. We use differences between successive Argo float profiles to study changes in mixed layer (ML) depth, temperature, and salinity caused by 705 global tropical cyclones over an 11-year time period (2000-2010 inclusive). In most cases and in all ocean basins, ML temperature decreased and the average ML cooling due to tropical cyclones was about 0.5°C. The ML depth appeared to have an equal probability of deepening or shoaling. We observed larger cooling on the right (left) of tropical cyclone tracks in many cases in the Northern (Southern) hemisphere. This is consistent with the observed locations of cold wake features that have been the subject of many case studies. As part of our analysis, we estimate the fluxes of heat and freshwater due to these storms in the context of global ocean heat and freshwater budgets. (Abstract ID 10651)

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A SECOND MOMENT CLOSURE MODEL OF LANGMUIR TURBULENCE

The Reynolds stress equation is modified to include the CL vortex force from the interaction of surface waves and Stokes drift u'w with upper ocean turbulence. An algebraic second moment closure yields an equilibrium model where a component of vertical momentum flux is down the Stokes drift gradient u w in addition to the conventional component down the gradient u w of mean Eulerian velocity. For vertical w' and horizontal u' fluctuations, the momentum flux is (u w)v K u w u w v w, where coefficients K u w and eddy diffusivity K e are distinct. The relevance of this equilibrium model to solutions of the CL equations is demonstrated in comparisons with Large Eddy Simulation (LES) solutions. Rational expressions for the stability functions S u w S u w S w w and S w w are derived for use in second moment closure models where prognostic models for turbulent velocity and length scale include vortex force production terms. The limitation of proximity to the surface, and the model's closure constants, are tuned to LES results. (Abstract ID 11663)

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MOLECULAR MARKERS OF NITROGEN AND PHOSPHORUS LIMITATION IN MICROCYSTIS AERUGINOSA

Blooms of the toxic cyanobacteria Microcystis aeruginosa have become common occurrences across the globe and are typically associated with excessive nutrient loading. While phosphorus is the nutrient that most commonly controls primary productivity in freshwater ecosystems, nitrogen limitation of non-diazotrophic cyanobacteria has also been documented. Furthermore, Microcystis blooms often persist even when the inorganic forms of nitrogen and phosphorus are depleted. To better understand the nutritional ecology of Microcystis blooms, we investigated genes that may be regulated by nitrogen and phosphorus limitation. During culture experiments with Microcystis, genes involved in phosphorus assimilation and transport (phoX, psnX, and plbX) were strongly (50- to 400-fold) up-regulated under phosphorus
expression of the gene coding for alkaline phosphatase, limitation and were down-regulated upon phosphorus replenishment. Furthermore, the with alkaline phosphatase activity (\(p<0.05\)).

**THE PRIMARY FACTORS DRIVING ARAGONITE SATURATION STATE IN THE**

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**COUPLING SEDIMENT TRANSPORT TO BIOGEOCHEMICAL PROCESSES: EFFECTS OF RESUSPENSION ON OXYGEN CONSUMPTION**

Though it enhances the exchange of porewater and solids with the overlying water, the role that sediment resuspension and redeposition play in biogeochemistry of coastal systems is debated. Numerical models of geochemical processes and diagenesis have traditionally parameterized relatively long timescales, and rarely attempted to include resuspension. Likewise, numerical models that represent sediment transport have largely ignored geochemistry. Here, we couple the Community Sediment Transport Modeling System (CSTMIS) to an NPIED (Nitrogen – Phytoplankton – Zooplankton – Detritus) biogeochemical model within the Regional Ocean Modeling System (ROMS). The multi-layered sediment bed model accounts for erosion, deposition, and biodeposition; and has been modified to include dissolved porewater constituents, particulate organic matter, and geochemical reactions. We explore the role that resuspension and redeposition play in biogeochemical cycles within the seabed and in the water column by running idealized, one-dimensional test cases designed to represent a 20-m deep site on the Louisiana Shelf. Results are compared to another model, configured similarly to a standard diagenesis model. Comparing these, the results indicate that resuspension acts to enhance sediment bed oxygen consumption. (Abstract ID 10458)

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**THE PRIMARY FACTORS DRIVING ARAGONITE SATURATION STATE IN THE OREGON COASTAL UPWELLING ZONE**

The anthropogenic increase in atmospheric CO2 has led to decreasing ocean pH – also known as ocean acidification. Coastal upwelling zones, like that along the U.S. Oregon Coast, naturally see large variations in pH, CO2, and carbonate mineral saturation states due to the upwelling of high pCO2, low pH source waters. Saturation states are further reduced due to the anthropogenic CO2 burden, which could have ill effects on many types of marine calcifiers. To study what controls the aragonite saturation states (\(\Omega_{arag}\)) in this highly dynamic ecosystem, Submersible Autonomous Moored Instruments for pH (SAMIPh) and for \(pCO2\) (SAMIC\(CO2\)), were deployed in surface waters above the continental shelf and at depth at the shelf break. The pH and \(pCO2\) data were collected for varying durations (from three months to seven months), encompassing spring and autumn transitions and winter on the shelf. The roles of biological productivity, salinity, temperature, and water mass mixing in driving \(\Omega_{arag}\) during each season studied are discussed. Knowing the controls of \(\Omega_{arag}\) in coastal upwelling zones can be used to improve models predicting future \(\Omega_{arag}\) in these regions. (Abstract ID 11307)

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**THE TATTERED CURTAIN HYPOTHESIS REVISITED**

Benthic larval settlement dynamics along the US West Coast is often thought to be driven by relaxation of upwelling winds. In this scenario the upwelling front, broken up by squirts and filaments, acts as a “tattered curtain”, retaining coastaly released material and transporting it back to the coast during wind relaxation. Other studies take the approach that settlement is more stochastic and driven by transport in and around coastal eddies. We test these two hypotheses in a coupled ocean particulate tracking model of an idealized eastern boundary current forced by realistic winds. We find that neither of the previous holds for this system on their own, but instead there is a combination of both processes. Settlement patterns are predominantly driven by retention of larvae in an upwelling jet, modulated by coastally trapped waves and interrupted by squirts. This jet is broken up and moved offshore by extended strong upwelling, reducing coastal retention. Spatially discrete, dense packets of coastal material are entrained in the jet and result in locally large pulses of settlement. Lagrangian coherent structures are used to characterize the two transport boundaries associated with jet, one consistent with the upwelling front, and one inshore of this. Findings here are consistent with observed recruitment patterns along the Oregon coast, suggesting the upwelling jet impacts coastal retention in that region. (Abstract ID 11375)

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**PREDATOR-PREY INTERACTIONS AND SALINITY TOLERANCE CAN IMPACT HARMFUL ALGAL BLOOM FORMATION IN HETEROSIGMA AKASHIWIO**

Harmful algal blooms (HABs) are ubiquitous and frequent, causing economical and ecological harm in affected areas. We hypothesized that some HAB species experience decreased heterotrophic protist grazing pressure, allowing bloom formation. We investigated the impact of salinity structure and individual movement behaviors on grazing interactions, by concurrently observing population distributions and 3D movement behaviors of the toxic raphidophyte, Heterosigma akashiwo and its heterotrophic protist predators in a 30cm/L tank with a 0-30 psu linear salinity gradient. Heterosigma akashiwo exhibited broad halo-tolerance, rapidly distributing throughout the tank. The predator Oxyrynia marina exhibited a similar broad distribution. In contrast, the predator Pavilla ehrenbergii avoided low salinities. When \(H. akashiwo\) and \(P. ehrenbergii\) co-occurred, 50% of the \(H. akashiwo\) population was inaccessible to \(P. ehrenbergii\). Furthermore, \(H. akashiwo\) exhibited retentive movement behavior (e.g. higher turning rate, slower swimming speed) in areas inaccessible to \(P. ehrenbergii\), resulting in decreased encounter rates, which could ultimately lead to reduced grazing pressure. This coupled physiological/behavioral advantage may be a mechanism that leads to enhanced survival of \(H. akashiwo\) and promotes bloom formation. (Abstract ID 11898)

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**A METHODOLOGY FOR PROTEIN EXTRACTION AND PROTEOMIC CHARACTERIZATION IN MARINE MATRICES**

To fully understand the fate of proteins in the environment, improved methods of isolation and analysis within complex environmental matrices are needed. We developed and validated a modified electrophoretic extraction and preparative technique used prior to high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) analysis. Multiple forms of gel electrophoresis were evaluated to enhance recovery of sedimentary protein prior to proteomic characterization and compared with a direct enzymatic digestion of proteins in sediments. Resulting tryptic peptides were analyzed using shotgun proteomics and tandem mass spectra and were evaluated with SEQUEST against multiple databases to determine the ability to confidently identify proteins from environmental samples while minimizing search-time requirements and necessary computational resources. Evaluation of tandem mass spectral data against larger databases with high diversity of proteins did not yield greater numbers or more confidence in protein identifications. Regardless of the protein database used, identified peptides correlated to proteins with the same function across taxa. This suggests that while taxonomic level information remains a challenge, it is possible to confidently identify and assign the function of identified proteins from environmental samples. (Abstract ID 10996)

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AN INTERDISCIPLINARY, MULTI-SCALE APPROACH TO MONITORING THE DEVELOPMENT AND SUCCESSION OF HARMFUL ALGAL BLOOM COMMUNITIES IN THE MONTEREY BAY

The abundance of toxigenic diatoms of the genus *Pseudo-nitzschia*, the domocid acid phyco toxin they produce, and associated zooplankton (russes, barnacles, polychaetes, crabs and copepods) were tracked and sampled in Monterey Bay during BloomEx October 2010. Observations from satellites, ships, drifters, autonomous underwater vehicles (AUVs), and environmental sample processor (ESP) robotic molecular detection systems permitted description of ecosystem variability from regional to molecular scales. Different human-in-the-loop and autonomous decision making algorithms developed for the AUVs enabled Lagrangian tracking of phytoplankton bloom patches and targeted water sampling of chlorophyll-a.
fluorescence maxima within the water column. Moor ed ESPs conducted in situ molecular analyses of plankton communities and phyctocyan in near-real-time. Sampling by AUVs, moored ESPs and ships revealed a series of oscillations in the abundance of toxicogenic diatoms and toxin concentrations during the month. These biological oscillations were correlated with changes in oceanographic conditions. Molecular identification of zooplankton identified probable toxin-transfer candidates. Synthesis of the extensive BloomEx data set demonstrates our ability to monitor compositional changes in planktonic communities, examine trophic linkages, and assess how physical processes drive plankton community variability. (Abstract ID 10008)

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DIGITAL HOLOGRAPHY OF FEEDING MECHANISMS IN DAPHNIA ON COLONIAL DIATOMS

Size and shape as a limiting factor in grazing among Daphnia is most accentuated in diatoms where single cells are ingested at a higher rate than cells that are part of large colonies. While numerous accounts of ingestion rates are published and the conclusions differ from account to account, little is known about the mechanics of feeding on colonial diatoms by Daphnia and other planktonic grazers. We observed Daphnia swimming freely in a vessel of 125 ml in water with normal densities of colonial diatoms. High-speed digital holography was used to observe encounters between the algae and the grazers. Additional observations using tethered animals revealed the mechanics of capturing and handling of colonial diatoms. The results will be shown in videos. (Abstract ID 9985)

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COASTAL UPWELLING AND UPPER OCEAN CIRCULATION IN THE BISMARCK SEA - OBSERVATION AND MODEL SIMULATION

We investigate the upper ocean currents in the Bismarck Sea and related oceanic thermal changes in the western equatorial South Pacific for December 2001 - January 2002; during this period, coastal upwelling occurred along the Papua New Guinea (PNG) coast, and then upwelled relatively cool water spread out over a wider area to the northeast. Simultaneously, strong northeasterly surface winds occurred along the north coast. At that time, a northeastward outflow toward the equator from the PNG coastal area is also found. This northeastward outflow could bring the upwelled relatively cool coastal water, to the western equatorial South Pacific near PNG. The present results indicate that northeastward transport of the cold water is related to the complicated upper-ocean currents in the Bismarck Sea, and that will have strongly affected the upper-ocean thermal change in the western equatorial Pacific near PNG in association of coastal upwelling before the onset of 2002/2003 El Nino event. Similar behavior is also found in CGCM simulation. Furthermore, potential effect of high mountains in the PNG to atmospheric and oceanic variations is examined by regional AGCM. (Abstract ID 10137)

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UPWELLING VELOCITIES AND EDDY DIFFUSIVITY FROM THE MEASUREMENTS USED TO COMPARE VERTICAL NUTRIENT FLUXES TO EXPORT POC FLUX IN THE ETSP

The cosmogenically produced radionuclide, Beryllium-7 (half-life = 53.3d), is deposited on the sea surface by rainfall and subsequently homogenized in the mixed layer. The mass balance of its inventory in the water column can be used to estimate upwelling velocities (w) and vertical diffusivity (κ). if the atmospheric input can be established, thus giving insight into vertical transport of nutrients across the upper thermocline. Five the profiles were measured in an area bounded by 10-20S and 80-100W, and used in a one-dimenional diffusion-advection model to determine Kz. Observations indicate an inverse relationship between mixed layer nutrient concentrations and mixed layer 7Be activity, indicating the influence of upwelled nutrient-rich, 7Be-poor water into the mixed layer. Thorium-234/half-life = 24.1d) flux and sediment traps were also used to constrain POC export from the euphotic zone at each site, presumably driven by nutrient fluxes. Values for upwelling velocity, nutrient flux and export POC flux are compared. Neglecting subduction, upwelling velocities were estimated to be up to 0.19m/d, Kz values ranged from 0.90*10^-4-1.55*10^-4m2/s, and diffusive nitrate fluxes across the 1% light horizon ranged from 7.1-4550 umol/m2*d. (Abstract ID 10540)

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TOWARD A U.S. ANIMAL TELEMETRY OBSERVING NETWORK FOR OUR OCEANS, COASTS AND GREAT LAKES

The new National Ocean Policy (NOP) calls for strengthening our capacity to observe the nation's oceans, coastal waters and Great Lakes. The U.S. Integrated Ocean Observing System (U.S. IOOS), is providing a framework for the integration of observing capabilities. The development of the ocean observing system began with an effort to integrate physical and chemical data on the oceans, and currently an important near-term goal of IOOS is to increase the amount of biological data in the observing system. One valuable addition to the existing US ocean observing capabilities is animal telemetry observations. In recent years the scale of animal telemetry activities has greatly increased, and there are now a number of self-organized regional networks making concerted efforts to make these data into an operational part of the observing system. A group of scientists including industry, met recently with the goal of establishing a sustainable U.S. Animal Telemetry Observing Network (ATN) and linking observations from this network to U.S. IOOS. The group generated eight recommendations for implementing an ATN and identified potential roles for U.S. IOOS to coordinate the integration of animal telemetry observations. The group consensus was that an observing system that monitors animals on a range of temporal and spatial scales will yield both short and long-term benefits, fill knowledge gaps and advance many of the NOP Priority Objectives, particularly EBM and CMSF. (Abstract ID 11911)

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IMPACT OF VARIOUS IRON SOURCES TO TASMAN SEA PHYTOPLANKTON: FROM BIOAVAILABILITY TO COMMUNITY SHIFT

The effect of different iron forms was studied at two sites in the Tasman Sea to mimick allochthonous (terrestrial (fulvic acid) and atmospheric (two Australian desert dusts)), and autochthonous sources (monosaccharide, exopolysaccharide, and siderophore). In these experiments, the total added iron was kept constant (2nM) and compared with inorganic iron or absence of iron enrichment. The bioavailability of these different forms of iron was measured on size fractionated phytoplankton and their impact on phytoplankton was measured following 4 day incubation. The phytoplankton community structure, photosynthetic health, primary productivity, nutrients, iron chemistry; and humic-like substances were measured. Results demonstrate that iron sources have different bioavailabilities to different phytoplankton size fractions and exopolysaccharide was the most efficient to enhance iron bioavailability. Following incubation, iron bound to fulvic acid and siderophore elicited little response, however exopolysaccharides and dust induced increased phytoplankton biomass and a community shift. Different responses were measured between different iron forms and sites, indicating that both iron source and the original community are important factors to consider for the prediction of...
the impact of iron input to the phytoplankton community. (Abstract ID 10892)

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PLUGGING THE HOLES: EVALUATIONS AND DESIGNS FOR ACOUSTIC ARRAY INTEGRITY IN A COMPLEX COASTAL ECOSYSTEM

Ecological hypotheses concerning the movement of marine animals are sensitive to Type-II errors: the failure to detect the passage of an individual into or out of an ecosystem. The hypothesis that Atlantic Salmon are able to close their life cycle within the Bras d’Or estuary of Cape Breton, Canada can be tested by acoustically tagging smolts and tracking their return to natal rivers without migration into the NW Atlantic. This is easier said than done, despite the fact that there are only three possible avenues of transit from this complex, 1200km2 estuary. These channels include a broad range of bathymetric, hydrodynamic, and hydrological features that severely compromise the ability of acoustic receptors to detect tags. We have conducted a series of detailed tests that demonstrate high probability of type-II error (low power) as a result of acoustic shadowing, turbulent and turbidity scattering, and pycnocline reflection. We conclude that tagged fish will often be able to transit without detection even in shallow, narrow channels much smaller in cross-sectional area than the optimum range of receivers. We suspect that this is a common problem with acoustic tracking arrays in coastal and inland aquatic ecosystems, and identify tactics to evaluate and design such arrays for greater statistical power. (Abstract ID 12773)

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IRON FLUXES FROM THE SHELF REGIONS IN THE SOUTHERN DRAKE PASSAGE DURING THE AUSTRAL-WINTER 2006

Spatial distributions of dissolved iron (Fe), manganese (Mn) and aluminium (Al) in the upper 500m in the region near Antarctic Peninsula (AP) during the 2006 austral-winter are consistent with diagnostically-produced sedimentary sources and also with data obtained in the region during the 2004 austral-summer. Nearest King George Island (KGI) elevated levels of dissolved Al, Fe and Mn are found uniformly down to the sediment water interface in high energy regions above the shelf. These distributions contrast with the offshore Antarctic Circumpolar Current (ACC) where very low concentrations of Fe coincide with high nutrients and low concentrations of chlorophyll (HNLC). In the Bransfield Strait (BS), the elevated trace metal concentrations correspond to the flow path of the Bransfield current near KGI. This enriched plume can also be seen exiting the BS, between Clarence and Elephant islands into the Scotia Sea where it mixes with the high nutrient ACC waters leading to high productivity in this region during the growing season. (Abstract ID 10854)

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CAN DOC INFLUENCE THE AVAILABILITY OF THE CLIMATE FEEDBACK GAS DMS?

Dimethylsulphide (DMS) production in the ocean represents ca. 40 % of the global input of volatile sulphur to the atmosphere, where it can affect cloud albedo and may have a role in global climate regulation. Remarkably ca. 90 % of all the DMS produced in the ocean never escapes to the atmosphere, but up to now we had not fully understand where it went to. Our research along with a growing body of evidence strongly suggests that most of the DMS removed is actually oxidised to DMSO. Furthermore, it suggests this pathway is ubiquitous in the oceans and may represent an important mechanism by which marine bacteria provision their cellular energy requirements. More importantly, it is now becoming apparent that the amount and rate of DMS oxidation may be influenced by the availability of dissolved organic carbon (DOC), meaning that the availability of DOC may have important implications for the cycling of DMS and climate feedback, and in turn the availability of DMS may influence the rates of biogeochemical cycling and energy derived from the DOC pool by marine bacteria. (Abstract ID 9862)

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SINGLE-NUCLEOTIDE POLYMORPHISMS (SNPS) SHED LIGHT ON TRANSPORT-RELATED CONDITION AND CONNECTIVITY IN CORAL REEF FISH LARVAE

While there is potential for long distance larval dispersal, recent research indicates that local retention of larvae may be more important in replenishing coral reef fish populations than influx from distant sources. Because of carryover effects, larvae with different levels of condition in the plankton may differ in their post-settlement mortality. Thus, in order to better understand the relative contributions of local retention and long-distance dispersal in maintaining reef fish populations, it is necessary to examine the relationship between larval condition and dispersal pathways. We have used high-throughput sequencing to identify over 56,000 SNPs from 385 bluehead wrasse. By using a subset of these SNPs to genotype bluehead wrasse larvae collected from locations along and upstream of the Florida Keys reef tract, we can identify particular loci that covary with condition-related traits (growth rates, RNA/ DNA ratios), and document sparse differences in spatial distributions of particular SNPs, especially among nearshore and offshore water masses. Additionally, we can investigate differences in the frequencies of particular SNPs among newly hatched larvae, and older (longer-surviving) larvae and juveniles as a means of identifying loci under selection. (Abstract ID 12690)

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MAPPING SPATIOTEMPORAL PATTERNS IN TIGER SHARK HABITATS USING SATELLITE TECHNOLOGY

Twenty-two tiger sharks (Galeocerdo cuvier) were tagged with SPOT tags near Bermuda between 2009-2011. Shark tracks were filtered for quality and swimming behavior. We matched GPS locations of the sharks with ocean surface data (SST, Chla, ocean color, biomass) measured by NASA’s MODIS Aqua satellite, as well as bathymetry and distance to land measurements. Local regression and distance based modeling techniques were applied to identify and predict ideal shark habitat type based on satellite data. Most tiger sharks followed similar migration patterns. We found a strong interaction between shark location and solar properties as well as sea surface temperature. We used these sharks to develop a dynamic habitat model that spatially and temporally predicts the location of tiger shark habitat. This is the first study to integrate tiger shark tracking efforts with the dynamic ocean properties that can be measured remotely by satellites. These habitat maps can be integrated into ecosystem and climate models to test the interaction between apex predators and global change. (Abstract ID 10236)

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CONCORDANT PHYLOGEOGRAPHIC PATTERNS ASSOCIATED WITH THE MAJOR HEADLAND OF CAPE MENDOCINO IN NORTHERN CALIFORNIA

Coastal geographic features are important determinants of dispersal for marine larvae. We consider the role that Cape Mendocino may play in limiting larval dispersal along the coast of northern California. Though Cape Mendocino is a prominent headland, it has been largely ignored in the eastern Pacific phylogeographic literature. We review and synthesize phylogeographic studies that include sampling sites north and south of Cape Mendocino and discuss oceanography and topography of the cape as potential mechanistic drivers of larval dispersal. Slightly more than half of species showed significant genetic structure around this headland. This result suggests, for some species, Cape Mendocino may provide a barrier to larval dispersal. This concordant phylogeographic break is coincident with a large persistent upwelling jet, an offshore cyclonic eddy, poleward-moving water in the south, and a large stretch of sandy habitat to the north, which may combine to reduce larval dispersal across the cape. If populations north of Cape Mendocino have higher connectivity with populations in Oregon than with those in central California, marine spatial planning must occur at a multi-state scale to reach conservation goals. (Abstract ID 12170)

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The West Coast Governing Agreement (WCGA) was formed by the governors of California, Oregon, and Washington and spans the California Current Large Marine Ecosystem (CCLME). In 2006, the governors developed a high-level policy directive and formalized an action plan to address West Coast’s most pressing ocean issues. Ten Action Coordination Teams (ACTs) were established to take on-the-ground steps in ocean and coastal policy at local, state, and regional levels by bringing together science and policy experts. As a Regional Ocean Partnership, the WCGA interacts with the National Ocean Council and can assist in implementing national ocean policy priorities, which largely mirror regional priorities. The West Coast Sea Grant programs jointly funded four Fellows to assist the WCGA to coordinate across ACTs, promote research and information priorities for the West Coast, and facilitate the formation of a West Coast regional data network to increase access to geospatial data. These efforts will help the WCGA assimilate scientific data and information into ocean resource policies and practices within the CCLME, implement their plan, and maintain a leadership role within the National Ocean Policy. (Abstract ID 12117)

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Transition Decades for Ocean Acidification in the California Current System  
Due to seasonal upwelling the California Current System (CCS) has a naturally low pH and aragonite saturation state (Ωarag), making it particularly prone to ocean acidification. We define transition decades as the time period when chemical changes induced by the long-term trends exceed those experienced over the annual cycle. To do so we use a CCS set up of the Regional Ocean Modeling System (ROMS). Despite the large variability of pH and Ωarag, the present day levels are already distinctly different from those during the preindustrial era. By 2040 pH and Ωarag of the nearshore 50 km are expected to be distinctly different than today. The aragonite saturation horizon is projected to permanently shoal into the upper 75 m in approximately 2030. The model tends to underestimate the annual variability of the system and overestimate pH and Ωarag, which implies that transition decades are expected later, while permanent undersaturation is expected earlier. We show that organisms of the CCS will be forced to rapidly adjust to conditions that are inherently chemically challenging and also distinctly different from the present day. (Abstract ID 11119)

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Spray Effects on High-Wind Speed Momentum Fluxes in Both Marine and Fresh Water  
Understanding the coupling between the atmosphere and ocean in extremely high winds is of significant interest due to its effect on hurricane intensities. One of the most challenging aspects of this problem has been isolating the sea spray contributions to the momentum flux. Although freshwater laboratory observations offer highly repeatable drag coefficient measurements for wind speeds up to 50 m/s, the question exists of whether they appropriately represent marine sea–spray effects. To evaluate the differences between seawater and freshwater spray on air-sea momentum transfers a series of laboratory experiments has been conducted in the Air-Sea Interaction Salt-water Tank (ASIST) of the University of Miami. Droplet size distributions were measured in both seawater and freshwater using a Cloud Droplet Imaging Probe (CDIP) over a range of wind speeds up to U10N of 50 m/s. Bulk momentum exchange coefficients (CD10) were directly observed using a momentum budget technique. A key aspect of this approach is that the total stress was observed (both interfacial and spray induced). Although corrections are required to account for the local spray generation and for spray droplets that evaporate out of the system and not returned to the surface, with the existing data we can evaluate the differences between the marine and freshwater spray effects. (Abstract ID 10375)

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Factors Contributing to the Atmospheric Decadal Warming of Sub-Polar North Atlantic 2001 - 2011  
Recent ocean observations demonstrate a strong warming trend in the sub-polar North Atlantic over the past two decades. This is concurrent with typically milder than usual winters over the North Atlantic region. Atmospheric warming can be considered as a major factor that contributes to the weakening of winter cooling at the surface and intermediate layers of the ocean. We examine links between the recent warming of the sub-polar North Atlantic and fluctuations in patterns of occurrence of large scale North Atlantic atmospheric regimes. These regimes are defined by performing cluster analysis on reanalysis derived 500 mb geopotential heights, to allow identification of more subtle distinctions than possible with more standard indices. The clusters are fit using fuzzy membership functions so as to determine a consistent measure of the atmospheric state. These memberships are well correlated with Labrador Sea Ocean temperature. We discuss the influence of variation in atmospheric synoptic scale features relating to these regimes on the ocean temperature. (Abstract ID 12892)

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Comparison of Altimetric DataSets Near the US West Coast  
Correction algorithms and orbits for satellite altimeter missions have been successfully improved over time; however, these improvements were focused on the deep ocean while coastal measurements remained undeveloped due to land contamination and measurement errors associated with the different oceanic physics in shallow and coastal waters versus deep water. To alleviate the lack of accurate coastal data, several datasets have been designed for coastal regions by using tailored correction algorithms or integrating tide gauge data with the altimetric data. But, how accurate are these datasets? In this study we used the tide gauge augmented coastal altimetry dataset developed by Oregon State University/Cooperative Institute for Oceanographic Satellite Studies (OSU/CIOUS) as “truth” to evaluate several along track altimetry data sets within 0.75 degrees of the US West Coast. Three along track altimeter datasets: French coastal altimetry dataset (PISTACH), multi-mission integrated altimeter data from NASA, and OST/Mason-GDRs with enhanced radiometer correction are compared to the OSU dataset in this region to evaluate the differences in the various coastal datasets and to perform an initial assessment of their accuracy. (Abstract ID 12591)

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Observations of Sediment Transport During the Winter in the Laurentian Great Lakes  
The Laurentian Great Lakes are subject to ice cover, particularly in the shallower areas, for several months each winter. Since most sediment resuspension in the lakes is caused by surface wave action, the presence of significant ice cover can inhibit sediment movement during these periods. Direct observations of sediment resuspension and transport during the winter are difficult to make, but time series observations of water transparency, temperature, current velocity and wave action were made at several sites in Lake Erie during the winters of 2004-2005 and 2010-2011. The observations show that the presence of ice over significant portions of the lake essentially eliminated wave action, so little or no resuspension occurred, and the water column became cleared of suspended material. Since ice is an annual feature of the lake’s climate, its presence causes a yearly episode of sediment sequestration on the bottom prior to resuspension and transport after the ice breaks up. (Abstract ID 10395)

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On the Vertical and Temporal Structure of Flow and Stress Within the Turbulent Oscillatory Boundary Layer Above Evolving Sand Ripples  
The vertical structure of flow and stress within turbulent oscillatory boundary layers above evolving sand ripples is investigated in experiments carried out using a prototype wide-band coherent Doppler profiler in an oscillating boundary facility with beds of 0.216 mm height, to allow identification of more subtle distinctions than possible with more standard indices. The clusters are fit using fuzzy membership functions so as to determine a consistent measure of the atmospheric state. These memberships are well correlated with Labrador Sea Ocean temperature. We discuss the influence of variation in atmospheric synoptic scale features relating to these regimes on the ocean temperature. (Abstract ID 12892)
but detectable isopycnal gradients in the concentration of dissolved $^{230}$Th exist across a zonal settings sampled during the 2010 leg of the U.S. GEOTRACES North Atlantic Transect. Small initial results for dissolved $^{231}$Pa and $^{230}$Th concentrations in the contrasting oceanographic circulation. Motivated to deconvolve these influences for their use as proxies, we present decay, adsorption-desorption reactions with particulate matter, and redistribution by ocean TRANSECT

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AIR-SEA INTERACTIONS ON TITAN: WIND DRIVEN CAPILLARY-GRAVITY WAVES; HARD TO DETECT OR NON-EXISTENT?
Saturn's moon Titan has lakes and seas of liquid hydrocarbons in a dense atmosphere, an environment notionally conducive to generating wind-waves. However, Cassini spacecraft observations so far show no indication of wave activity. Here we review common models for wind-wave generation and apply them to the Titan environment. Results suggest U10 thresholds of 0.3-0.7 m/s for likely lake compositions, depending on liquid viscosity. This reduced threshold, compared to Earth, results from Titan's increased atmosphere-to-liquid density ratio and reduced gravity and surface tension. While available observations have been acquired near Equinox, when predicted wind-speeds are below this threshold, future observations will be acquired during Northern Spring/Summer, when wind-speeds above the threshold are predicted. Once gravity-capillary waves begin to grow, gravity waves will soon follow, leading to a fully developed sea. For a given wind-speed, Titan's reduced gravity will lead to H, 1/3) ~ 2 times greater than Earth. Cassini's ongoing observations may detect such seas. However, the low winds speeds predicted on Titan suggest that H), 1/3) will remain below ~0.6 m, which is below the maximum potential tidal amplitude of the largest seas. (Abstract ID 10721)

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PA AND TH DISTRIBUTIONS ALONG THE GEOTRACES NORTH ATLANTIC TRANSCET
The oceanic distribution of $^{218}$Pa and $^{230}$Th is the combined result of production via uranium decay, adsorption-desorption reactions with particulate matter, and redistribution by ocean circulation. Motivated to deconvolute these influences for their use as proxies, we present initial results for dissolved $^{218}$Pa and $^{230}$Th concentrations in the contrasting oceanographic settings sampled during the 2010 leg of the U.S. GEOTRACES North Atlantic Transect. Small but detectable isopycnal gradients in the concentration of dissolved $^{230}$Th exist across a zonal transect between Mauritania and Cape Verde. Boundary scavenging, in response to high biological productivity and particle flux off the Mauritian margin, may be less dramatic than once thought but potentially quantifiable here. Dissolved $^{218}$Pa concentrations and dissolved $^{218}$Pa/$^{230}$Th ratios at mid-depth (1000-2500 m) in the Cape Verde transect are much larger than in the more northerly stations (30-40°N, 10-20°W). We speculate this gradient reflects some combination of water mass ageing and the much greater fluxes of biogenic opal in the Mauritian upwelling region. Finally, vertical concentration gradients in $^{218}$Pa near the seafloor suggest enhanced removal of this isotope at the seabed. (Abstract ID 10514)

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RESPONSE OF BENTHIC FORAMINIFERA TO A NATURALLY CO2-RICH COASTAL HABITAT IN FLENSBURG FJORD (SW BALTIC SEA)
It is expected that the calcification of unicellular foraminifera is negatively affected by the ongoing acidification of the oceans. Nevertheless, compared to the open ocean, already today these organisms are subjected to much more adverse carbonate system conditions in coastal and estuarine environments such as the Baltic Sea. Although foraminifera are abundant in the brackish Hensburg Fjord, test dissolution of living benthic foraminiferal assemblages was observed during the seasonal cycle. Similar levels of test dissolution were observed, when living Ammonia aequirotia were exposed to elevated pCO2 levels from 929 to 3130 µatm in a culturing experiment. These data indicated drastic effects of the prevailing acidotic conditions on benthic foraminifera. In this study, we compared the seasonal changes of the carbonate chemistry (pCO2, pH) and the response of the foraminiferal community in more detail on bi-monthly cruises to Hensburg Fjord. We observed large seasonal fluctuation of bottom water pCO2, and permanent low pH. Further, foraminiferal assemblages were characterized by seasonal community shifts. Despite adverse pCO2, and pH conditions, most tests were intact which indicates the ability of foraminifera to cope with fluctuating pCO2. These results emphasize the need to understand the biological control of the calcification process in foraminifera. (Abstract ID 12300)

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PARAMETRIZATION OF SUBMESOSCALE PARTICLE TRANSPORT IN THE GULF STREAM REGION USING LAGRANGIAN SUBGRIDSCALE MODELS
We study the Lagrangian transport in the Gulf Stream region, which exhibits clear indications of strong submesoscale activity from both models and observations. A hybrid approach is put forward, in which the modeled transport is based on the deterministic Lagrangian Coherent Structures (DGLS) over the mesoscale range and the statistical Lagrangian subgridscale (LSGS) models over the submesoscale range. Two HYCOM solutions at different resolutions, namely with 1/12 and 1/48 degree horizontal meshes respectively, are considered, and a measure of relative dispersion, the scale-dependent finite scale Laxpovun exponent, is used as our main metric to diagnose their differences in terms of transport. The particular focus of this study is on correcting the underestimation of submesoscale dispersion regime in the 1/12 degree solution, while the 1/48 degree resolution case and an existing observational data set indicate a trend toward much higher dispersion. Three LSGS models that had been developed on the basis of statistical considerations are investigated in order to tackle the multi-scale ocean transport problem. We characterize them and define their parameter ranges that yield an improvement in multi-scale relative dispersion. (Abstract ID 9760)

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PACIFIC TOP PREDATOR HABITAT SHIFTS IN A CHANGING CLIMATE
Climate change scenarios have predicted an average rise from 1.4°C to 2°C which could effect the habitat and distribution of many marine species. We used spatially explicit habitat models (e.g. generalized additive mixed models) to examine present-day distributions and foraging habitat of 23 top predator species in the Pacific from 2001-2009 as a function of fixed bathymetric variables, sea surface temperature, wind, Ekman pumping, mixed-layer depth, and chlorophyll-a. Consequently we used a 1° and monthly resolution climate models from the Geophysical Fluid Dynamics Laboratory to predict potential habitat under future scenarios. We found oceanographic changes, such as the northward migration of the transition zone that
affected top predator biodiversity throughout the Pacific and highlighted potential changes in important conservation corridors. (Abstract ID 9917)

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ECOGENOMICS OF THE DEEPWATER HORIZON SPILL

The explosion on April 20, 2010 at the BP-leased Deepwater Horizon drilling rig in the Gulf of Mexico off the coast of Louisiana, resulted in oil and gas rising to the surface and the oil coming ashore in many parts of the Gulf. It also resulted in an immense oil plume 400-500 ft deep. Despite spanning more than 600 feet in the water column and extending more than 10 miles from the wellhead, the dispersed oil plume was gone within weeks after the wellhead was capped — degraded and diluted to undetectable levels. Ecoinformatics enabled discovery of new and undersampled species of oil-eating bacteria that apparently lives in the deep Gulf where oil seeps are common. Using 16s rRNA sequences, functional gene arrays, done libraries, lipid analysis, phenotypic microarrays, metagenomes, metatranscriptomes, single cell sequencing, stable isotope analysis in combination with a variety of hydrocarbon and microntinutrient analyses we were able to characterize the deep-sea microbial ecosystem and the effect of the oil spill. (Abstract ID 12178)

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EFFECT OF THE GULF STREAM ON WINTER EXTRATROPICAL CYCLONE OUTBREAKS

A high-resolution, regional coupled atmosphere-ocean model is used to investigate strong air-sea interactions during a rapidly developing extratropical cyclone (ETC) off the east coast of the United States on 22-23 January 2008. In this two-way coupled model, wind stress and net heat flux from the Weather Research and Forecasting (WRF) atmosphere model and sea surface temperature (SST) from the Regional Ocean Modeling System (ROMS) are exchanged via the Model Coupling Toolkit (MCT). Model validations against in-situ buoy and ocean glider data show that the coupled-air-sea model accurately reproduces the strong storm winds, fluctuations in sea level pressure, persistent ocean cooling, and upper ocean temperature structures observed. It is found that the air-sea interactions near the Gulf Stream are important for generating and sustaining the ETC. In particular, locally enhanced winds over sharp SST discontinuities induce large surface heat flux which cools the upper ocean by up to 2°C. Detailed model analyses show the ocean-to-atmosphere heat flux dominates the upper ocean heat content variations, and that the synoptic surface wind convergence (SWC) is proportional to the Laplacian of sea level pressure and sea surface temperature. SWC induces strong upward vertical motions throughout the marine atmospheric boundary layer and enhances ocean heat loss, supporting rapid ETC intensification. (Abstract ID 12814)

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WHAT IS HAPPENING AT THE NORTHWEST CORNER OF THE NORTH ATLANTIC CURRENT?

The North Atlantic Current (NAC) travels northward east of the Grand Banks until approximately 50°N where it makes a sharp turn to the east. Previous analysis of sea level variability in this region, known as the Northwest Corner, showed a quasi-regular production of anticyclonic eddies, some of which appear to disappear in place. It was hypothesized that these eddies become denser due to a large latent heat flux to the atmosphere and that they sink in place. To address these ideas, four high resolution and two broader scale hydrographic surveys in two separate expeditions spanning a three-month period during Spring 2011 were undertaken. Results from these surveys as well as output from the data assimilative HYCOM model of this region will be discussed. Evidence of interaction of eddies with the NAC, including the spin up and decay of eddies, and interleaving and subduction between the different water masses in the region will be presented. (Abstract ID 9943)

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THE SOUTHERN OCEAN AND ITS CLIMATE IN CCSM4

The Southern Ocean is a key area in the climate system for many reasons, and good representation of its mean state, internal variability, and response to external forcing is essential for the fidelity of coupled climate simulations. Here we present results of our evaluation of the Southern Ocean in the Community Climate System Model v4 (CCSM4). The CCSM4 is a state-of-the-art coupled climate model, and a suite of simulations have been performed following the protocol of the Coupled Model Intercomparison Project, phase 5 (CMIP5). We focus on the representation of the major water masses of the Southern Ocean (Antarctic Bottom Water, Subantarctic Mode Water, and Antarctic Intermediate Water), compare water mass properties and tracer distributions to observations, and address the representation of the Antarctic Circumpolar Current and the interocean exchanges that take place along the northern edge of the Southern Ocean. (Abstract ID 9654)

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EFFECT OF THE WIND STRESS ON THE VARIABILITY OF THE YELLOW SEA BOTTOM COLD WATER IN SUMMER

Sea surface temperature is important to primary products and marine life. The Yellow Sea Bottom Cold Water (YSBCW) colder than 10°C is observed below the thermocline in summer. The cold water persists in spite of surface heating for the whole year. Many scientists have interested in this unique water mass. This study investigates interannual variability of the YSBCW and their causing mechanisms. The observed temperature by the National Fisheries Research & Development Institute in the southern Yellow Sea shows that remarkable two modes of the southern boundary location of the YSBCW. Interannual variation of the YSBCW has strong relation with the southerly wind stress in summer whereas they have weak relation to the previous winter temperature. This implies that southerly wind may play important role in driving southward flow of the YSBCW. Detail dynamics will be explained with numerical model experiment. (Abstract ID 11121)

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HISTORICAL PRIMARY PRODUCTION IN THE EASTERN GULF OF MEXICO

Examination of short and long-term impacts of the Deepwater Horizon spill and the resulting dispersal of crude oil, oil-dispersant mixture and the weathering products on primary production in the eastern Gulf of Mexico is complicated by a lack of systematic and long-term primary production measurements. We have compiled and synthesized primary production data from 1992 to 2010 for this region from a variety of sources. Values in offshore oligotrophic areas were generally low, <1.0 C g m(-2) d(-1), except in localized areas with blooms of Ncutinizing cyanophyte Trichodesmium or in one instance, a subsurface bloom of Phaeocystis spp. where values ranged up to 4.23 C g m(-2) d(-1). Size fractionated data generally showed a trend of equivalent production occurring in the 0.2–3.0 µm and >3.0 µm fractions in these regions. Production in coastal regions was elevated, up to 5 C g m(-2) d(-1) with values exceeding 15 C g m(-2) d(-1) in areas of Karenia brevis blooms. This variability suggests that documenting and predicting impacts of the spill on primary production will be both complicated and challenging. (Abstract ID 11468)

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EXAMINATION OF KEY PROCESSES INVOLVED IN THE BIOCHEMICAL CYCLING OF MANAGANESE IN THE OCEAN

Mn is biologically important for phytoplankton as it is critical for many redox enzymes required for photosynthesis, in particular in Photosystem II where it converts water to oxygen. Many marine organisms also utilize Mn as the metal centre in superoxide dismutase (SOD). SODs are essential for intracellular defences against reactive oxygen species (ROS) like superoxide. In oxygenated seawater soluble Mn(II) is slowly oxidized (biotic or chemically) to insoluble MnO2, which precipitates out of the water column. In the sulfidic ocean, ROS can reduce MnO2 back to Mn(II) introducing a redox cycle. Recent work suggests that Mn(III), which is a transient intermediate between Mn(II) and MnO2, may play an important role in both, the Mn and Fe biogeochemical cycles, however until now it is unidentified how and if this species is stabilised in the ocean. Here we will present data for Mn concentrations, speciation and its kinetic reactivity with ROS from two research cruises (M83-1 and M83-17) in the Tropical Atlantic. In this presentation we examine the current evidence for Mn(III) in the euphotic zone of the open ocean. (Abstract ID 11078)

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CHARACTERIZATION OF THE MAIN FRACTION OF DISSOLVED ORGANIC MATTER FROM DIVERSE OCEANIC ENVIRONMENTS BY REVERSE OSMOSIS COUPLED WITH ELECTRODIALYSIS

Only a small fraction of marine DOM is readily identifiable. Determining the chemical nature of the remaining fraction of oceanic DOM has been impeded by lack of efficient and non-fractionating methods for isolation and desalting. Here, reverse osmosis-electrodialysis (RO/ED) was used for isolating a representative DOM fraction (~75%) for analysis by solid-state 13C-NMR. Samples were obtained from biogeochemically diverse environments; i.e., photobleached surface gyre, productive coastal upwelled, oxygen minimum, deep Atlantic, and old deep Pacific waters. Advanced NMR spectral editing revealed new insights into carbohydrate biodegradation, and preservation of carboxyl groups and condensed aromatic structures (deep sea samples). Quaternary alginic carbon were identified as an important component of bio-refractory carbohydrates. However, despite some differences, these diverse samples yielded remarkably similar DOM compositions. Our results support the 3-pool DOM model (labile, semi-labile, and refractory). Evidence of ‘background’ refractory carbon was seen throughout the ocean DOM samples, and the high carboxyl signal in the deep Pacific sample supports the hypothesis that a major fraction of the refractory pool is carboxyl-rich alicyclic material (CRAM). (Abstract ID 11250)

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QUANTITATIVE ASSESSMENT OF MACROINVERTEBRATE COMMUNITIES IN AN URBAN NEW ENGLAND WATERSHED

The Neponset River watershed is 1 of 5 urban watersheds flowing into Boston Harbor. The top 5 land-uses in the watershed are forest, golf-course, residential, industrial, and wetland. Physical and chemical analyses showed that land use impacts water quality in the watershed. The goal of this study was to assess water quality using aquatic macroinvertebrate bioassessments and relate bioassessment scores to land-use type in the watershed. In summer of 2010, we deployed a cluster of 3 Hester Dendy artificial substrates at 8 total sites; 2 reaches for each for golf, residential, industrial, and forested land-use treatments. Community parameters examined included EPT/Chironomids ratio, total number of taxa collected per site, Shannon-Wiener Diversity Index, and Invertebrate Community Index. We expect forested areas to have higher water quality than the more perturbated land-uses as shown in habitat assessments and physical and chemical water analyses. Our results can be used to show the utility of assessing water quality via bioassessment, comparing water quality of different land uses, and be used to make management decisions to improve water quality in the watershed. (Abstract ID 10577)

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WAVE-GENERATED, WIND-MIXED NEAR-SURFACE SHEAR OBSERVED OVER A TIDAL FLAT

Around high tide over a flooded tidal flat, vertical shear measured 0.13-0.4 m beneath the sea
surface by upward-looking Acoustic Doppler Profilers (ADPs) was usually aligned with the wind. However, shear did not increase with increasing windspeed, likely owing to an increase in wave heights and wave-generated mixing with increasing wind. The associated increase in water-side drag coefficient with windspeed was predicted, with substantial scatter, by a model for near-surface mixing by breaking waves. A depth-independent eddy viscosity model yielded only slightly less skill than a fitted depth-dependent model. Farther (0.3-0.6 m) from the surface the model skill was low. Wave heights tended to increase with increasing water depth. Consequently, the simulated wave-generated surface eddy viscosity tended to increase with increasing depth. (Abstract ID 12839)

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OCEAN PLUME AND TRACER MODELING FOR THE FUKUSHIMA DAI-ICHI EVENT
NCEP/NWS deployed particle tracing to predict the movement of radionuclides in the ocean shortly after the Japanese Nuclear disaster near Fukushima. Daily nowcast/forecast fields from 1/12 HYCOM (RTOS-Global) model output were used to track inert particles at the ocean surface, assuming that the surface behavior is reasonably representative for the ocean mixed layer, and that the radionuclides will mostly be contained in and distributed by the upper mixed layer of the ocean. With the particle tracing information, NCEP produced estimates of retention times of radionuclides near the coast, as well as dispersion time scale of these materials through the Pacific Ocean, particularly by persistent current systems like the Kuroshio and the extension, and the Oyashi. This helped identify both potential safe areas in the Pacific, and areas of potential exposure on the time scales of weeks to months. Full tracer computations capability of HYCOM has also been used to predict the dispersion of radionuclides in a nested North West Pacific subregion model within RTOS-GLOBAL. The initializations and boundary conditions of the nested subregion were incrementally updated daily from the nowcast fields of the global model. Some preliminary results from the tracer computations will also be presented. (Abstract ID 11761)

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HIGH RESOLUTION RECONSTRUCTION OF PALEOENVIRONMENTAL VARIABILITY DURING THE LAST 20 KYR IN THE SOUTH EAST LEVANTINE BASIN, EASTERN MEDITERRANEAN
The eastern Mediterranean Sea is particularly sensitive to climate change. Its sediments record not only global climate periodicities such as glacial/interglacial periods and shorter time-scale climate oscillations, but they do so in an amplified manner (e.g. sapropels). Sediment deposition in the southeastern Levantine Basin are perfect recorders for high-resolution studies, since the Nile maintained a continuous high sedimentation rate. Here we present a well-dated (210-Pb and 14-C), comprising a detailed continuous record (~5-25 yr per sample) of the last 20 ky. Results of the bulk sediment inorganic geochemistry, grain size, foraminiferal C/O isotopes, organic C/N isotopes, and TOC are used to investigate short time scale paleoceanographic variability. We will focus on productivity, fresh water (Nile) and deep water oxygenation changes from the Last Glacial Maximum through the Holocene with emphasize on times of global abrupt climate change (H1, B-A, Y .Dryas, African Humid Period, and 8.2 kyr event). (Abstract ID 11064)

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ACCLIMATION OF THE COLD WATER CORAL, LOPHELIA PERTUSA TO PREDICTED RISES IN ATMOSPHERIC CO2 AND SEA TEMPERATURES
Cold-water corals are amongst the most three-dimensionally complex deep-sea habitats known and are associated with high local biodiversity. Despite their importance, little is known about how these organisms will face the face of predicted future climate change. Currently, the long-term synergistic effects of projected increases in atmospheric pCO2 and sea temperatures upon the cold-water coral Lophelia pertusa are unknown, and studies to date have only examined L. pertusa response to either increased temperature or increased pCO2 on short time scales. Here, we present data on the effects of increased sea temperatures (by 3°C) and increased pCO2 (750 and 1000ppm) upon the metabolism and growth of the cold-water coral Lophelia pertusa, collected from the Mingulay Reef Complex, Scotland, UK. Results from short-term exposure to increased temperature and pCO2 on freshly collected corals will be contrasted with current data from an ongoing 18-month experiment. Comparison of short and long-term data will help define the impact of ocean acidification and increased temperatures upon the growth, physiology and structural integrity of the reef framework forming coral Lophelia pertusa. (Abstract ID 9494)

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GLOBAL OBSERVATIONS OF INTERNAL WAVES BY ARGO FLOATS
Internal waves are a significant contributor to deep ocean mixing, and consequently are likely a factor in ocean circulation and meridional overturning. We discuss here an analysis method that uses data from Argo floats equipped with Instrid communications. The method examines temperature measurements collected during the drift phase between vertical profiles, while the floats are parked at a quasi-isobaric stage. The combination of temperature stratification within the ocean and the vertical heaving of internal waves causes the temperature to vary at the parking depth of the float. The temperature variation is used to estimate internal wave displacement. Harmonic analysis of the displacement time series yields power spectra that are similar to the Garrett-Munk spectrum, with prominent tidal and inertial peaks. While Instrid floats do not yet provide comprehensive global coverage, the existing dataset is large enough in spatial extent to clearly identify a number of active and quiet regions for internal gravity waves in different ocean basins. (Abstract ID 10992)

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EVALUATION OF A TRANSURANIC COMPONENT IN REACTOR DERIVED RELEASES FROM FUKUSHIMA DAI-ICHI TO THE MARINE ENVIRONMENT
The incident at Fukushima Dai-ichi on March 11, 2011 was the consequence of several events (earthquake, tsunami, equipment failures, etc.) and led to the release of radioactive contaminants into the atmosphere and ocean. Although the specific details regarding the mechanism and/or the extent of radioactivity released to the environment are lacking, significant levels of fission products such as 131I, 134Cs, and 137Cs have been observed in the vicinity of Fukushima. As part of a research cruise in June, 2011 to study the problem, we received water samples collected between 30 and 600 km offshore. The main objective of our work is to determine the presence of/characterize a transuranic component in the reactor releases. Specifically, we are in the process of evaluating the levels of 237 Np and Pu isotopes in samples from the cruise with a focus on the surface waters. Depending on the levels presented, the measured isotopic composition should be diagnostic in resolving reactor derived contamination from background levels associated with global fallout. We will report our findings and compare them to other available data sets. (Abstract ID 11572)

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TEMPERATURE EFFECTS ON THE METABOLISM OF THE DEEP-SEA STONY CORAL, LOPHELIA PERTUSA
Lophelia pertusa was collected from the Gulf of Mexico. Oxygen consumption and metabolic enzyme activities were measured at 8°C (control), 11, 13, and 5 degrees Celsius. Activity of malate dehydrogenase (MDH) and citrate synthase (CS) were measured to determine aerobic capacity. Lactate dehydrogenase (LDH), an indicator of anaerobic poise, was undetectable. Oxygen consumption at 8 and 11 degrees were similar, averaging 4.14 and 3.30 ul. O2/polyph/b, respectively. At 13 degrees, respiration plummeted to 1.84 ul O2/polyph/b and half of the corals died. At 5 degrees, the temperature at which corals were held after collection, the lowest rate was observed, 1.17 ul O2/polyph/b. Despite this drop in metabolism, the corals seemed to adapt well to this temperature. CS averaged 0.13, 0.21, 0.09, and 0.14 units/g for the treatments at 8, 11.13 and 5 degrees, while MDH varied little at 1.79, 1.44, 1.48, and 1.55 units/g for the respective treatments. This study contributes much-needed knowledge about the basic biology of corals and their metabolic response to temperature, so that the effects of climate change can be elucidated on a physiological level. (Abstract ID 9483)

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TOS/AGU/ASLO 2012 Ocean Sciences Meeting
NOAA’s Center for Operational Oceanographic Products and Services (CO-OPS) recently began measuring and disseminating visibility observations in coastal regions using forward scattering infrared sensors. Instrumentation was installed in response to requirements from the NOAA Physical Oceanographic Real-Time System (PORTS) partners for the main purpose of enabling safe navigation. Although CO-OPS previously participated in extensive visibility sensor testing to understand instrumentation, measuring and interpreting visibility along U.S. coasts is a new area for CO-OPS. In order to better understand processes of fog formation and to determine how relative humidity (RH) and solar irradiance measurements can be used to enhance visibility assessments, a field experiment is being conducted at a United States Army Corps of Engineers (USEACE) facility in Chesapeake City, MD. A test system consisting of visibility, RH, and solar sensors was deployed alongside an existing NOAA coastal water level station where wind and air and water temperatures are measured. The purpose is to analyze the relationships between visibility, RH, solar irradiance, and air/sea temperature gradients. Observations from the field experiment will be presented along with interpretation of results. (Abstract ID 12092)

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DEcadal Variability in phytoplankton Populations in response to the North Atlantic Oscillation and Implications for organic carbon flux

Phytoplankton phenology and community structure is expected to change on interannual and decadal time scales in response to changing physical forcing, and to have subsequent impacts on ocean biogeochemistry. However, records of phytoplankton abundance are rarely long enough to address decadal variability – the exception is the Continuous Plankton Recorder dataset. Here we examine a time series of diatom and dinoflagellate abundance from 1958-2009 in the Northeast Atlantic, in the transition region between the subpolar and subtropical gyres. We find that in positive NAO periods, the region experiences subpolar-type conditions, with increased wind stress, deep mixed layers and enhanced upper ocean nutrient concentrations. In contrast, in negative NAO periods the region shifts towards more subtropical-like conditions. In response to negative NAO periods, not only is the phytoplankton bloom peak shifted one month later, but dinoflagellates are able to outcompete diatoms. The implications for carbon flux to the deep ocean are investigated using the Porcupine Abyssal Plain sediment trap time series data. Unexpectedly, the abundance of dinoflagellates is closely correlated with deep carbon flux, but abundance of diatoms is not. (Abstract ID 10986)

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A MultiVARiate Analysis of observed and modeled Biophysical Variability on the Bering Sea Shelf: Multidecadal hindcasts (1969-2009) and Forecasts (2010-2040)

Coupled physical/biological models can be used to downscale global climate change to the ecology of subarctic regions, and to explore the bottom-up and top-down effects of that change on the spatial structure of subarctic ecosystems - for example, the relative dominance of large vs. small zooplankton in relation to ice cover. Here we utilize a multivariate statistical approach to extract the emergent properties of a coupled physical/biological hindcast of the Bering Sea for 40 years (1969-2009), which includes multiple episodes of warming and cooling (e.g. the recent cooling of 2003-2009). Specifically, we employ multivariate Empirical Orthogonal Function (EOF) analysis to derive the spatial covariance among physical and biological time series from our simulation. These are compared with EOFs derived from 1) spatially gridded measurements of the region, collected during the multi-year BASIS and BEST/BSERF field programs; 2) a midtidecadal regional forecast of the coupled models, driven by an IPCC global model forecast of 2010-2040. (Abstract ID 11631)

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Insights into Seasonal Organic Carbon Cycling in the Delaware Estuary from n-Alkane Biomarkers and Stable Carbon Isotopes

Mixing across biogeochemical gradients in estuaries controls the geochemical reactivity and partitioning of marine and terrestrial organic carbon (OC). In the Delaware Estuary, urbanization and wetland sources further obscure OC pathways. Here, we show results from four axial surveys in four seasons (2010-2011) of water column particulate OC. Our bulk-δ13C values range from -30‰ upstream and -19‰ at the mouth, recording terrestrial inputs while tracking seasonal phytoplankton productivity in the lower estuary. However, bulk parameters lack sufficient sensitivity for OC source apportionment. n-Alkane biomarker patterns better delineate OC sources and show differences in OC inputs and transport between surface and bottom water samples. Export of terrestrial carbon from the estuary occurs in both surface and bottom water, but the depth of export varies with seasonal conditions. Mixed OC sources at the estuarine turbidity maximum (ETM) reinforce the importance of ETM for OC processing. Pronounced marsh n-alkanes suggest marsh-OC is a significant source of carbon within the Delaware Estuary. Thus, wetland OC may be important both geochronically and quantitatively for OC processing in the Delaware and other estuaries. (Abstract ID 9516)

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A Ten-Year Plan to Build an End-to-End Regional Coastal Observing System (RCOOS) for the Southeast Region of the US

The Southeast Coastal Ocean Observing Regional Association (SECOORA) is one of eleven regional associations (RAs) that make up the U.S. Integrated Ocean Observing System (IOOS®). SECOORA covers coastal estuarine and ocean waters from North Carolina to the west coast of Florida. This region is vulnerable to storm hazards, potential impacts from oil drilling, and climate variability. SECOORA is building a RCOOS that integrates and augments existing observational, modeling, data management, educational, and scientific assets to improve our understanding of risks, improve decision making, reduce environmental and societal impacts, and support the economy of the region. This plan prioritizes user needs, leverages partnerships with other RA, federal and state agencies and stakeholders, and will improve data collection and accessibility. Improved decision support tools are also proposed within four themes: marine operations; coastal hazards; ecosystems, water quality; and living marine resources; and climate change. We present a regional plan that describes coastal, moored, and mobile monitoring assets build-out scenarios, and provides an integrated data management, modeling, product development, education and governance framework that assures the data collection assets are efficiently and effectively configured. (Abstract ID 12261)

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Zooplankton, Micronekton and the Biological Pump: Beyond the Meso-scaleic Zone

Migrant biota transports carbon to the mesopelagic zone due to their feeding at the shallower layers and their defecation, respiration, excretion and mortality at depth. The so-called active flux has been considered a small number compared to gravitational sinking. Recent assessments in subtropical waters show an important effect due to predation by interzonal diel vertical migrants (DVMs). The consumption and subsequent transport of epipelagic zooplankton by DVMs (mainly micronekton) to the mesopelagic zone seemed similar to the mean gravitational export. However, the consequences of this active transport to the bathypelagic zone are almost unknown. Here, we show the effect of the Atlantic and Pacific equatorial upwelling systems on the vertical distribution of acoustic backscatter from the
surface to bathypelagic depths. The enhancement of the acoustic signal below the upwelling zone was observed to reach 4000 m depth, coinciding with high abundances and activity of bacteria at those depths. The results suggest an active carbon transport from the epipelagic driven by zooplankton and micronekton, enhancing the efficiency of the biological pump and giving an insight about the fate of an increased productivity at the shallower layers of the ocean. (Abstract ID 12174)

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SPATIAL PATTERNS AND VARIABILITY THEREIN OF MICROBIAL POPULATIONS: AN ATLANTIC FIELD STUDY

In a seminal 1995 paper, Alan Longhurst divided the ocean into biogeochemical provinces using physical oceanographic processes and images from satellite observations. This partitioning has since been widely applied in a range of studies from carbon flux to zooplankton distributions. But how do these provinces relate to microbial plankton biogeography? These smallest planktonic organisms dominate primary production and are important drivers of biogeochemical cycles in the vast oligotrophic Atlantic. However, there is evidence that they are missed by remote sensing and it is still uncertain whether the marked mesoscale variability seen in their abundances in shelf seas also is a ubiquitous feature of the open ocean. Plankton surface samples were collected at 20 km resolution along an Atlantic Meridional Transect in May 2004, crossing five Longhurst defined provinces from the Fallland Islands to the British Isles. Nine microbial populations, including phototrophs and heterotrophs, were discriminated and enumerated by flow cytometry. A range of statistical analyses were used to assess the relationship between Longhurst provinces and microbial distributions, and to quantify mesoscale variability in populations within and between these provinces. (Abstract ID 10273)

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A HIGH-RESOLUTION REGIONAL MODEL FOR THE BERING SEA ECOSYSTEM

The Bering Sea contains one of the most productive ecosystems in the world with significant social and economic implications. The ocean circulation in this region is complex with a broad range of spatial and temporal scales. In this presentation, we focus on the cross-shelf exchange processes explaining some of the dominant mechanisms controlling the dynamics of both physical and biological properties of the Bering shelf. We also present new data from an extensive survey of the shelf during the summers of 2010, 2011, and 2012. The new data support previous findings that the shelf waters in the Bering Sea are driven by the Kuroshio Extension, a strong, cold current that flows along the western coast of Alaska. The new data also indicate that the shelf waters are influenced by the Bering Front, a boundary between warm, saline water from the North Pacific and cold, fresh water from the Siberian Shelf. The new data provide a more complete picture of the physical and biological processes occurring on the Bering Shelf, and will be used to improve our understanding of the complex interactions between the physical and biological components of the Bering Sea ecosystem. (Abstract ID 12708)

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WIND AND TIDAL INFLUENCES ON EXCHANGE IN A LARGE INVERSE ESTUARY IN WESTERN AUSTRALIA

The maintenance of a healthy estuarine environment depends on the ability of the system to exchange water with the ocean. In Shark Bay Western Australia, a large inverse estuary, gravity currents form during periods of reduced wind and tidal mixing. Field data from 2009 and numerical model results were used to predict an outflow event during the winter of 2011 and design a field experiment. The resulting measurements of current velocity and density profiles in the northern entrance channel showed that stratification and gravity currents were strong (up to 30 cm/s) and more persistent than previously estimated. Stratification in the deeper channels persisted even during periods of increased tidal mixing, and advection and mixing by intense wind events were important factors controlling exchange. The hydrodynamic model, validated by the field data, was then used as a tool to assess the relative importance of wind and tidal mixing. This work supports previous hypotheses that gravity currents are likely important for the larval dispersal of commercially fished scallop, prawn, and pink snapper. (Abstract ID 10948)

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VIRAL DIVERSITY AND ECOLOGY IN AQUATIC METAZOA: EVIDENCE FOR VIRAL ROLES IN HOST MICROBIOMES

Viruses play important roles in pelagic and benthic compartments of aquatic habitats, contributing to the mortality of bacteria to whales. However, our knowledge of viral diversity in the oceans is limited. Metaviromics has proved a useful tool for investigating viruses associated with a variety of habitats, including metazoa. When combined with quantitative molecular approaches, this tool may provide insight into the ecology of discovered viruses amongst host populations. We recently have investigated viruses associated with several ecologically critical metazoa in both freshwater and marine habitats. Concomitant investigation of Daphnia population dynamics and the presence of two viral genotypes demonstrated patterns of prevalence and viral load consistent with potential population decline during summer 2011. Investigations into viral decay of several putatively metazoan viruses in lake waters and sediments suggest that these viruses may persist in aquatic habitats on longer timescales than native phage. Microscopic and genomic investigations of virus-like particles and genomes in echinoderms (urchins, sea stars and sand dollars) and the dogfish Squalus acantius demonstrate the unexpected presence of viruses in healthy populations of metazoa. Our data suggest that viruses may occur as components of multi-kingdom host microbiomes, and that there is much to be learned about the diversity and dynamics of viruses in aquatic metazoan populations. (Abstract ID 10641)

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ALONGCOAST STRUCTURE OF SEASONAL WATER PROPERTIES AND VELOCITY ON THE NORTHERN CALIFORNIA CURRENT SHELF

Moored sensors were maintained for five years in an alongshelf array spanning ~60 km. The array included a location strongly influenced by the Columbia River year round (Grays Harbor, Washington); central Oregon (Newport); and sites just north (Coos Bay) and just south of a coastal promontory, Cape Blanco, where the equatorward coastal jet frequently separates from the shelf (Rogue River). In spite of the local environment and physical and physical differences, seasonal cycles in salinity and temperature were very similar in magnitude below a depth of about 10 m. However, south to north seasonal lags of 1-2 months in T/S extrema were observed over the array. Properties of water upwelled onto the shelf in summer were similar over the array and
displayed no memory of properties from the preceding winter; the latter had a much greater degree of site to site variability. In contrast to water properties, velocity in the summertime equatorward jet had significant alongshore structure. Maximum equatorward flow in spring/summer precedes local upwelling-favorable wind stress (~1 month) and the occurrence of coldest, saltiest water (~2 months) at all locations. (Abstract ID 10867)

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Adaptive meshes as a tool for submesoscale ocean modeling

Adaptive mesh models aim to efficiently simulate transient and complex multi-scale processes by dynamically adjusting mesh resolution. The utility of adaptive meshes, as implemented in Fluidity-ICON [1], for submesoscale ocean modeling is assessed by evaluation of simulations of the lock-exchange. This simple set-up incorporates diverse processes, including gravity currents, internal waves and turbulence, that all enhance the mixing.

The Froude number (non-dimensional gravity current front speed) and background potential energy (a measure of the mixing) are used to evaluate the performance of fixed and adaptive meshes. The adaptive mesh simulations produce comparable values of the diagnostics to the higher resolution fixed mesh simulations whilst using at least one order of magnitude fewer nodes. The results also compare well with published values, e.g. [2] [3]. The choice of metric, which guides the mesh adapt, is shown to be crucial for good representation of the dynamics. The accurate and efficient modeling of the flow and mixing at varying scales offers a promising outlook for the use of adaptive meshes in submesoscale ocean modeling.


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Differential Effects of Ocean Acidification on Calcification of Algal-Symbiont Larger Rentic Foraminifers

Ocean acidification, which is an outcome of anthropogenic CO2 as well as global warming, may have a severe impact on marine calcifying organisms, especially those living in coral reef ecosystems. Here we show results of a series of culture experiments on two groups of algal symbiont-bearing, reef-dwelling foraminifers, Amphisorus kudakajimensis and Calcarina gaudichaudii, in acidified seawater prepared with a precise CO2-bubbling technique. While A. kudakajimensis showed a reduced net calcification with higher pCO2 conditions, calcification of C. gaudichaudii was generally increased as pCO2 elevated. In another culture experiment conducted in seawater in which bicarbonate ion concentrations were varied under constant pCO2 conditions, calcification of C. gaudichaudii was generally increased as pCO2 elevated. In another culture experiment conducted in seawater in which bicarbonate ion concentrations were varied under constant pCO2 conditions, calcification of C. gaudichaudii was generally increased as pCO2 elevated. From these results, we concluded that carbonate ion and CO2 were the carbonate species that most affected growth of Amphisorus and Calcarina, respectively. The opposite responses of these two foraminifer genera probably reflect different sensitivities to these carbonate species, which may be due to their different symbiotic algae. (Abstract ID 11205)

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Particle Composition and the Area-to-Mass Ratio of Suspended Marine Particles

The accurate conversion of an optical signal into suspended sediment mass depends on an accurate estimate of the ratio of particle cross-sectional area to particle mass. This ratio has been observed to vary over an order of magnitude among many field studies. Historically, the variability has been attributed to particle size, but recent work shows that, because marine particles are aggregated, size only accounts for about a factor of 2 variability in the ratio. Therefore, component particle composition and particle packing within aggregates must account for a significant fraction of the observed variability in the area-to-mass ratio. With data from coastal waters around the west coast of the United Kingdom, we examine the hypothesis that composition accounts for only a factor of 2 variability in the area-to-mass ratio. When all data are considered together, the hypothesis receives support. Removal of apparently anomalous data from a single site, however, suggests that the organic fraction in suspension has a significantly greater effect on the area-to-mass ratio. This result suggests that particle composition and particle packing within aggregates are correlated. (Abstract ID 9936)

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Interrelated Influence of Ni and Light on Trichodesmium Growth

Nitrogen fixation in the ocean influences global biogeochemical cycles of nitrogen and carbon. Understanding how nitrogen fixation is regulated in the oceans may shed light on mechanisms controlling carbon dioxide cycling and climate change globally. Trichodesmium, the primary diazotrophic phytoplankton in tropical and subtropical oceans, accounts for half of new production in the oceanic regions. Our previous study demonstrates that Ni availability can control cellular superoxide dismutase activity and nitrogen fixation rates, suggesting that the enzyme may be involved in the protection of nitrogenase from superoxide radical inhibition during photosynthesis in the non-heterocystous diazotroph. In this study, we further demonstrate that the interrelated influence of Ni availability and light intensity can either limit or sustain Trichodesmium growth. The growth of the cells is inhibited under high light and low Ni conditions. Relatively, sufficient Ni supply sustains the elevated growth of Trichodesmium under high light conditions. This finding exhibits major implications for interpreting spatial distributions and activities of Trichodesmium, and for the existing models of mechanistic controls on nitrogen fixation in modern and ancient oceans when and where Ni availability and light intensity have varied. (Abstract ID 10145)

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TESTING A NEW TECHNOLOGY FOR BIVALVE LARVAE IDENTIFICATION

Identification of bivalve larvae is challenging due to their small size. A new technique using polarized light may revolutionize the way bivalve larvae are classified. It is based on the understanding that bivalves build their shells out of calcium carbonate and lay down crystals in species-specific patterns. This technique has shown to be highly accurate using larvae grown under controlled conditions, but previous studies revealed that field conditions increased error in larval recognition (Thompson 2011). In this study, the oyster, Crassostrea virginica, was raised under different conditions of temperature, salinity, and food concentration to test whether growth conditions affect the accuracy of the polarized light analysis. Our results indicate that differences in growth conditions do affect the accuracy of the technique. In addition, we found that the technique had the highest accuracy (86%) when image training sets included larvae reared in multiple growth conditions. (Abstract ID 10529)

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INTERRELATED INFLUENCE OF NI AND LIGHT ON TRICHODESMIUM GROWTH

Nitrogen fixation in the ocean influences global biogeochemical cycles of nitrogen and carbon. Understanding how nitrogen fixation is regulated in the oceans may shed light on mechanisms controlling carbon dioxide cycling and climate change globally. Trichodesmium, the primary diazotrophic phytoplankton in tropical and subtropical oceans, accounts for half of new production in the oceanic regions. Our previous study demonstrates that Ni availability can control cellular superoxide dismutase activity and nitrogen fixation rates, suggesting that the enzyme may be involved in the protection of nitrogenase from superoxide radical inhibition during photosynthesis in the non-heterocystous diazotroph. In this study, we further demonstrate that the interrelated influence of Ni availability and light intensity can either limit or sustain Trichodesmium growth. The growth of the cells is inhibited under high light and low Ni conditions. Relatively, sufficient Ni supply sustains the elevated growth of Trichodesmium under high light conditions. This finding exhibits major implications for interpreting spatial distributions and activities of Trichodesmium, and for the existing models of mechanistic controls on nitrogen fixation in modern and ancient oceans when and where Ni availability and light intensity have varied. (Abstract ID 10145)

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INTERRELATED INFLUENCE OF NI AND LIGHT ON TRICHODESMIUM GROWTH

Nitrogen fixation in the ocean influences global biogeochemical cycles of nitrogen and carbon. Understanding how nitrogen fixation is regulated in the oceans may shed light on mechanisms controlling carbon dioxide cycling and climate change globally. Trichodesmium, the primary diazotrophic phytoplankton in tropical and subtropical oceans, accounts for half of new production in the oceanic regions. Our previous study demonstrates that Ni availability can control cellular superoxide dismutase activity and nitrogen fixation rates, suggesting that the enzyme may be involved in the protection of nitrogenase from superoxide radical inhibition during photosynthesis in the non-heterocystous diazotroph. In this study, we further demonstrate that the interrelated influence of Ni availability and light intensity can either limit or sustain Trichodesmium growth. The growth of the cells is inhibited under high light and low Ni conditions. Relatively, sufficient Ni supply sustains the elevated growth of Trichodesmium under high light conditions. This finding exhibits major implications for interpreting spatial distributions and activities of Trichodesmium, and for the existing models of mechanistic controls on nitrogen fixation in modern and ancient oceans when and where Ni availability and light intensity have varied. (Abstract ID 10145)

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ACID AND PHENYLALANINE IN PRIMARY PRODUCERS AND Δ, THE 15N ENRICHMENT AT EACH TROPHIC STEP

The Monterey Bay Aquarium Research Institute (MBARI) has developed a new long range AUV called Tethys. In a little over a year of science field operations the first vehicle has logged over 2000 hours of operations during mostly 7 day long deployments using rechargeable batteries. The vehicle is currently at sea with a set of primary batteries and is two weeks into a three week experiment that extends 500 km offshore. Interactions with the vehicle at sea are accomplished via a web interface which displays science and engineering data and allows the operator to modify mission parameters or even start new missions. The core science payload measures the temperature, salinity, dissolved oxygen, nitrogen, chlorophyll and two channels of backscatter. A turbulence sensor and an AUV Docking payload have been built and there are plans for additional payload in the extendable flooded nose section. (Abstract ID 12517)

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KELVIN-HELMHOLTZ OVERTURN BOUNDARY IN VISCOS FLOWS

Shear instability in stratified flow is explored using two- and three-dimensional numerical simulations of the Boussinesq equations. There is a region in Richardson-Reynolds number space where the Kelvin-Helmholtz instability grows but is dissipated before it can significantly change the mixing dynamics. The appearance of density overturns is used to distinguish mixing regimes as a function of Reynolds and Richardson numbers. An approximate criterion for this overturning in terms of initial Richardson and Reynolds number is proposed and compared with the numerical results. Initial conditions use perturbations of the Kolmogorov scale for the initial shear flow. Linear stability analysis of the flow is used to help characterize the viscous instability. (Abstract ID 9995)

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COMPOND SPECIFIC ISOPTE ANALYSIS IN FOOD WEB STUDIES: THE NEED FOR ACCURATE ESTIMATES OF TROPHIC ENRICHMENT FACTORS

Ecosystem-oriented fisheries management strategies require knowledge of trophic relationships. Trophic position (TP) estimates from compound specific nitrogen isotopic analysis of amino acids (AA-CSIA), although promising, have not been thoroughly tested. TP estimates from AA-CSIA require knowledge of the difference in 15N values between glutamic acid and phenylalanine in primary producers and the 15N enrichment at each trophic step or trophic factor enrichment. Values of 0.7‰ and 7.6‰ have been suggested for aquatic environments, however recent observations indicate that Δ may be variable particularly or trophic enrichment factor. Values of β (3.4‰) and ∆ (7.6‰) have been suggested for aquatic environments. (Abstract ID 11921)

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A 2003 REANALYSIS OF THE CHESAPEAKE BAY USING SATELLITE AND IN SITU DATA

An advanced data assimilation system has been set up for the Chesapeake Bay using the local ensemble transform Kalman filter (LETKF) and a ROMS model of the Bay (ChesROMS). Errors in wind forcing dominate the chaotic growth of initial condition errors, but using an ensemble of forcing fields as well as adaptive inflation techniques these errors are managed. We will show results from the assimilation of real SST from NOAA’s AVHRR instrument and in situ temperature and salinity profiles. Performance is evaluated for the year 2003 as both dependent and independent in situ observations of temperature and salinity. We also investigate the nature of the flow changes made by the assimilation. (Abstract ID 11908)

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THE CIRCULATION OF THE MIDDLE ATLANTIC BIGHT (MAB) AND DELAWARE BAY ON THE US EAST COAST WAS SIMULATED USING A VERSION OF THE REGIONAL OCEAN MODELING SYSTEM CONFIGURED FOR THOSE AREAS. WATER FOLLOWING LAGRANGIAN PARTICLES RELEASED IN THE CIRCULATION FIELDS SIMULATED THE GROWTH AND Vertical MIGRATION IN RESPONSE TO FOOD, TEMPERATURE AND salinity FOR LARVAL OYSTERS (CRASSOSTRANGIDENTA) IN DELAWARE BAY AND ATLANTIC SALMON SMOLTS (SALMO SISALISSINUS) IN THE MAB. THE LARVAL PARTICLES WERE TRACKED UNTIL THEY REACHED SETTLEMENT SIZE. THE OYSTER LARVAL SIMULATIONS SHOWED THAT ORITENIC VERTICAL MIGRATION behavior resulted in shorter dispersal scales which favored larval settlement in areas with major oyster reefs. THE SURF CLAM LARVAL SIMULATIONS SHOWED THAT behavior reduced the total transport distance and retained the larvae in inner shelf regions. FOR BOTH AREAS VARIABILITY IN ENVIRONMENTAL CONDITIONS PLACED STRONG CONTROLS ON LARVAL SURVIVAL. THESE COUPLED CIRCULATION-LARVAL MODELS ALLOWED EVALUATION OF CONNECTIVITY AND GENETIC EXCHANGES IN OYSTER AND SURF CLAM POPULATIONS
and investigation of changes that may occur in larval dispersal patterns and settlement areas as a result of climate change. (Abstract ID 11452)

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Elevated pCO2 (Ωarag ~ 0.8) was roughly 8%; however, present conditions for Antarctic larvae are more divergent coastal regions: a temperate upwelling site in California, and an Antarctic site. These physical data were coupled with manipulative laboratory experiments using larval-stages of sea urchins from these two regions; these experiments tested species responses to environmentally relevant fluctuations in ocean pH to identify risk from future ocean acidification. Various performance metrics suggest that development is quite resilient in the species tested; for example, length differences between larvae of both species at control pCO2 were consistently the most abundant class in the largest size fraction of the DCM until the transition to the furthest offshore SCM where Gamma proteobacteria dominated. Gene abundance data demonstrate a widely distributed potential for microbial assimilation of low-molecular weight compounds in all sampled size fractions and ecological regimes. Positive correlations between the abundance of genes coding for the active transport of high-molecular weight iron complexes and increasing size fraction suggest that organically complex iron may be an important resource for particle-associated bacteria. Our data highlight prokaryotic assemblages, particularly those in SCM, with strong potential for internal recycling of nutrient elements. (Abstract ID 12247)

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The South China Sea (SCS) hosts large-amplitude, non-linear internal waves (NLW) that originate via poorly-understood processes at bathymetric ridges in the Luzon Passage. We present new images of thermohaline finestructure in the SCS and Luzon Passage from a seismic (plus XBT) cruise conducted by R/V Langseth in summer 2009, which may shed light on the generation mechanisms of NLW. We image several clear sets of NLW in the SCS, down to depths of about 1200 m. Wave amplitudes are up to 75 m, and the vertical wave heights are consistent with a mode-1 wave. Horizontal wavelengths are much shorter (~400 m) in the upper 200 m of the wave, in contrast to deeper depths, where wavelengths are between 1-2 km. Near the ridge, clear changes occur in patterns of finestructure; within ~30 km of the ridge, long, continuous reflections become progressively disrupted and reflector displacements become higher. Reflector slope spectra show evidence of enhanced internal wave energy and turbulence near the ridge. Comparisons to a numerical model of isopycnal displacement show strong turbulence during times of peak tidal displacement. (Abstract ID 12674)

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The Lena River strongly influences physical, biological and chemical processes on the Laptev Sea shelf through vast amounts of freshwater runoff. The Lena river water is poor in nutrients and carries high concentrations of dissolved organic matter (DOM) and colored dissolved organic matter (CDOM). Here we present CDOM absorption complemented by profiles obtained with an in situ WETStar fluorometer during expeditions in August 2010 and 2011, in order to study the vertical and horizontal CDOM distribution on this shelf. The results show that the river Lena dominates the supply of CDOM which exhibits a conservative mixing behavior over a wide range of salinities. The low light penetration of the CDOM rich river water in conjunction with low concentrations of dissolved phosphate and nitrate and a strong density stratification of the water column result in low chlorophyll a concentrations within and beneath the river plume. Outside of the river plume increased water transparency and the
upward transport of phosphate and nitrate from nutrient enriched bottom waters lead to the formation of deep chlorophyll maxima at the pycnocline. (Abstract ID 9514)

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DEPOSITION, DISTRIBUTION AND FATE OF MACONDO OIL IN THE SEDIMENTS OF THE NORTHEASTERN GULF OF MEXICO

Blowout of BP’s Deepwater Horizon drill-rig in the northern Gulf of Mexico resulted in an expansive surface oil layer and the formation of toxic subsurface oil plumes. High-resolution imaging, compositional and sedimentological analyses of sediment cores collected in the region of the oil spill show fundamental changes in the contemporary sedimentary processes with the deposition and accumulation of laminated, organic-rich, fine-grained surface sedimentary layers, particularly in the DeSoto Canyon region. Down-core analyses of short-lived radioisotopes document a dramatic thickening of the post-blowout surface-layer (up to 6 cm) and a >10-fold increases in mass accumulation rates relative to pre-blowout conditions. High-resolution molecular organic geochemical analyses of the post-blowout surface-sediments reveal spatial variability with petroleum derived hydrocarbon deposition occurring in three modes: as almost pure horizons, in direct association with algal, terrestrial plant and bacterial biomass, and as a minor component mixed with terrestrial plant waxes. Multiple mechanisms of oil-sediment deposition including: 1) a toxic-bath tub ring, 2) a flocculent blizzard and 3) an open flood-gate must be invoked. Benthic ecosystem impacts are discussed. (Abstract ID 12270)

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TRANSIENT DISPERSIVE PROCESSES IN CHANNEL-SHOAL ESTUARIES

Dispersive processes in estuaries are often modeled as Fickian diffusion, with assumptions of complete lateral mixing and linear growth of the second central moment. We investigate scalar plumes in a channel-shoal estuary, focusing on transient dispersive processes during the period before lateral homogenization can be assumed. For wide estuaries, with scalar sources and sinks away from the head or mouth, this is an important period as in many cases a plume never mixes completely shore to shore. Residual circulation, tidal stirring and turbulent mixing vie for dominance in determining the relationship between lateral mixing time and residence time. Regimes of transient dispersion include Taylor dispersion and unbounded shear dispersion. Idealized simulations are used to characterize how estuary length, width, channel-shoal bathymetry and tidal phasing assert control over the timescales of lateral mixing and residence time. Extending to sediment transport, we examine the difference in dispersion when settling and resuspension are taken into account. Applied to South San Francisco Bay we find that the norm is not Fickian diffusion but instead to semi-bounded shear dispersion with quadratic variance growth. (Abstract ID 11517)

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REDUCTION IN ARCTIC OCEAN FRESHWATER EXPORT

The changing nature of the export of freshwater from the Arctic to the North Atlantic subpolar gyre is explored. Freshwater is critical to the restraint of dense water formation via its capacity to ‘cap’ ocean convection, and, through control of Labrador Sea dynamic height, has a profound effect on the circulation intensity and zonal extent of the subpolar gyre. Changes in Arctic outflows could therefore disturb the dynamics of the subpolar gyre and the global thermohaline circulation. We examine evidence from two independent high resolution oceanographic models (NEMO-ORCA205 and OCCAM 1/12), salinity measurements on the Labrador and Newfoundland shelves, and a hydrographic survey in late summer 2008. We show that the model results are consistent with measurements from moored current meter arrays, and that freshwater storage in the Arctic. The evidence consistently supports the hypothesis that Arctic freshwater export decreased west of Greenland from the 1990s to 2008. During this period the Arctic Ocean was storing freshwater in the upper layer; we show that the cumulative reduction in export could account for most of the observed increase in storage. (Abstract ID 10166)

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TRADE-OFFS ASSOCIATED WITH MODELING FISH AND SHELLFISH RESPONSES TO CLIMATE CHANGE IN GLOBAL CLIMATE MODELS OR EARTH SYSTEMS MODELS

The marine science community has embarked upon an effort to project climate change impacts on marine ecosystems and the responses of fishery dependent communities to these ecosystem changes. Considerable progress has already been made in coupling nutrient, phytoplankton and zooplankton into physical models using the existing Global Climate Model and Earth System Models. There is considerable interest in extending this capability to include commercially exploited fish and shellfish. Fish and shellfish exhibit complex responses to changes in the distribution and abundance of prey, competitors and predators. Incorporation of these complex processes will come at a high computational cost. This paper compares the costs and benefits of different methods for modeling fish and shellfish responses to climate change on a global scale. A variety of different modeling approaches are considered including: minimally realistic tropic energy transfers, size spectrum models, single species and multispecies stock assessment models, whole ecosystem food web models, spatially explicit coupled-biophysical models (e.g. NEMURO-FISH), and spatially explicit gradient tracking models. (Abstract ID 12904)

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OPTICAL ESTIMATION OF THE FRACTION OF BREAKING WAVES

Dissipation of incident waves in the surf zone affects not only the energy balances but also momentum budgets through radiation stress gradients that force nearshore circulation. In 1978, Battjes and Janssen suggested that the dissipation of a single depth-limited breaker should scale with depth so that the total dissipation just depends on this time the probability of breaking, the so-called fraction of breaking waves, Q_b. This is the form used in the wave model SWAN, but Q_b is a model product rather than an observable input. Since breaking waves have strong optical signatures, our goal is to develop and test a method for directly measuring Q_b from optical data. Breakers are identified by a sharp increase in reflectance, detected using standard edge detection methods in space-time data from cross-shore transects of optical data (Argus time stacks). Stacks are first adjusted using chlorophyll estimates to remove wave propagation delay. Methods were tested using data from the Surf Zone Optics experiment at Duck, NC in September, 2010. (Abstract ID 10916)

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DUST FERTILIZATION OF THE WESTERN ATLANTIC BIOTA: A BIOCHEMICAL MODEL

Every year an estimated 50 million tons of African dust reaches the Western Atlantic. This dust is composed of quartz sand, clay, and a mixture of quartz and clay particles agglutinated with micronutrient enriched ferruginous cement. However, whether it is friend or foe to biochemical systems is a matter of conjecture. Corals are ideal recorders of changing conditions, as the layers can be dated so that the record of chemical changes is easily assessed. There is every reason to believe that the coral reef is a recorder of the history of the dust and its effects on the environment. Corals are complex organisms that have strong optical signatures, our goal is to develop and test a method for directly measuring Q_b from optical data. Breakers are identified by a sharp increase in reflectance, detected using standard edge detection methods in space-time data from cross-shore transects of optical data (Argus time stacks). Stacks are first adjusted using chlorophyll estimates to remove wave propagation delay. Methods were tested using data from the Surf Zone Optics experiment at Duck, NC in September, 2010. (Abstract ID 10916)
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AIRBORNE SAR RAPID-REPEAT OBSERVATIONS OF SMALL-SCALE EDDIES OBTAINED DURING THE SUBMESOSCALE EXPERIMENT-1 IN THE SOUTHERN CALIFORNIA BIGHT

Repetitive observations of small eddies were obtained on April 14-16, 2011, by NASA's UAVSAR aircraft system, coincident in time and aircraft optical observations being collected during the NASA-supported Submesoscale Experiment-1 (SubEx1). This experiment was designed to improve the understanding of eddy dynamics and energetics with a unique combination of in situ, aircraft, and satellite observations. The experiment took place north of Catalina Island in the Southern California Bight, an area known to have extensive small-scale eddies. Small-scale eddies are detected by SAR in coastal environments by the appearance of surface features, which act as tracers of the underlying current field. Multiple repeat SAR observations were obtained approximately on hourly intervals that enable the tracking of the rapidly evolving eddy field and derivation of rotation velocity maps through feature tracking. This study will present preliminary results of eddy tracking from this fine resolution (5m) aircraft SAR, and an interpretation of the surface features when compared with coincident high-resolution ocean surface temperatures, measured through airborne infrared observations, and in situ temperature transects. (Abstract ID 9863)

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STRUCTURE, PROPERTIES, AND HEAT CONTENT OF EDDIES IN THE SOUTHEAST PACIFIC OCEAN

The southeast Pacific (SEP) requires an input of cold water to balance solar heating. One potential source is the offshore transport of cool, coastal waters by eddies. In this study, a variety of observations were used to estimate the effect of eddy transport on upper-ocean temperature in the SEP. Data from the VOCALS-REx field program were used to characterize eddy structure. Cyclonic (anticyclonic) eddies possessed shoaling (depressed) isopycnals, shallow (deep) salinity minimum layers, and high (low) stratification beneath the mixed layer. An intensively surveyed cyclonic eddy had a salty and highly stratified anomaly along the 26.5 °C isotherm. The Southern Ocean locations have little vertical structure, with a −1°C at 100m depth. A relationship between sea level anomaly and upper-ocean temperature transects. (Abstract ID 9895)

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IMPROVED CONSTRAINTS ON TRANSIT TIME DISTRIBUTIONS FROM ARGON 39: A MAXIMUM ENTROPY APPROACH

We use Ar-39 in conjunction with CFCs, natural C-14, PO4*, temperature, and salinity to estimate the ocean’s transit time distributions (TTDs). A maximum entropy approach is employed to deconvolve the tracer data for the TTDs. The constraint provided by Ar-39 allows us to estimate TTDs even in the deep Pacific where CFCs have not yet penetrated. From the TTDs, we calculate the ideal mean age, the TTD width, and the mass fraction of water with transit times less than a century. We also quantify the uncertainties due to the nonuniformities of the deconvolutions. In the Atlantic, the patterns of T and reflect the distribution of the major water masses. At the deepest locations in the Atlantic (T = 300–500°C), while at the deepest locations in the Southern Ocean (T = 500–1000°C). The Pacific is nearly homogeneous below 2000m with T = 1300–2000°C. In the North Pacific and T = 900–200°C, a in the deep S Pacific. The Southern Ocean locations have little vertical structure, with T = 300 to 450°C with an uncertainty of about +150 to 40°C. The importance of eddy diffusion compared to advection as quantified by ΔT has most probable values ranging from 0.2 to 3 but with large uncertainty bounds ranging from 0.2 to 9. For most locations analyzed, the effect of Ar-39 is to reduce f and to correspondingly increase by about a century. Ar-39 reduces the uncertainties of f by ~50%. (Abstract ID 10901)

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THE ISOTOPE COMPOSITION AND FLUX OF ION FROM MARINE SEDIMENTS TO THE EASTERN SOUTH ATLANTIC (GEOTRACES A10)

Sediment pore waters collected from 6 Stations between 18°E and 5°W in an E-W transect of the South Atlantic Ocean (GEOTRACES transect A10), have been characterized for diagenetic reactions of oxygen, nitrate, Fe and Mn, and a range of redox gradients are observed. South African shelf-slope sediments (700-1100 m water depth) intersect the oxygen minimum within Upper Circumpolar Deep Water (~170-200 µM) in this region, and oxygen penetration depths are correspondingly shallow (<1 cmbls) compared with shallower shelf-top (236 m), deeper shelf-slope (2002 m) or Cape Basin sediments (~4000-5200 m) under more oxygenated bottom waters. Diffusion-reaction modeling of pore water Fe and O2 data indicates that the thin oxygenated surface layer overlying dissolved Fe maxima (up to 6 µM) on shelf-slope sites contributes ~0.1-0.3 µmol Fe m−2 d−1 to bottom waters in this region, with implications for the bioavailable inventory of dissolved Fe in this region. We also present the isotope composition of Fe in the pore waters to constrain the Fe isotope supply from Cape margin sediments to South Atlantic seawater and refine tracer studies of benthic Fe sources. (Abstract ID 11167)

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DETERMINING SEAFLOOR COMPOSITION THROUGH MULTIBEAM SONAR

A study conducted in the Triple Junction Area of Puget Sound over October 17-18, 2011 used EM302 Multibeam Sonar data to map not only the bathymetry of the seafloor, but also to determine the basic seafloor composition. Advantages of using multibeam rather than singlebeam bathymetry include extremely high resolution data covering a larger study area. By assessing both rate and intensity of return from sonar beams, one can distinguish seafloor solidity (the more solid the composition, the greater the intensity of the return). Combining sonar data with groundtruth samples (Van Veen grabs), we can associate individual beam intensity to a corresponding seafloor category (rock, gravel, sand, or mud). These categories can then be correlated with seafloor bathymetry to produce a more comprehensive map than one strictly showing bathymetry. Mapping seafloor composition is useful in the Puget Sound area to help understand the influences of urbanization on the seafloor; show the composition of erosional features, and assist in understanding bathymetric patterns. If studies are conducted over longer temporal scales, this method can also be used to study changes in seafloor composition, which can help provide insight into anthropogenic influences in the estuary. (Abstract ID 12875)

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DIFFUSION OF ARTIFICIAL CAESIUM-134 AND -137 IN THE WESTERN NORTH PACIFIC ONE MONTH AFTER THE FUKUSHIMA ACCIDENT

In March 2011, an accident at the Fukushima Daiichi nuclear power plant (FNPP) was caused by the Tohoku earthquake and tsunami. Here we show the distribution of artificial caesium-134 and -137 (134Cs and 137Cs) in the western North Pacific Ocean one month after the FNPP accident. In surface seawater, 137Cs concentrations were from several times to two orders of magnitude lower than before the FNPP accident. 134Cs was also detected, and in many seawater samples the 134Cs/137Cs ratio was about 1. These findings indicate that radionuclides from the FNPP dispersed quickly in the western North Pacific. 134Cs and 137Cs concentrations in suspended particulate matter were much lower than before the accident. Numerical simulation results show that the higher caesium observed in the western North Pacific one month after the FNPP accident was transported not only by diffusion and advection of seawater but also via the atmospheric as an aerosol. (Abstract ID 9397)
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We also compare the surface currents to concurrent vertical current profiles of a bottom UHF radar system. The land-based installation collected observations of radial surface current data collected from October 10 to December 11, 2010 using a RiverSonde (CODAR) their accuracy is often hindered by the limited tidal current observations available for validation.

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REMOTE OBSERVATIONS OF SURFACE CURRENT STRUCTURE AT AN ENGINEERED TIDAL INLET MOUTH

An understanding of physical and ecological communication between ocean and estuary is vital for predicting pollutant dispersal, fishery protection, and harbor entrance safety. While numerical models can simulate the governing circulation processes at inlet mouths, evaluating their accuracy is often hindered by the limited tidal current observations available for validation. Surface currents measured by remote sensing devices are a relatively new option, providing long term, continuous data that can span the width of the inlet mouth. Here we present surface current data collected from October 10 to December 11, 2010 using a RiverSonde (CODAR) UHF radar system. The land-based installation collected observations of radial surface current components over an 800 by 400 meter footprint at 7.5 meter range and 1 degree azimuthal grid spacing between the jetties at the mouth of Yaquina Bay (Newport, Oregon) every 5 minutes. We also compare the surface currents to concurrent vertical current profiles of a bottom mounted ADCP located within the radar footprint, and examine the spatial structure of the surface currents and its dependence on the tidal forcing and freshwater estuarine inputs. (Abstract ID 11693)

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ARRIVAL OF RADIOESCIUM FROM THE DAMAGED FUKUSHIMA DAI-ICHI NUCLEAR REACTORS OF IN THE SEAS LOCATED IN THE WEST OF FUKUSHIMA

Korean Peninsula is located about 1,000 km westward from Honshu Island of Japan. Radioiodides started to be released on March 12 into the atmosphere from the damaged reactors in Fukushima, eastern coast of Honshu Island. Radioiodines appeared to arrive over the Korean Peninsula first on March 24 and the atmospheric activity concentrations of 134Cs and 137Cs peaked around April 7 and subsequently decreased toward the end of April with occasionally detected in the early May. The Fukushima originated radioiodines appeared to be largely arrived in Korea from the west rather than the east due to the prevailing westerlies at that time. The seas adjacent to Korean Peninsula, Yellow Sea, Korea Strait, and the East Sea (Sea of Japan) were monitored from March 30 to June 8. 134Cs and 137Cs in the surface waters were found to be 0.11 - 1.19 and 1.3 - 3.0 mbq/kg, respectively. The 134Cs were detected on March 29 and increased to April 8 in the Korea Strait, probably reflecting the temporal atmospheric 134Cs concentration peak. The activity ratios between 134Cs/137Cs were 0.1~0.5. Samples are still being measured and we will report our findings in relation to the earlier measurements in the seas to Korean Peninsula at the meeting. (Abstract ID 11038)

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SPECIES SPECIFIC VARIATIONS IN COPEPOD GRAZING BEHAVIOR RESULTING FROM EXPOSURE TOXIC DINOFLAGELLATE

Our objective is to quantify the behavioral response of copepods to varying diets, in particular when they are exposed to toxic dinoflagellates. The conjectured role of toxins as grazing deterrents is investigated using digital holography to compare the behavior of Acartia tonsa on nutritional Storeatula major to that occurring during exposure to toxic and non-toxic Karenia brevis and Karlodinium veneficum. Analysis of the feeding appendage beating duration enables us to distinguish between two beating modes with lognormal distributions: short duration “sampling beating” with little fluid entrainment, and longer period “grazing beating” that generates feeding currents. Without prey, A. tonsa only samples water infrequently, and upon introduction of desired food, it increases the grazing substantially. On mono-algal diets of toxic dinoflagellates, sampling durations are high, but grazing remains low. In mixtures of S. major and toxic K. brevis, sampling and grazing both diminish, presumably due to neurological effects of consuming brevetoxins during attempts to prey on S. major. In contrast, both modes persist during A. tonsa exposure to mixtures of toxic K. veneficum, indicating that karlotoxins do not inhibit grazing. (Abstract ID 11582)

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A GLOBAL, EDDYING, DYNAMICALLY-CONSISTENT, OCEAN AND SEA ICE STATE ESTIMATE OBTAINED USING ADJOINT METHOD

As part of the Estimating the Circulation and Climate of the Ocean, Phase II (ECCO2) project, a two-year (January 2009 to December 2010), eddy-permitting ocean and sea ice state estimate has been obtained using the adjoint method. The model is a cubed-sphere configuration of the Massachusetts Institute of Technology general circulation model (MITgcm) with 18-km horizontal grid spacing and 50 vertical levels. The data constraints include AMSR-E SST, OSTM almsterr, and ARGO temperature and salinity profiles. The control parameters include the temperature and salinity initial conditions and the time-evolving surface atmospheric state. At time of abstract submission, 23 forward-adjoint minimization steps have been completed and the overal cost function has been reduced by approximately 57% relative to the baseline integration, with significant improvements relative to data in the mean stratification of the solution as well as in the variability relative to almsterr and SST data. This presentation will show details of this minimization and assess this solution versus a variety of metrics established by the CLIVAR Global Synthesis and Observations Panel. (Abstract ID 12264)

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MODELING EMERGENT MICROBIAL COMMUNITY STRUCTURE AND BIOGEOCHEMICAL CYCLING IN THE AMAZON RIVER AND PLUME

The Amazon River has the largest drainage basin in the world, about 7,050,000 square kilometers, and it accounts for approximately one-fifth of the world’s total river flow. It carries commensurately large nutrient, sediment and organic matter loads, which include a rich microbial community that is dominated by heterotrophic organisms that require under oxygen replete conditions. In this paper we present the first results from a genomics-based emergent properties model that simulates changes in the composition of the microbial community and their impact on biogeochemical cycling in the Amazon River as water flows down the lower reaches and out into the plume in the Atlantic Ocean. Due to the rapid transport in the river the microbial community composition and nutrient concentrations do not change dramatically as the water flows downstream except where there are substantial lateral tributary inputs and exchanges with flooded surrounding forests. Dramatic changes are also driven by mixing between fresh and saltwater microbial communities in the plume. Efforts to validate the model with genomic data are presented. (Abstract ID 12063)

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EXPERIMENTAL INVESTIGATION OF TURBULENCE AND SUSPENDED SEDIMENT IN THE WAVE BOTTOM BOUNDARY LAYER

Sediment resuspension due to waves is an important mechanism for sediment transport in lakes and continental shelves, supporting gravity driven flows of high concentration muds. Models describing wave generation of suspension layers typically invoke a balance between turbulence and suspended sediment concentration, resulting in a fixed Richardson number. However, due to the thinness of the wave boundary layer and the episodic nature of waves, these models are difficult to test in the field.

We present results from a series of laboratory experiments conducted in a U-tube wave tank that resolve the turbulent structure of the wave boundary layer in high sediment concentration flows. We use a Fiber Optical Backscattering array, multi-beam Acoustic backscatter and a profiling ADV to make very high resolution co-located measurements of suspended-sediment concentration and velocity over a range of wave conditions and bed slopes typical of the continental shelf. We present a detailed phase-averaged description of the turbulence and sediment transport processes within and just above the wave boundary layer, particularly TKE budget and the effect of suspended sediment concentration on it. We observe the wave boundary layer is transitionally turbulent, developing as a laminar boundary layer after wave resuspension, and becoming turbulent after the transition to minimum turbulence. The results are also compared favorably with a time-varying eddy viscosity model. (Abstract ID 11845)

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THE GELATINOUS ZOOPLANKTON COMMUNITIES OF GODTHÅBSFJORDEN, WEST GREENLAND

We conducted a survey of the composition, abundance, and distribution of non-copepod groups along a transect leading from the furthest inland extend of Godthåbsfjorden into the offshore waters of Fylas Bank, West Greenland. Gelatinous zooplankton were identified and measured on unpreserved material with the aid of a light table. In total we collected 17 species of hydrocladus, 2 species of siphonophores, 3 species of scyphomedusae, 3 species of ctenophore, 5 species of chaetognaths, 1 species of pteropods, 1 species of pelagic polychaete, 2 species of hydromedusae, 2 species of siphonophores, 3 species of scyphomedusae, 3 species of appendicularians, for a total of 36 species. Ctenophores were unexpectedly abundant during the cruise with Fylas Bank communities dominated by the ctenophore Mertensia ovum, with lesser contributions by Bolinopsis infundibulum. Inside the fjord, Mertensia abundance declined precipitously with the community becoming dominated by at least 2 species of Beroe. The grazing impact of these communities must be substantial. (Abstract ID 12466)

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QUANTIFYING THE PROPAGATION OF THE AMAZON RIVER PLUME IN THE WESTERN TROPICAL NORTH ATLANTIC

The Amazon River plume is significant in the biochemistry of the western tropical North Atlantic; it brings nutrients and organic matter to aquatic ecosystems and influences how ocean currents structure communities. As part of the ANACONDAS nitrogen fixation and carbon sequestration project, we investigate the physical aspects of the Amazon River plume that dictates its interactions with ocean waters. We combine data from a spring cruise with satellite data to estimate plume volume and age, demonstrating how remote sensing data can corroborate and enhance field measurements. With these data sources we further derive mathematical relationships relating plume surface salinity, CDOM, and the light attenuation coefficient at 490 nm. These relationships improve on previous estimates of salinity based on K90 and quantify the decay of CDOM with salinity and time. Our combined results offer a snapshot of the plume’s trajectory in the open ocean and further explain variations in biochemically relevant plume properties both spatially and temporally. (Abstract ID 12501)

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A NEW CROSS-SHELF EXCHANGE MECHANISM: ON-SHELF ADVECTION OF SLOPE WATER WITHIN DISCRETE PYCNOCLINE TRAPPED LENSES

We present evidence of a shelf-edge exchange process, not previously identified, that is of importance for the transport of salt and biogeochemical properties onto the continental shelf. Lenses of high salinity slope water trapped within the pycnocline are observed 100 km or more from the Celtic Sea shelf-edge. The anomalies are typically 3-5 km in diameter and separated by 3-7 km, scales comparable to the internal Rossby radius, suggesting a geostrophically balanced feature optimum for maximum on-shelf dispersion. We propose that increased diapycnal mixing at the shelf-edge, associated with breaking internal wave packets, generated at a semi-diurnal frequency, is the mechanism by which high salinity slope water enters the pycnocline. These collapsing mixed patches are then advected on-shelf by residual flows of 0.02-0.06 m s⁻¹. An independent estimate of the advection speed, based on the expected rate of salt loss due to diffusion, compares favorably to observations and indicates timescale on the order of months. A combination of wind driven flow and transport by non-linear internal waves is thought to be responsible for this residual. (Abstract ID 9870)

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INSIGHTS INTO IRON SPECULATION FROM THE IRON TRANSPORTERS IN MARINE BACTERIAL GENOMES

The drive to acquire any available form of iron, constrained by evolutionary pressure to keep only useful genes, suggests that the types of iron transporters in marine bacterial genomes should reflect the species of iron available in their niche. To gain insight into the most bioavailable forms of iron and the iron transport capabilities of marine bacteria, we searched marine bacterial genomes and metagenomes for a variety of iron transporters including Fe³⁺, Fe⁴⁺, siderophore, and heme transporters. In both the genomes and metagenomes Fe³⁺ ABC transporters were the most common iron transporters, consistent with the dominance of Fe(III), the thermodynamically stable state of iron, in the environment. Fe⁺ transporters were fairly common in both the genomes and metagenomes suggesting that Fe⁺ is relatively common in the environment and can be important source of Fe for some bacteria. Heme and siderophore transporters were frequently found in bacteria thought to be particle-associated, but not in exclusively free-living bacteria such as cyanobacteria and Pelagibacter ubique. This distribution of transporters indicates iron-siderophore and heme are present in the microenvironments that develop around organic particles, but are rare in bulk seawater. (Abstract ID 10847)

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THE IMPACT OF WIDESPREAD SEDIMENTARY DENTRIFICATION ON THE BERING SEA SHELF

Continental shelf seas are hotspots for sedimentary denitrification, and as the largest contributor to global oceanic N loss, can have large implications in the global oceanic N budget. Through the Bering Sea Ecosystem Study (BEST) program, we measured the water column nitrate deficit and benthic fluxes of O₂ N₂, and inorganic nutrients on the Bering Sea shelf in the spring and summer from 2007 – 2010. Benthic O₂ consumption was largely similar among on-shelf stations, and ranged from 5 – 15 mmol O₂ m⁻² d⁻¹. Denitrification rates were similar over the entire shelf and at deep off-shelf sites and averaged 1.14 mmol N m⁻² d⁻¹. With widespread denitrification over the shelf, we estimate that N loss on the shelf and slope is at least 7.0 T N yr⁻¹. Sedimentary denitrification can account for the increase in water column nitrate deficit from summer to winter months. After the onset of water column stratification in the early summer, the nitrate deficit decreases only in the surface mixed layer; we propose that these results from high P requirements by blooming phytoplankton. (Abstract ID 11991)

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CHANGES IN ATMOSPHERIC INTRASEASONAL FORCING AND EQUATORIAL OCEAN HEAT CONTENT IN THE RECENT DECADE

Variations in the warm water volume (WWV) of the equatorial Pacific and the atmospheric forcing from intraseasonal variation (ISV) in the western equatorial Pacific are regarded as two good predictors for subsequent ENSO with a lead time of two to three seasons. We use ocean and atmospheric reanalysis data to evaluate the relative importance of WWV variations and ISV forcing for the ENSO in the last decade. The characteristics of ENSO related to these predictors have changed in recent years. Previously the magnitude of ISV forcing in boreal spring was closely related to a subsequent ENSO between 1981-2000, but the analysis shows that ISV forcing in the last decade is uncorrelated with ENSO, especially for the El Niño/La Niña events after 2005. Additionally, the correlation between the WWV and subsequent ENSO has weakened in the last decade. These changes may be caused by a decadal change in the background tropical Pacific in which El Niño/La Niña evolves. (Abstract ID 10824)

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MIXING AND INSTABILITY IN A RIVER PLUME FRONT

Mixing within river plume fronts is thought to contribute substantially to the overall mixing budget in the plume; however it is difficult to estimate because fronts are narrow and constantly moving. We use a combination of aerial infrared (IR) remote sensing and in-situ observations in the frame of reference of the Merrimack River plume front to examine the structure of the front and estimate the rate of mixing within it. The IR images are analyzed to generate surface velocity fields and we measured the vertical profile of salinity and temperature in the front. We construct a frontal control volume in the frame of reference of the front using the IR and density measurements to evaluate the relative importance of WWV variations and ISV forcing for subsequent ENSO with a lead time of two to three seasons. We use ocean and atmospheric reanalysis data to evaluate the relative importance of WWV variations and ISV forcing for the ENSO in the last decade. The characteristics of ENSO related to these predictors have changed in recent years. Previously the magnitude of ISV forcing in boreal spring was closely related to a subsequent ENSO between 1981-2000, but the analysis shows that ISV forcing in the last decade is uncorrelated with ENSO, especially for the El Niño/La Niña events after 2005. Additionally, the correlation between the WWV and subsequent ENSO has weakened in the last decade. These changes may be caused by a decadal change in the background tropical Pacific in which El Niño/La Niña evolves. (Abstract ID 10824)

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THE PERFECT STORM SURGE: DETAILED DYNAMICAL CONDITIONS FOR
EXTREME SEA LEVELS

Globally, 200 million people live on coastal floodplains and about $1 trillion worth of assets lie within 1 metre of mean sea level. Increased flood frequency or severity would impact on economic and social systems. It is crucial to understand the drivers of extreme storm surges to have confidence in datasets used for extreme sea level statistics. We apply joint probability techniques to tide gauge data and find independence between the height of the tide and the skew surge (the time-independent difference between peak prediction and observations).

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SYNTHETIC APERTURE RADAR WIND FIELD RETRIEVAL WITH RESPECT TO CYCLONES

Several synthetic aperture radar (SAR) images of tropical cyclones have been acquired by the C-band SAR aboard Envisat and Radarsat, as well as at the X-band SAR aboard TerraSAR-X and CosmoSkyMed, during the Office of Naval Research field experiment ‘Impact of Typhoon on the Ocean in the Pacific’ in summer of 2010. These SAR data provide a unique opportunity to investigate the utility of SAR data for estimation of extreme winds as well as other parameters useful for the improvement of tropical cyclone forecast. The resulting SAR-retrieved wind fields are compared to results of high-resolution numerical models as well as in situ measurements collected by aircrafts and buoy data. Uncertainty estimates are retrieved with respect to the low wind speed as well as wind imaging geometry. Furthermore, limitations of SAR wind retrieval at high wind speeds, in particular of the geophysical model functions (GMF) for retrieving wind speeds, will be addressed and discussed. Furthermore, assimilation of the SAR retrieved winds into the integrated tropical cyclone observing system H*WIND are presented. (Abstract ID 12181)

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FIRST GENERATIONS OF INVASION: POPULATION STRUCTURE, COHORTS, IN SITU GROWTH RATES, AND PATCHINESS IN A BENTHIC BIVALVE COMMUNITY

Some of the most exciting ecology can be observed during the first few cohorts of newly establishing long-lived species. Bivalve mussels are suitable candidates because of their strictly benthic, though not sessile adult character; moderately long lifespan in the 5-10 year scale; prolific broadcast spawning form of reproduction; and absence of significant natural predators in deeper water. For Lake Michigan, invasion by Dreissena bugensis, the zebra mussel, was chronicled from first sightings through what we hope is the end of the first life cycle (2002-2011). Until 2005, divergent individual growth had not yet smeared cohort integrity, allowing estimation of actual in situ growth rates of 11-15mm/year from distinctly bimodal size-frequency distributions. Survival and recruitment of prey into the population was approximated using time series size-frequency analysis. Initial annual frequency and early fall timing of broadcast spawn settlement was apparent from sudden appearance of ~2mm individuals. Scarcity of empty shells indicated high recruitment after attainment of 4mm size, and longer life span that congenic zebra mussels. Patchiness was patchy, with large areas uniformly colonized at ~25,000 individuals/m² (maximum 40,206/m²). (Abstract ID 10900)

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THE EFFECT OF STRATIFICATION ON WIND-DRIVEN, CROSS-SHELF CIRCULATION ON THE INNER SHELF

Three years of observations from the inner shelf south of Martha’s Vineyard, MA are used to describe the effect of stratification on wind-driven, cross-shelf circulation and transport. For along-shelf wind stress, the fraction of full Ekman transport scales with stratification, and the surface mixed layer thickness clearly limits the depth of the first zero-crossing of the velocity. For cross-shelf wind stress, stratification increases cross-shelf transport, but a 1D view of the dynamics is not sufficient to explain the relationship between circulation and stratification. For both wind orientations, the sign of wind stress driving offshore surface flow generates a more sheared circulation and a larger increase in transport between mixed and stratified conditions. (Abstract ID 10477)

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SENSE IT: STUDENT-CREATED WATER QUALITY SENSORS

Sensor development is a topical and highly interdisciplinary field, providing motivating scenarios for teaching a multitude of science, technology, engineering and mathematics (STEM) subjects and skill sets. This presentation will describe the development and implementation of a carefully scaffolded set of high school curriculum modules, in which students build, calibrate and test a set of sensors and circuits, that integrate fundamental STEM principles while at the same time introducing students to the field of sensors and sensor networks—technologies that are increasingly important in all fields, but particularly in the world of environmental research. The project has been highly successful in a wide range of classrooms and the results of classroom implementation, during which 36 teachers were equipped, trained on curriculum, and implemented the modules with approximately 3,000 students will be presented. Results show that building and testing sensors engaged the students and increased their interest in STEM subjects and careers, and increased their understanding of fundamental concepts of electricity and increased their basic math (algebra) skills. Furthermore, their awareness of water quality as an environmental issue grew as well. (Abstract ID 9755)

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UNDERWATER OPTICAL TURBULENCE AND IMPACTS ON BEAM SCINTILLATION

Underwater sensing is of primary importance to both civilian and military needs, in terms of visibility that are related to inspection needs, mine detection and identifications, search and rescues, and those applications linked to fundamental understanding of the oceanic processes. Optical turbulence has been known to degrade optical transmissions underwater. However, few studies have been conducted to understand and quantify the impacts until recently. Here we present recent lab and field efforts carried out by the US Naval Research Lab. Of these efforts, the focus will be on beam scintillation over transmission range, up to 5m, in lab tank, as well as from field exercises. Images obtained from a high speed camera are analyzed, along with optical and turbulence measurements. Optical properties of the water column are provided by ac-9 and LISST, while turbulence dissipation rates involving the temperature and kinetic energy are taken using Vertical Microstructure Profiler and 3D velocimeter Vector. The result of this study helps not only our understanding of the impacts on optical transmissions underwater, but also provides potential means to infer turbulence strength on a much more rapid time scale. (Abstract ID 11192)

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THERMOHALINE VARIABILITY IN THE NORTHWESTERN MEDITERRANEAN BASIN OVER THE RECENT PERIOD (2007-2011) FROM IN-SITU MEASUREMENTS

Open-ocean deep convection is a key process that transfers the heat and salt contents from the surface to the deep ocean. In the Northwestern Mediterranean Sea, this leads to the formation of the Western Mediterranean Deep Water (WMDW) which underwent in 2005 an abrupt increase in its thermohaline properties, and an important modification in the deep stratification (known as the Western Mediterranean Transition, WMT). We present here new in-situ observations collected between 2007 and 2011 in the convection region to characterize the deep water formation variability and subsequent thermohaline changes. During this period, time series from a mooring describing the water column together with CTD, ARG0 floats and gliders profiles reveal three consecutive deep convection events that modified dramatically the deep water properties, including a salinity increase of 0.01 and a temperature increase of 0.03°C in 4 years. We attempt to assess the respective role of the interannual variability of the atmospheric forcings and of the water column stability on the intensity of the deep convection. (Abstract ID 9489)

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A NOVEL METHOD TO QUANTIFY IN SITU GROSS PRIMARY PRODUCTION OF BENTHIC MICROALGAE USING TRIPLE OXYGEN ISOTOPE
We present a new method to quantify gross primary productivity (GPP) by benthic microalgae in an estuary, using the in situ triple isotopic composition of oxygen. Benthic microalgae significantly contribute to GPP; the total photosynthetic production, in many estuaries and coastal regions. Additionally, benthic microalgae are important in controlling fluxes of dissolved nitrogen between the sediment and water column. Therefore, production by benthic microalgae may be an important factor in the response of natural systems to eutrophication. We measure triple oxygen isotopic ratios (variations in ratios of $\delta^{18}O$, $\delta^{17}O$, and $\delta^{16}O$), successfully used for more than a decade in the pelagic ocean, in a novel experimental system to quantify in situ GPP by benthic microalgae in the Waquoit Bay estuary in Massachusetts, USA. The triple oxygen isotope technique relies on the fact that mass-independent fractionation in the stratosphere results in dissolved oxygen of atmospheric and photosynthetic origins having different isotopic compositions. Our approach will allow quantitative investigation of the response of benthic microalgal photosynthesis to eutrophication and vice versa. This approach may be globally applicable in estuarine and coastal environments. (Abstract ID 12759)

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Gulf of Mexico Pilot Prediction Project (GOMEX-PPP): Model-Data Comparisons

Output from eight numerical circulation models simulating the Gulf of Mexico for 2010-2011 were compared with observations. Observed data included remotely-sensed SSH and SST fields, in situ point observations collected from moored and mobile platforms and data from submarine cables. We benefited greatly from existence of the Gulf of Mexico Coastal Ocean Observing System, an enhanced number of data sets resulting from the Deepwater Horizon incident and the Loop Current Study conducted by SAIC. Volume transport through the Yucatan Strait and Straits of Florida were computed and compared. Time series from vertical profiles of model currents were compared with full-water column profiles from ADCPs. Simulated Lagrangian particle trajectories were compared with drifter trajectories. Several approaches were taken to identify frontal locations in the Loop Current and Loop Current Eddies including objective automated machine estimates and subjective interactive graphical techniques. These were compared with frontal locations determinated by Horizon Marine Inc. surveys. A series of statistical metrics were computed to assess model skill. The goal is to identify the best model or models for an operational Gulf of Mexico modeling system. (Abstract ID 11793)

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The Gulf of Mexico Coastal Ocean Observing System (GCOOS): A Data Stewardship Cooperative Supporting a Healthy Gulf

The Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA) is one of 11 regional observing systems that comprise the non-federal part of the U.S. Integrated Ocean Observing System (IOOS). GCOOS is composed of an increasing number of sub-regional observatories which make data available in near real-time through standardized interfaces. The GCOOS Data Portal assembles data from federal and non-federal partners and re-serves these in standardized and user-driven formats for human and machine consumption. Historical oceanographic data and operational numerical ocean circulation forecasts are housed and served. Common and specialized products are produced to serve the needs of various stakeholder groups. GCOOS-RA supports the Gulf of Mexico Alliance by participating in the activities of the Priority Issue Teams and the Gulf of Mexico Research Initiative. GCOOS is working with the GOMEX Pilot Prediction Project to select an operational circulation modeling system for the Gulf of Mexico and with the SURA modeling testing activity to develop a model infrastructure framework. These data stewardship activities are designed to increase knowledge to support decision-making leading to a sustainable healthy Gulf environment. (Abstract ID 11815)

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Aloha Cabled Observatory: Early Results Including Acoustics

Since June 2011, the ALOHA Cabled Observatory (ACO) is providing power, network communications and timing to a seafloor node and instruments at 4728 m water depth 100 km north of Oahu. The ACO is a prototypical example of a deep observatory system that uses a retired first-generation fiber-optic telecommunications cable. The cabled observatory system will provide the infrastructure for continuous, interactive ocean sampling enabling new measurements and new modes of ocean observing that integrate ship and cabled observations. Present sensors measure currents, pressure, temperature, and salinity, along with video and acoustics. Turbulence, internal waves, tides and water mass mixing are evident. Prior acoustic data have provided new insights about surface ultra-gravity waves; continuing measurements and analysis will be shown, with examples of nearby earthquakes, distant T-phase arrivals, whales, ships and wind noise. To extend the spatial sampling footprint, the ACO will host water-column spanning profiling mooring systems and multipurpose active and passive acoustics systems, e.g., acoustic tomography. (Abstract ID 10952)

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The Role of Salinity in North Atlantic Decadal Variability Simulated in a Coupled Climate Model

Several studies have shown that some features of observed decadal variability are simulated in a pre-industrial control run of the third Hadley Centre coupled climate model, HadCM3, such as Great Salinity Anomalies, (Wadley and Bigg, 2004) and anti-correlations between North Atlantic Oscillation indices and deep water formation (Cooper and Goedon, 2001). In this study we re-examine the role of salinity in decadal variability of deep convection in HadCM3. Surface salinity anomalies alter the surface density field as they propagate around the sub-polar gyre, resulting in decadal variations in the meridional and zonal surface density gradients across the southern limit of the gyre. These salinity-induced density gradients are highly correlated with Labrador and Greenland Sea deep convection and decadal variability in the pole–ward branch of Atlantic Meridional Overturning Circulation. The surface density anomalies also drive decadal variations in surface water mass transformation rates. We consider periods in HadCM3 which are comparable to the observational record and which are less than comparable, in order to explore how robust the relationships between salinity anomalies and the overturning circulation are in the model. (Abstract ID 12967)

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New Exploratory Multibeam Data in the Drake Passage

The seafloor of the Drake Passage between South America and the Antarctic Peninsula has not been well mapped with multibeam sonar, largely because of its remote location and severe weather conditions. During two cruises of the RVIB Nathaniel B. Palmer in 2008 and 2011 we used the EM120 multibeam sonar system to map seven areas, ranging from the outer continental shelf and slope to the deep ocean basin, including two seamounts and part of the Shackleton Fracture Zone. The bathymetry provided a context for choosing sampling sites for paleoceanography studies as well as valuable insights on the regional geology. The multibeam maps, when compared to existing altimetry-derived bathymetric maps (Etopo1), show significant new detail at all sites. Volcanic structures and faulting related to seafloor spreading were mapped in detail, erosional features created by mass-wasting and/or high currents were discovered, and the depth of Sars Seamount was found to be lower than 100m. Allocating personnel for multibeam bathymetry data collection and processing during cruises of opportunity is a cost-effective way to further our understanding of seafloor geology, particularly in remote regions. (Abstract ID 11413)

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Mesoscale Eddies in the Solomon Sea

High eddy activity in the interior Solomon Sea is a prominent feature of the sea level signal in the southwest Pacific. We investigate the mesoscale eddy field in the Solomon Sea using a 4-km resolution sigma-coordinate climate-forced (ROMS) model, nested in a basin solution, and evaluated against observational data. The model generates a vigorous upper layer eddy field. We diagnose the scales and vertical structure of the eddies in different parts of the Solomon Sea to illuminate their generation processes and propagation characteristics, and compare these to observed eddy statistics. Hypotheses tested are that the Solomon Sea mesoscale eddies are generated locally by baroclinic instability that the eddies are shed as the South Equatorial Current passes around and through the Solomon Island chain, that the eddies are turbulent features generated from instabilities of the swift western boundary current, or that eddies occurring outside of the Solomon Sea propagate or are advected into the Solomon Sea. These different mechanisms have different implications for the resulting mixing, and its timescales,
that may influence the properties of the equatorial undercurrent and subsequent cold tongue upwelling. They also provide different interpretations for SSH signals observed from satellites (e.g., that will be observed by the upcoming SWOT satellite). (Abstract ID 11449)

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IMPACT OF THE GULF STREAM SST FRONT ON NORTH ATLANTIC CLIMATE VARIABILITY: A HIGH-RESOLUTION REGIONAL MODEL STUDY

The inability of the current generation of global climate models to realistically resolve the Gulf Stream separation from the east coast of the North America leads to improper representation of the associated sea surface temperature (SST) front in these models. To evaluate the impact of this misrepresented SST front on the overlying atmosphere, ensembles of high-resolution regional atmospheric model simulations are carried out, forced with SST simulated by an intermediate resolution and a high-resolution regional ocean model. It is found that the difference in the representation of the Gulf Stream separation between the two ocean model simulations has a significant impact on the climatologies of regional precipitation, stormtracks, and the remote large-scale mean background states. As the simulation of the Gulf Stream separation improves with the increase in the ocean model resolution, the associated shift in the SST front causes a northward shift of the winter storm track in upper levels as the synoptic disturbances propagate eastward. Moreover, a trough at low levels originates near the warm SST associated with the Gulf Stream separation and a strong anomalous ridge forms far downstream near the northeastern Atlantic and West Europe, which leads to a weaker subtropical jet near this region. These results support the notion of active frontal-scale air-sea interactions along the Gulf Stream and highlight the importance of resolving fine-scale structures in climate models. (Abstract ID 11813)

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VERTICAL MIXING ASSOCIATED WITH NEAR-INERTIAL POINCARE WAVES IN LAKE MICHIGAN

In large lakes, near-inertial Poincare waves dominate the internal wave spectrum and are responsible for most of the vertical shear observed in the lake's interior during the stratified period. Our work seeks to test the hypothesis that basin-scale mixing in large lakes may be achievable in a fundamentally different manner than smaller lakes (and even ocean shelves), on account of the near-inertial character of the dominant internal seiche. We present thermocline shear and microstructure data from Lake Michigan in order to highlight the potential contribution of near-inertial Poincare waves to basin-scale mixing in the largest of lakes and enclosed basins. Of particular interest is the spatial and temporal distributions of vertical cross-thermocline shear, and the potential effects of these distributions on basin-scale cross-thermocline mixing. Episodes of particularly elevated shear are highlighted, and several existing shear-driven turbulence parameterizations are tested. Numerical model results are also presented in an attempt to generalize the conclusions beyond the measurement locations. (Abstract ID 10455)

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HETEROTROPHIC RESPIRATION AND DENITRIFICATION OF SEDIMENTS IN THE LOW OXYGEN AREA OFF THE CHANGJIANG (YANGZIE RIVER) ESTUARY

Incubations of intact sediment cores revealed a positive correlation between oxygen consumption and denitrification in the mud region (r=0.68) of the Changjiang Estuary where the seasonal water column hypoxia has been reported. The average heterotrophic respiration rate measured as O$_2$ consumption was 357.2±206 μmol O$_2$/m$^2$/hour in the cruise in August 2011. The spatial pattern of respiration rates matches the areal distribution of mud. The hydrodynamic control on particles indirectly manipulates the sedimentary oxygen consumption. Denitrification outperforms Anammox in this area. The production rate of N$_2$O from denitrification was 9.7±7.8 and 2.2±3.2 μmol N/m$^2$/hour, respectively, which were determined by a newly developed isotope pairing technique. N$_2$O yields were lower than 10% of total denitrification in most of stations but higher than 70% at two stations with more aerobic surface caused by bioturbation. The intimate relationship among mud distribution, oxygen consumption and denitrification implies the effect of hydrodynamic driven substrate supply on sedimentary nitrogen removal processes. (Abstract ID 10928)

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AN EXPERIMENTAL AND NUMERICAL INVESTIGATION ON WAVE-MUD INTERACTIONS

Wave attenuation over a fluid mud layer is investigated via laboratory experiments and numerical modeling in order to study wave-mud interaction and various mechanisms of energy dissipation. The experiments are carried out in a 2D wave flume in Tainan Hydraulic Laboratory, Taiwan. In all runs, the water depth is fix to be 30 cm with the bottom 6 cm cover by a mud layer made of fully saturated kaolinite. A fully developed fluid mud layer with a homogeneous concentration distribution is created to investigate the resulting energy
dissipation for different wave heights (2, 4, 6 and 8 cm), periods (0.6-2.1 sec) and mud densities (1200, 1310 and 1420 kg/m^3). Rheological analyses of mud samples suggest that in periodic motion the fluid mud displays very complex behavior. Empirical formulae are then developed to describe yield stress and viscosity as explicit functions of concentration and shear rate. Experimental results suggest non-linear wave effect reduces the viscosity and leads to less damping, and the Ilmenham plastic behavior of the mud layer also contributes to the development of boundary layer thickness. Measured data are used to validate a numerical model of wave-mud interaction based on RANS equations with a mixture formulation for mud transport. Empirical formulae developed from rheological analyses are implemented in the numerical model. The numerical model is then found to predict wave dissipation rate that agrees very well with the measured data. (Abstract ID 9472)
March, 2009 along a section crossing the shelf in the southern East China Sea to investigate the along-shore and cross-shore circulation and their response to wind. The observed residual currents over the shelf are strongly polarized in along-shore direction. The ZheMin Coastal Current flows from NE to SW in inner shelf and the Taiwan Warm Current (TWC) flows from SW to NE in mid-shelf. An Empirical Orthogonal Function analysis (EOF) is applied to residual currents. The first EOF mode explains 80% of the total variance with an in-phase spatial pattern of maximum amplitude at near surface 7km offshore. The first EOF temporal mode shows three peaks at 1.5d, 2-4d and 15d period. The residual currents are significantly correlated with local wind, and lags wind stress about 13h. The high correlation between the residual current and the wind stress suggests that the synoptic scale fluctuations of the coastal currents in the southern East China Sea are mainly forced by synoptic wind. (Abstract ID 9812)

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SPATIAL AND INTER-ANNUAL VARIABILITY OF NCP AND GPP IN THE WESTERN ANTARCTIC PENINSULA REGION, 2008-2011

The distribution of net community production (NCP) and gross primary production (GPP) in the western shelf of the Antarctic Peninsula (WAP) has been studied during cruises in 4 consecutive Januarys (2008-2011). NCP and GPP are derived from measurements of [O

2

] ratios and the triple oxygen isotopic compositions of dissolved O2 in the mixed layer water. This study shows large spatial and inter-annual variability of NCP and GPP. In the shelf and coastal waters where there is no significant iron limitation, NCP and GPP are persistently negatively correlated with the mixed layer depth (MLD). These results suggest that light availability may be the key factor regulating NCP and GPP in the inshore WAP, and highlights the importance of various physical processes that strengthen upper water column stratification and relieve light limitation. Control of productivity by stratification is especially observed in the southern part of the study region for Jan. 2011, where low wind, high surface photosynthetically active radiation (PAR) and freshening of the surface water by ice melting acted together to facilitate anomalously high NCP and GPP. (Abstract ID 12758)

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IMPACTS OF A WIND-DRIVEN, CROSS-SHELF LARGE RIVER PLUME ON BIOLOGICAL PRODUCTION AND CO2 UPTAKE IN THE GULF OF MEXICO

We used field surveys of partial pressure of carbon dioxide (PCO2) and satellite measurements of Chlorophyll-a data to examine how an unusual extension of the Mississippi and Atchafalaya River system (MARS) plume influences biological production and CO2 distribution in the northwestern Gulf of Mexico (GOM). An upwelling-favorable wind coinciding with a large freshwater discharge induced a wide-spread freshwater plume across the shelf in March 2010 with a pattern that is different from narrow plumes normally occurring in spring, such as Apr. 2009. This widespread cross-shelf MARS plume covered an area which is twice larger than the narrow plume area in Apr. 2009. In addition, this wide plume has nearly three times stronger CO2 uptake ability than the ability of plume in Apr. 2009, creating a CO2 sink for the atmosphere in a region that normally was a source of CO2, which significantly affected the air-sea CO2 flux of pelagic GOM. (Abstract ID 12188)

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OBSERVED TYPE-A AND TYPE-B INTERNAL SOLITARY WAVES IN SOUTH CHINA SEA

A 143-day long mooring experiment was conducted in the deep basin of the South China Sea to observe internal solitary waves (ISWs). A total of 139 ISWs, including 51 type-a and 88 type-b ISWs, were recorded. The propagation directions of these ISWs showed that the middle and southern parts of the east ridge of the Luzon Strait were their sources. The generation areas of type-a and type-b ISWs was also overlapped and did not have an apparent boundary. In general, the arrival time of type-a and type-b ISWs followed the period of K1 and M2 tides, respectively. However, some unknown factors also affected the arrival time of most individual ISWs. Type-a ISW always changed into type-b ISW at the end of each type-a ISW group. In contrast, only three type-b changed into type-a ISW during June and July, 2010. Analyses of the changes between type-a and type-b ISWs around July 13 showed that the generation mechanism of ISWs could be very complex during such changes. (Abstract ID 10227)

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CHEMICAL REACTIVITY AND SPECIATION OF DISSOLVED COPPER IN WEST PHILIPPINE SEA

Dissolved Cu in seawater is now recognized to be dominated by complexation with naturally occurring ligands. Marine humic substance (HS) are known to be one of the main components of bio-reactor DOM which plays an important role in copper speciation, affecting its bioavailability. In this study, depth profiles of the reactivity and speciation of dissolved copper in west Philippine Sea waters were investigated by cross flow ultrafiltration (1kDa), ion exchange (Chelex-100, APVIG 1), solid phase extraction (XAD-4, C-18) and differential elution (hydrochloric acid, sodium hydroxide and methanol) techniques. Results have shown that the concentration of dissolved Cu from surface to near bottom (3 m above sediment surface) waters ranged 0.5–5 nM. Chemical reactivity of dissolved Cu in the surface ocean had diurnal variations, which were mediated by colloidal compounds released from plankton and bacterial mineralization, as microbial mucilages. The fractions of dissolved humic bound Cu changed insignificantly through out the water columns, accounted for ~20–30 % of total dissolved copper. Less than ~2% of these reactive Cu were associated with low molecular weight fulvic acid, majority (>90%) were bounded with low molecular weight humic acids. (Abstract ID 10161)

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MULTIDECADAL OSCILLATIONS OF THE MERIDIONAL OVERTURNING CIRCULATION IN PRESENCE OF BOTTOM TOPOGRAPHY AND STOCHASTIC ATMOSPHERIC FORCING

Flat-bottom idealized-geometry ocean models forced by fixed surface buoyancy fluxes show generic bifurcations towards multidiscal oscillations when the overturning circulation is large enough or the eddy-dissipation reduced. These oscillations are prevented in the presence of large-scale bottom topography like a Mid-Atlantic Ridge. Here we address this issue through a multimodel approach. We distinguish two main damping processes and quantify their relative influence: (1) the damping of Rossby basin modes through bottom-topography interactions; (2) the changes in the mean circulation with bottom topography that no longer supports unstable linear modes. On the contrary, stochastic NAO-like atmospheric forcing maintains these oscillations against bottom topography damping. The opposite influence of these processes on the multidiscal variability is investigated for actual North-Atlantic Ocean conditions. (Abstract ID 11002)

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TOWARDS UNDERSTANDING THE DYNAMICS OF FRESHWATER AND SEDIMENT FLUX FROM THE GREENLAND ICE SHEET TO THE COAST WITH MODIS IMAGERY AND OCEANOGRAPHIC SURVEYS

Very few in-situ measurements of runoff from the Greenland Ice Sheet (GrIS) exist. We continue to develop the use of MODIS imagery to gauge river discharge of sediment and freshwater into fords hydrologically linked to the GrIS. To ground-truth satellite imagery and investigate the applicability of our methods to a range of Greenland’s ford-river systems we conducted oceanographic surveys of plume characteristics in five systems in Southwest Greenland. Orbital satellite calibration consisted of CTD, transmissometer, and in situ grain size analysis measurements. Ford conditions range from ocean to river dominated. Other plumes maintain low salinities (0 – 10 PSU) to depths exceeding six meters and down fjord over 65 km. Ford geometries, tidal range, and other conditions impact sediment plume dynamics. These dynamics must be accounted for to link plume imagery to discharge into the fords. Our insights into controls on plume processes help expand the method developed in a single end member fords to a wider spectrum of land-terminating outlets of the GrIS. (Abstract ID 12350)

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FEEDING ECOLOGY AND CARBON TRANSPORT OF DIET VERTICALLY MIGRATING MYCTOPHIDS FROM THE NORTHERN MID-ATLANTIC RIDGE

Myctophids are among the most abundant vertically migrating fishes in the world's ocean, however little is known regarding their contribution to carbon export. We quantified diet depth distribution and analyzed the diet of myctophids from the northern Mid-Atlantic Ridge (MAR) between Iceland and the Azores in order to elucidate their role in the MAR food web and carbon export. The myctophid Boreogadus saida was the numerically dominant fish from the MAR, constituting 35% by number of the total fishes caught. This species was largely zooplanktivorous, with copepods and euphausiids comprising 59% and 15% of the diet by weight, respectively. By consuming zooplankton in surface waters and metabolizing their food at depth, myctophids may contribute to the biological pump, although, carbon actively transported to depth by migrating myctophids at the MAR varied along the ridge and was lower than export by vertically migrating zooplankton in the North Atlantic estimated in other studies. Due to their high abundance, myctophids not only directly contribute to carbon export, but also may exert top-down control on zooplankton communities, potentially affecting zooplankton-mediated carbon export. (Abstract ID 9573)

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EDDY CORRELATION MEASUREMENTS WITH FAST OXYGEN OPTODES

Oxygen flux measurements in aquatic environments with the eddy correlation technique require fast sensors that can follow the rapid changes in flow and its oxygen concentration changes. We present measurements that demonstrate the suitability of fast optical oxygen sensors (optodes), in place of the traditionally used electrodes. Optodes have the advantage over microelectrodes of being less susceptible to signal drift, more durable under field conditions, less expensive, and repairable. Comparisons of the response times of optodes and electrodes to rapid oxygen changes showed that the optimized optodes had a slightly longer response time (169 ± 70 ms) than the microelectrodes (151 ± 60 ms) but were fast enough to capture the oxygen fluctuations that are relevant for the eddy correlation flux calculations. Side by side comparisons of benthic oxygen fluxes collected with both electrode-based and optode-based eddy correlation instruments in freshwater and marine environments showed good agreement between the measured fluxes. (Abstract ID 12157)

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RANGE-WIDE, SEASONAL DISTRIBUTION OF GREEN STURGEON HABITAT IN THE PACIFIC OCEAN DERIVED FROM ACOUSTIC TAG DATA AND A REGIONAL OCEANOGRAPHIC MODELING SYSTEM

The anadromous green sturgeon (Acipenser medirostris) is found in the eastern Pacific from Baja California to the Bering Sea. Previous studies show sturgeon to be highly migratory throughout this range, moving long distances among estuaries, spawning rivers, and distant regions of the coastal ocean. Factors determining the distribution of green sturgeon within this region are unclear; but broad scale ocean conditions may be important. We report the results of an acoustic tagging study that used data-logging hydrophones from the Pacific Ocean Shelf Tracking experiment. We connected modeled bottom temperature, dissolved oxygen, geostrophic currents, and depth to acoustic detections using a maximum entropy model. We then described the seasonal distribution of marine habitat and its overlap with bottom-trawl fishing. We found that sturgeon migrated seasonally with the prevailing currents and that depth, dissolved oxygen, eddy kinetic energy and temperature were important determinants. Our study is the first to utilize output from a regional oceanographic model to delineate sturgeon habitat and will provide insight concerning the effects of changing ocean conditions and fisheries management. (Abstract ID 10613)

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MIXING EFFICIENCIES OF OCEAN PROCESSES: INSIGHTS FOR THE ENERGY BUDGET OF THE GLOBAL CIRCULATION

The amount of energy required to support turbulent mixing represents a major unknown in the global oceans. We discuss the insight offered by recent laboratory measurements of the efficiency of several mixing processes. The results suggest that shear instabilities in exchange flows and overflows rise to substantially less mixing than would be estimated from the commonly assumed efficiency of 20%. Conversely, recent measurements suggest that mixing associated with the large scale convective overturning can be characterized by much higher efficiencies. These findings prompt new questions regarding the energy requirements of the global circulation. (Abstract ID 9921)

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INFLUENCE OF SST ON SURFACE WINDS: BAROCLINIC VS. STABILITY IMPACTS

The effects of baroclinicity and stability on oceanic surface winds in the presence of an idealized sea surface temperature (SST) front are investigated using the University of Washington planetary boundary layer (UW-PBL) model. On spatial scales of O(1000 km), a definitive relationship between SST and surface winds (and wind stress) is observed in regions of strong SST fronts, where winds are generally higher (lower) over relatively warm (cold) water. Debate remains as to the physical mechanisms responsible for the small-scale coupling between SST perturbations and surface wind. O'Neill (2011), using in situ observations, concluded that the surface layer stability does not appear to strongly influence the surface wind stress response to small-scale SST variability. This study demonstrates that under certain conditions either the baroclinic or stability effects can dominate. (Abstract ID 11868)

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RADIONUCLIDE INDICATORS OF SEASONAL SEDIMENT DEPOSITION IN THE DELAWARE ESTUARY

A study was conducted to determine how fine sediment deposition in the turbidity maximum zone of the Delaware Estuary varies with seasonal river discharge conditions. Beginning in spring 2011, coring stations were reoccupied seasonally to measure activity profiles of 1-131 (8.0 day half life), Be-7 (53.3 day half life), and Pb-210 (22.3 year half life), which is derived from wastewater effluent discharged at head of the estuary, provided information on sediment transport distances, whereas cosmogenic Be-7 was used along with excess Pb-210 to determine the relative age of bed deposits. During a period of low river discharge in summer, new deposition was centralized in the upper estuary near the salt intrusion. In September, following extreme river discharges associated with Hurricane Irene and Tropical Storm Lee, the upper estuary floor was scoured and the mud depocenter migrated seaward along with the salt intrusion. The new deposits were enriched in Be-7 and I-131, demonstrating that fine sediment resident in the tidal freshwater segment was swept seaward to the middle estuary within just days of the storm-produced riverflow events. (Abstract ID 11650)

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SUMMER PARTICULATE ORGANIC CARBON FLUX IN THE EAST CHINA SEA

Recent studies have shown that continental marginal sea is wealth of nutrient which can promote the growth of phytoplankton and the absorption of atmospheric CO2. These carbon source fixed by phytoplankton were possibly transported to the open ocean by the continental shelf pump mechanism. The previous studies have shown the vertical particulate organic carbon (POC) flux in the East China Sea (ECS) are usually higher in the in-situ primary production. Therefore, this study was performed to measure the POC in the ECS with floating sediment trap and the re-suspension was confirmed with two-component mixture model. The result was showed that uncorrected POC flux in the inner shelf was 720-8790 mgC/m2/d and was gradually decreased to 80-150 mgC/m2/d in the outer shelf. Although there was not any effect on the distribution of POC flux after correction, but the POC flux values, 49-3499 mgC/m2/d were apparently lower than uncorrected values. The result was showed that 24-98% POC flux was generated by re-suspension of the particles at the bottom rather than the biological particles from the ocean surface. The flux of vertical, buried and remineralized POC at the edge of shelf was 49-50, 5-9 and 6 mgC/m2/d, respectively. It is estimated that about 33-39 mgC/
m2/d biological POC was exported to the ECS. (Abstract ID 9591)

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DIVERSITY AND ACTIVITY OF BACTERIOPLANKTON IN THE NORTH PACIFIC (STATION ALOHA)

Culture independent studies have revealed marine bacterioplankton to be exceptionally dynamic and genetically diverse, yet how the activity of these microbes varies between clades or with time and space is largely unknown. Here using paired large-scale pyrosequencing of ribosomal DNA gene (rDNA) and ribosomal RNA (rRNA) libraries, we investigate the relative activity of microbial communities from two depths (25 m and 100 m) at a representative site in the north Pacific Ocean (Station ALOHA). Sequences from a 454 library with >500,000 reads were trimmed, denoised and chimeras checked using QIME. Sequence clustering at 97% identity identified ~1,400 operational taxonomic units (OTUs). Prochlorococcus and SAR11-like sequence types dominate the libraries at both depths. Comparisons of sequence abundance between the libraries revealed patterns with depth and apparent uncoupling of abundance (rDNA) and activity (rRNA). These data provide insight into the activity of specific members of the microbial community, and more broadly applied this technique may help to distinguish the roles of specific clades within diverse marine bacterioplankton communities. (Abstract ID 10087)

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LAGRANGIAN OBSERVATIONS IN THE JAMES RIVER ESTUARY - 2010 DYE INJECTIONS, LATERAL MIXING AND THE SPING-NEAP CYCLE.

During May of 2010, a series of four dye injections was carried out over a spring-neap cycle with the objective of quantifying diurnal mixing and lateral circulation in the James River Estuary. Fluorescein dye was injected into the bottom boundary layer near Newport News, VA, on May 5th, 7th, 25th and 27th. The survey plan which mapped each dye patch consisted of two vessels, one equipped with a CTD profiler to map the along-channel extent and variability of the dye patch, the other with a towed undulating CTD cage for cross-channel transects. In addition, a high resolution moored instrument array was deployed for the duration of the survey. Data from the dye surveys and mooring array is presented here. The four dye injections consisted of flood and ebb injections during a spring and neap tide. The dye surveys yielded from 6-8 synoptic realizations of the dye patch for each injection. Analysis will access if a simple 1-D mixing model can explain the observed salting of the dye patch based on estimates of shear production from both moorings and microstructure data. (Abstract ID 11960)

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NEW ALGORITHM FOR REMOTE SENSING OF VARIABILITY IN THE QUANTUM YIELD OF CHLOROPHYLL FLUORESCENCE

The emission of fluorescence from chlorophyll within phytoplankton cells illuminated by sunlight (i.e. sun-induced chlorophyll fluorescence [SIF]) varies due to four main variables: the quantum yield, the incident irradiance, the absorption coefficient of phytoplankton, and the total absorption coefficient of the water. Consequently, remotely measured SIF should contain information on all four variables. Here we examine how standard ocean color algorithms can benefit from utilizing Sun-induced fluorescence to improve our accuracy. We follow this analysis by presenting a new type of algorithm to observe variability in the quantum yield of fluorescence. We show that this algorithm provides fields that are vastly different from previously derived algorithms at the global scale. (Abstract ID 12079)

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DIFFERENTIAL SUSCEPTIBILITY OF COASTAL CALCIFIERS TO OCEAN ACIDIFICATION

Trends in pH at the surface of three ecologically important cold-water calcifiers (coralline seaweed, abalone, urchin), under a range of fluid flows, differ substantially from one another and, for two of the three calcifiers, the pH in darkness is lower than that projected for the surface waters beyond the year 2100. Using micro-probes, we show that abalone encountered only mainstream seawater pH4, whereas pH at the sea urchins’ surface was reduced by ~0.35 units. For coralline algae, pH4 was ~0.5 units higher in the light and ~0.35 units lower under darkness than in ambient mainstream seawater. This wide range of pH within the diffusion boundary layer of some calcifiers could affect their performance under projected future reductions in pH due to OA. Differing exposure to a range of surface pH may result in differential susceptibility of calcifiers to OA. Our study, by considering physics (flow regime), chemistry (pH gradients vs. OA future projections) and biology (trophic level, physiology and morphology), reveals that predicting species-specific responses and subsequent ecosystem restructuring to OA is complex and requires a holistic, eco-mechanical approach. (Abstract ID 19806)

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THE ROLE OF SEA ICE DYNAMICS IN INCREASING LATITUDINAL EXPANSION OF THE SEASONAL ICE ZONE IN THE CHUKCHI AND BEAUFORT SEAS.

The Chukchi and Beaufort Seas have lost perennival ice cover since 1997. After the record Arctic sea ice minima of 2007, the Beaufort seasonal ice zone continued to expand. The Chukchi and Beaufort ice packs are closely coupled through Beaufort Gyre return of ice from the Chukchi to the Beaufort, and export of multi-year ice from the Beaufort to the Chukchi. We show that since 1997 import of multi-year ice to the Chukchi has been hindered by increasing summer melt in the Beaufort. Recirculation in the Beaufort Gyre comprises first year ice from the Chukchi, that has acted to create an ice pack younger than 5 years old throughout most of the extent of the Beaufort Gyre. This relatively young Beaufort ice (compared to conditions prior to 1997) melts out completely below 76N. Older ice is exported from the Canadian Holding zone into the Southern Beaufort, where ship observations from the CCGS Louis S. Laurent demonstrate a diffuse ice pack that has experienced substantial melt in summers 2007-2011. Hence the survivability of the oldest ice traversing the southern Beaufort Sea is reducing. To increase perennial ice area in the Arctic requires consolidated ice older than 10 years drifting in the southern Beaufort (like 2006), followed by recirculation of this in the Beaufort Gyre (unlike 2006, where this ice was exported to the transpolar drift). (Abstract ID 10687)

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CAN CHANGING PCO2 CONTROL THE GLOBAL DOMINANCE AND DIVERSITY OF N2-FIXING CYANOBACTERIA?

Studies showing N2 fixation rate increases with rising pCO2 in marine diazotrophic cyanobacteria have all used the same one or two culture isolates, raising questions about relevance to large-scale environmental trends. We generated CO2 response curves (0-2000 ppm) for N2 fixation rates using seven Pacific and Atlantic Trichodesmium and Crocosphaera isolates from a global culture collection. Responses to changing pCO2 were variable and strain-specific, with N2 fixation half saturation constants (K1/2) ranging from 63-408 ppm CO2. Using these K1/2 values and GMC simulated changes in sea surface pCO2 we estimate the potential N2 fixation rates of each isolate from last glacial maximum (LGM) to projected year 2100 concentrations. As pCO2 levels rise from the LGM to today and over the next century, strain-specific differences in the magnitude of maximum N2 fixation rate responses to CO2 fertilization are on the order of 200-300%. CO2 availability could therefore be a powerful selective force determining the relative competitive success of different Trichodesmium and Crocosphaera species and ecotypes, and so may help to shape the global distributions and biodiversity of marine N2-fixing cyanobacteria. (Abstract ID 11675)

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METABOLIC CONSEQUENCES OF SURFACE RUNOFF AND GROUNDWATER INPUT TO A COASTAL MICROBIAL COMMUNITY: CONTRASTING EFFECTS OF TERRESTRIAL LANDSCAPES AND FLOW

Frequent hypoxic events in Long Bay, South Carolina occur despite a lack of substantial riverine or upwelled inputs. One theory suggests that nutrient-rich groundwater is being contained nearshore via limited cross-shelf mixing others suggest that stormwater run-off channelized through small tidal creeks or outfall pipes is delivering nutrients and organic matter that initiate conditions that subsequently lead to hypoxia. In an effort to understand
the effects of input source on key biological rate processes, surface water and groundwater from developed (Myrtle Beach) and undeveloped (North Inlet) uplands was introduced to a coastal water microbial community in a controlled microcosm experiment. Both treatments from the developed basin resulted in a more heterotrophic system than the control while both treatments from the undeveloped basin resulted in greater autotrophy. Surface run-off additions operated higher levels of production and a much more heterotrophic system than all other treatments, likely because impervious surfaces in the developed basin re-route a significant proportion of allochthonous nutrients through surface, rather than subsurface flowpaths compared to the undeveloped basin. (Abstract ID 11142)  

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MICROBIALITES AS POSSIBLE FRAMEWORK CONTRIBUTORS FOR MESOPHTHIC CORAL ECOSYSTEMS (MCES)  
Microbialites are defined as lithified cemented deposits formed by benthic microbial fauna. In reef environments, microbialite communities often correspond to episodes of elevated nutrient levels and sea surface temperatures. However, current observations of microbialite structures in modern substrates from mesophotic coral ecosystems (MCES), far from anthropogenic and terrestrial influences, indicate recent formation under oligotrophic conditions. Substrate hand samples collected from MCES off La Parguera, Puerto Rico, suggest that microbialites can contribute to the reef framework, by encrusting and stabilizing loose sediments, possibly creating new habitat suitable for coral recruitment and colonization, which is known to be limited in these ecosystems. Although coral-microbialite dynamics are not well understood, documenting microbialite morphology and development, as well as environmental conditions that promote their growth will contribute to understanding their function in mesophotic reef communities. The present study is based on the identification of possible microbialites within MCESs and provides data of growth patterns and contributions to framework building. (Abstract ID 10794)  

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ALKENONE UNSATURATION AND FLUXES ON THE NORTHWEST ATLANTIC MARGIN  
Alkenone unsaturation index (UK\textsuperscript{37}) has been used widely in paleotemperature reconstruction. It is important to understand how faithfully marine organisms record the growth temperature and this temperature signal is transferred to the sediment. Tied sediment trap arrays can provide useful information on the biogeochemical processes that partition organic matter (POM) undergoes during passage through the water column and on the transfer and preservation of signals of surface ocean. We examined alkenone distribution in sinking POM intercepted at three nominal depths-1000m, 2000m, and 3000m (50m above the bottom)- on the North Atlantic margin from 2004 to 2007. UK\textsuperscript{37} did not exhibit any significant trend with increasing depth, supporting the previous observations that UK\textsuperscript{37} is not altered despite several-fold attenuation in alkenone flux. Alkenone flux decreased from 1000m to 3000m as a linear function of the alkenone flux at 1000m with a positive slope, indicating talinum was not altered despite several-fold attenuation in alkenone flux. Alkenone flux decreased from 1000m to 3000m as a linear function of the alkenone flux at 1000m with a positive slope, indicating  

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WHEN AND WHY ARE ZOOPLANKTON PIGMENTED?  
The reddish color of salmon flesh is caused by pigments called carotenoids. These substances are common in nature and have many beneficial functions. Accumulated carotenoids can for example function as "suntan" for zooplankton (copepods) reducing ultraviolet radiation (UVR) damages on DNA, but pigments also increase the animals’ visibility to predators. Other UV-protective compounds such as mycosporine-like amino acids (MAAs) provide sunscreens but are non-pigmented. They are hence hypothesized to give UV-protection without increasing the predation risk. Our results from laboratory and field studies show that accumulation of carotenoids and MAAs is dependent on food source and level of UVR exposure. Egg production and growth rates are negatively affected by UVR but this negative effect is reduced if MAA-rich algae are included in the food. This indicates that zooplankton can detect changes in UVR and optimize their blend of UV-defensive compounds. The preference of non-pigmented MAAs over red carotenoids may be an adaptation to high predation pressures in pelagic habitats in the ocean. (Abstract ID 11951)  

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A DAY IN THE LIFE OF A PHYTOPLANKTER: AN INDIVIDUAL-BASED MODEL OF DIET CYCLING IN PROCHLOROCOCUS Prochlorococcus spp. are the smallest and most numerous phytoplankton in the ocean, producing about 1/5 of the oxygen we breathe. The tightly-phased diel dynamics of growth and division can be used to estimate growth and mortality rates of Prochlorococcus both in situ and in silico. In this study, we used an individual-based model (IBM) to capture the cell size patterns, cell concentrations, and cell cycle phase distributions of Prochlorococcus in order to elucidate factors driving cellular dynamics. The model was compared to cell cycle data from field populations in the Sargasso Sea of the North Atlantic Ocean. We have found that there is a threshold cell size for the initiation of DNA replication, we must sufficiently reproduce the dynamics of cell size in order to accurately model in situ Prochlorococcus cell cycle dynamics. This model has been used to test the effects of sampling frequency on field calculations of growth rate from cell cycle parameters (Carpenter & Chang, 1988). In future studies, the model can be embedded in a 3-D circulation model to investigate the effects of light, nutrients, and grazing on Prochlorococcus population dynamics. (Abstract ID 10481)  

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ANALYZING SATELLITE DERIVED PHYTOPLANKTON FUNCTIONAL GROUP ESTIMATES FOR USE IN FISHERY PRODUCTION MODELS  
Fishery production potential is a function of primary production, the fraction of production available to higher trophic levels and trophic transfer efficiency. Two pathways are recognized for trophic transfer of primary production in marine ecosystems – direct grazing by mesozooplankton, principally on diatoms; and nanoplanクトon production transferred through the microbial food web with a greater number of trophic transfer steps. Analyses in northeast U.S. continental shelf Large Marine Ecosystem (LME) suggest that phytoplankton biomass has increased up to 33% during the last decade compared to the 1970-80s. However, phytoplankton composition data from the Continuous Plankton Recorder (CPR) shows a decrease in large diatoms and dinoflagellates species abundance. The goal of this current study is to evaluate the speciess in phytoplankton species composition using various remote sensing phytoplankton functional group size class models and then incorporate this data into estimates of size fractionated primary production. A possible shift from larger to smaller phytoplankton species has important fisheries implications because it can impact the total amount of production in the system available to higher trophic levels and affect the fishery production potential. (Abstract ID 11197)  

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COASTAL UPWELLING AND LAND HEATING OVER THE CALIFORNIA-OREGON COAST: DYNAMICS AND CLIMATE SCALE LAND-OCEAN-ATMOSPHERE INTERACTIONS

Long-term buoy observations suggest that the summertime water temperatures off the US West Coast have been steadily declining since the 1980s, with the greater cooling trends in central-southern California compared to Oregon-northern California. While alongshore wind stress exhibits the opposite trend patterns, the wind stress curls in the south have become increasingly cyclonic, implying a possible role of topographically-driven wind stress curls in the upwelling trend pattern. With cooler coastal waters, the daytime near-coast land air-temperatures have been declining due to stronger sea breezes, in contrast to the continuous inland warming. A popular hypothesis posits that strengthened upwelling and sea breezes are associated with the anthropogenic greenhouse gas forcing. Analyzed upwelling fields, however, also exhibit large interannual to multi-decadal variabilities coherent with major modes of climate variability. To attribute the observed variability and trends objectively to these remote, local and anthropogenic causes, process modeling studies will be reported using a high-resolution regional air-sea coupled model over the US West Coast. This is a critical step toward the robust projection of potential coastal climate responses to various climate change scenarios. (Abstract ID 10030)

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PALEOCENOGRAPHIC ENVIRONMENTAL EVOLUTION IN THE EAST SEA (JAPAN SEA) SINCE THE LAST 400 KYR

Geochemical proxies of stable oxygen isotope of foraminifera, carbon and nitrogen isotope of organic matter, and total organic carbon (TOC) and inorganic carbonate content of two piston cores taken from the Korea Plateau, East Sea (Japan Sea) were investigated to understand the paleoenvironmental evolution since the last 400 kyr. Oxygen isotope signals of foraminifera shows large fluctuation, ranging from MIS (Marine Isotope Stage) 1 to MIS 11. Comparison of oxygen isotope record during the 400 kyr reveals that paleoceanographic and paleoclimatic changes in the East Sea is quite different from those of open oceans. The content of biogenic carbonate, TOC and carbon and nitrogen isotope of organic matter (δ13C and δ15N) were determined and used to interpret paleoenvironmental changes during glacial and interglacial periods. Based on the isotopic composition of δ13C and δ15N, which showed extreme temporal variation since MIS 11 influx of large amount of terrestrial organic matters from the neighboring continent during MIS 2, 8 and 10 can be implied. In particular, depleted values of δ13C during MIS 2, 8 and 10 were coincident with lower nitrogen isotope values indicating local paleoceanographic effects such as paleo productivity changes. Therefore, the paleoenvironment in the East Sea is sensitive to the global climate changes associated with not only orbital-scale glacial-interglacial variations but also local paleoclimatic variations. (Abstract ID 10795)

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IMPACT OF NON-VOLATILE DIATOM OXIDINES ON THE REPRODUCTIVE SUCCESS OF THE COEPOD TEMORA STYLIFERA

Abstract: Diatoms produce toxic compounds that inhibit growth and reproduction in copepods. The toxic effects of some oxidenones is well known, for example those of polyunsaturated aldehydes (PUAs), while questions remain on the toxic nature of others. We compared the effect of PUAs found in Skeletonema marinoi to the effect of hydroxy fatty acids (HEPA) found in both S. marinoi and Pseudoschizochytrium delicatissimum which does not produce PUAs. Using an experimental approach we measured reproductive parameters in the copepod Temora stylifera for 15 days. Egg production, egg viability and naupliar recruitment were negatively affected with both diatoms. Hatched naupli were often abnormal and positive to apoptosis. The most common hydroxycyclo (15S-HEPA) tested on newly spawned eggs, reduced hatching success and induced apoptosis, at higher concentrations compared to PUAs. Other hydroxycyclids (5-9 and 11-5 HEPA), which vary only in the position of the hydroxy group, were more active. Thus diatoms produce a variety of compounds that negatively affect the growth and reproduction of copepods. (Abstract ID 12576)

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PARTICLE KALMAN FILTERING: A NON-GAUSSIAN BAYESIAN FRAMEWORK FOR ENSEMBLE KALMAN FILTERS

This contribution investigates an approximation scheme of the optimal nonlinear Bayesian filter based on the Gaussian mixture representation of the state probability distribution function. The resulting filter is similar to the particle filter, but is different from it in that, the standard weight-type correction in the particle filter is complemented by the Kalman-type correction with the associated covariance matrices in the Gaussian mixture. We show that this filter is an algorithm in between the Kalman filter and the particle filter, and therefore is referred to as the particle Kalman filter (PEKF). In the PEKF, the solution of a nonlinear filtering problem is expressed as the weighted average of an ensemble of Kalman filters" operating in parallel. Running an ensemble of Kalman filters is, however, computationally prohibitive for realistic atmospheric and oceanic data assimilation problems. For this reason, we consider the construction of the PKF through an ensemble of ensemble Kalman filters (EnKFs) instead, and call the implementation the particle EnKF (PEnKF). We show that different types of the EnKFs can be considered as special cases of the PEnKF. Similar to the situation in the particle filter, we also introduce a re-sampling step to the PEnKF in order to reduce the risk of weights collapse and improve the performance of the filter. Numerical experiments with the strongly nonlinear Lorenz-$96$ model are presented and discussed. (Abstract ID 9375)

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IMPACT OF A FINE SCALE SST OVER THE KUROSHIO EXTENSION REGION TO WINTERTIME RAINFALL

In the present study, the winter precipitation in the vicinity of Japan is simulated by the Weather Research Forecasting model by using two sets of sea surface temperatures (SSTs) data with different spatial resolutions. It is found that the difference in the SSTs resolution has the interannual variance of the local precipitation over the Kuroshio–Oyashio Extension (KEO) region. The warm (cold) SST anomaly in the KEO region near Japan, caused by ocean processes, induces an increase (decrease) in the local precipitation to the east of the SST anomaly. This increase is accompanied by the enhancement of surface wind convergence (divergence). Furthermore, the anomalous ascent associated with the enhanced surface wind convergence in response to the warm SST anomalies extend to the mid-troposphere up to around 500 hPa, this is accompanied by an increase in the cloud ice. This suggests that the SST in the KEO region can affect the atmosphere above the planetary boundary layer. Moisture budget analysis indicates the influence of moisture advection by mean wind on the spatial phase difference between the SST and precipitation anomalies. (Abstract ID 9835)

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ATTEMPT OF MODEL INTER-COMPARISON PROJECT FOR RADIONUCLIDE DISTRIBUTIONS FROM FUKUSHIMA-I

Radionuclide-polluted water flowed out of Fukushima-I in early April, Radionucleotides also fall out from the atmosphere in March and spread much more widely than the water flow. The ocean simulation models were developed to reproduce current patterns and radionuclide distributions, under atmospheric forcing and river flows. For the coastal region, the models were applied to reproduce freshwater- and wind-driven coastal currents and nested with the offshore mesoscale features, which were updated with data assimilation. A systematic inter-comparison of these models (MIP) was useful for higher reliability of the simulations. The models were first verified against current meter data before the event. With the two kinds of radionucleotides, the polluted water spread along the coast southward on the average with variations due to winds and was gradually taken away within the mesoscale eddies. In addition, low-level pollution spread along the Kuroshio Extension and also the general circulation for a few years. Even though the current patterns were reproduced consistently among the models, the radionuclide contents showed significant differences in the southern coastal region. The component in sediments was also estimated. (Abstract ID 9340)

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A COMPARISON OF NEARSHORE KELP HABITATS ACROSS THE ALASKAN ARCTIC COAST

Rocky habitat dominated by kelps is rare in the nearshore Arctic, but where they occur, these habitats are known to be distinct biodiversity hotspots. These boulder regions are ecologically important because they support benthic primary producers with tightly linked food webs. Here we present the first results on the exploration of a new boulder field in the coastal Chukchi Sea

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near Barrow, including a first quantitative biological description of this boulder community. We also compare this community to other such kelp communities in the coastal Beaufort Sea. Our results show that these nearshore boulder communities along the Alaskan Arctic shore share many of their community elements but that each community also has dominant members that are inefrequent at the other locations. This indicates that dispersal and exchange among these communities may be limited and a substantial amount of local recruitment may occur. (Abstract ID 9400)

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SPURIOUS DIAPYCNAL MIXING AND THE ROLE OF MOMENTUM CLOSURE

Spurious numerical mixing needs to be minimized in order to investigate the global sensitivity to spatial distribution of mixing. One of the main motivations to understand and reduce spurious dianeutral transport is due to the need to retain water masses over basin scales for timescales of decades to centuries. Explicit mixing values can be masked by the implicit numerical mixing in geopotential and sigma coordinate ocean models. Performance of four different ocean models (GOLD, MITgcm, MOM and ROMS) has been investigated using four different idealized test cases (lock-exchange, overflow on a slope, internal waves and eddying channel). Simulations with the isopycnal model GOLD provide a benchmark for the smallest level of spurious mixing. ROMS generally produces smaller spurious dianeutral mixing than MITgcm or MOM, since ROMS employs a higher order upwind-biased scheme with less mesoscale eddies. The GOLD simulations have detectable levels of spurious cabbeling from simulations with the isopycnal advective truncation errors. Significantly larger spurious mixing arises in a non-eddying MOM simulation. In an eddying MOM simulation, spurious dianeutral transport is larger still but is reduced by increasing momentum friction. (Abstract ID 10817)

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TURBULENT MIXING AND HEAT DELIVERY IN A SE GREENLAND FJORD: THE ROLE OF PSW.

The region of greatest mass loss from the Greenland Ice Sheet is the southeast, where icebergs calving from marine-terminating outlet glaciers dominates mass loss. The main outlet glaciers terminate at the heads of deep, long fjords which extend as troughs as far as the shelf break. Accelerated ice loss has been attributed to changing oceanic conditions, both in deeper Atlantic-origin waters, and in shallower Arctic-origin waters (Polar Surface Waters, PSW), although evidence for this is sparse. Concentrating on Kangerdlugssuaq Fjord, this presentation quantifies the role of fjordic circulation in transporting oceanic heat along the axis of the fjord. Historic and recent (2010) hydrographic and velocity measurements are used to diagnose a circulation scheme. Full-depth turbulence microstructure measurements, which reveal highly turbulent upper layers atop more intermittently turbulent deeper layers, are combined with the circulation scheme to construct layer-wise heat and salt budgets. PWS emerges as a key player in the melt-rate equivalent residual of the heat budget. Results of 3D hydrodynamic modelling demonstrate a circulation pattern consistent to that diagnosed from the observations. (Abstract ID 11194)

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GLOBAL BAROTROPIC OCEAN MODELING DRIVEN BY SYNTHETIC ATMOSPHERIC DISTURBANCES: VALIDATION USING GLOBAL IN-SITU OCEAN BOTTOM PRESSURE DATA

A global barotropic ocean model forced by atmospheric disturbances is developed and validated by global in-situ ocean-bottom pressure (OBP) data. Parameters and boundary conditions of the model are tested in order to accurately simulate non-tidal (<2 days) OBP variations. The horizontal resolution of the model most strongly affects the model output. The finer the horizontal resolution is applied, the weaker the model variabilities are. The model accuracy is highest when the horizontal resolution is 1/12 deg. At a period of 2-20 days, the 1/12 deg. model yields a correlation coefficient of 0.66 to the OBP observations on global average. The 1/12 deg. model is shown to be useful to reasonably detect slow vertical seafloor deformation of centimeters in timescales of days from in-situ OBP records. On the other hands, high resolution models with grid sizes of finer than 1/12 deg. yield worse results, which is discussed. (Abstract ID 10999)

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SUSTAINED CABLED OCEAN OBSERVING SYSTEMS FOR MANAGING FISHERIES WEALTH IN THE SEA OF OMAN AND ARABIAN SEA

In 2005 Lighthouse R&D Enterprises, Inc. began developing an ocean observing system that would help manage fisheries wealth for the Sultanate of Oman. The resulting cutting-edge, fiber-optic cabled observatory was installed in the northern Sea of Oman and became operational in August, 2005; this summer the system surpassed the milestone of 2100 days of successful operation. A second, deepwater cabled observatory was installed where the Sea of Oman meets the Arabian Sea, in January, 2010. Both systems monitor physical properties throughout the water column including current velocity, temperature, pressure, conductivity, dissolved oxygen and turbidity. The entirely subsea nature of the fiber-optic cabled observatory capitalizes on several advantages over traditional buoyed systems including lack of exposure to environmental wear and tear, collision, vandalism and theft. The systems are cabled to nearby shore facilities, where data are relayed instantly to Houston via satellite for processing, analysis and modeling – the data may also be used in making real time decisions. The design and obstacles, lessons learned and scientific questions being addressed by the Lighthouse systems will be covered in this presentation. (Abstract ID 12820)

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INTERNAL WAVES, SHEAR INSTABILITY, AND TURBULENCE BELOW THE SURFACE MIXED LAYER OF EQUATORIAL PACIFIC.

The entrainment heat flux below the surface mixed layer is important to the heat budget of the Pacific equatorial cold tongue. During night-time, the equatorial undercurrent, tropical instability waves (TIWs), surface mixed layer convective turbulence, and small-scale internal waves interact with each other leading to instabilities, turbulence and therefore mixing in the stratified shears layer below the surface mixed layer, the so-called deep-cycle layer. In fall 2008, a mooring was deployed at equator 140W to capture these processes. High vertical resolution, O(1 m), and temporal resolution, O(1 s) of velocity, temperature, and salinity observations were obtained in the deep-cycle layer. Characteristics of the mixing varied with the phase of the TIW. When the meridional velocity of the TIW changed from north to south, stratification in the deep-cycle layer was relatively weak and the deep-cycle turbulence mixing was persistent following the deepening of the night-time surface mixed layer. When the meridional velocity of the TIW was southward, the stratification was strong, the surface mixed layer was shallow, and the deep-cycle turbulence mixing was intermittent. In this presentation, properties of internal wave-like features are compared, and the dynamics of instabilities in different flow phases are discussed. (Abstract ID 10886)

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NEURAL NETWORK MODELING OF THE OCEAN COLOR INVERSE PROBLEM

Retrieving inherent optical properties of water from remote sensing multispectral reflectance measurements is made more difficult by the complex nature of forward modeling and the inherent nonlinearity of the inverse problem. We present here the construction and validation of three NNs working in parallel to model the inverse problem for both case 1 and case 2 waters. The first NN is used to relate the remote sensing reflectance at available MODIS visible wavelengths (412-667 nm) to the absorption and backscattering coefficients at 442 nm. The second and the third NNs output the ratio of algal to non-algal absorption and non-algal particulate to dissolved absorption coefficients respectively. Using the outputs of these statistically derived networks we can then analytically obtain the absorbing properties of the three known major water components, which include CDOM, phytoplankton, and NAP. The resulting synthetically trained algorithm was validated on both NOMAD and our own field data obtained from measurements in the Chesapeake Bay and Long Island Sound. The algorithm is also applied to two years of data collected by our Long Island Sound Coastal Observatory (LISCO). (Abstract ID 12106)
aph(555) spectra were compared to those of the diatom reference aph_diatom(λ)/aph_diatom(555) for becoming a promising approach to detect diatoms bloom from space. (Abstract ID 10920)

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DETECTION OF A VARIABLE INTERNAL CI-POOL IN EMILIANIA HUXLEYI AND THALASSOSSIRA WEISSFLOGII IN RESPONSE TO CHANGES IN THE SEAWATER CARBON SYSTEM

The accumulation of an intracellular inorganic carbon pool (Ci-pool) is one strategy by which marine algae overcome low CO2(aq) in modern seawater. To determine Ci-pool accumulation prerequisites, we applied a 14C-pulse-chase method to two classes of algae. The diatom Thalassiothrix weissflogii and the calcifying coccolithophorid Emiliana huxleyi develop significant internal Ci-pools over the range 4–20 µmol/L CO2(aq). The absolute Ci-pool is related to cell size. For both algal classes the Ci-pool becomes a negligible contributor to photosynthesis once CO2(aq) exceeds 30 µmol/L. Combining the 14C-pulse-chase method and 14C-dis-equilibrium method enables us to assess whether increasing CO2(aq) results in similar thresholds for foregathering accumulation of Ci, reducing eCA activity, and reducing the reliance on bicarbonate uptake. We show a negative correlation between the Ci-pool and the proportion of CO2 satisfying photosynthetic Ci-demand. Furthermore, even when the Ci-pool of T. weissflogii disappears eCA activity is detected, implying that eCA activity is not directly related to the existence of a Ci-pool. Our new data facilitate predictions of marine phytoplankton responses to anthropogenic carbon cycle changes. (Abstract ID 9711)

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INTERANNUAL VARIABILITY OF ANTHROPOGENIC AND NATURAL AIR-SEA CO2 FLUXES IN THE PACIFIC OCEAN

A better understanding of natural and anthropogenic carbon cycle is critical in determining sea surface chemical environment including ocean acidification. Besides the long term accumulation of the anthropogenic CO2 since pre-industrial era, the anthropogenic CO2 in the ocean is highly variable in interannual timescale. We have investigated the variability of air-sea CO2 fluxes using an ecosystem and carbon-cycle model combined with an ocean general circulation model. The analysis suggests that the phase relation of the interannual variations of the natural and anthropogenic fluxes depends on the regions. The variations of natural and anthropogenic CO2 flux are in phase in the central North Pacific but out of phase in the equatorial region. The different relations are caused by the differences of the regional chemical and biological responses to the climate variations. (Abstract ID 11246)

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MODE WATERS: THE UPTAKE WINDOW OF NATURAL AND ANTHROPOGENIC CO2 INTO THE OCEAN INTERIOR

Is the ocean uptake of CO2 changing? And in particular, is it changing in mode water formation regions which research over the last several decades has revealed to be regions of large uptake of anthropogenic CO2? We have been measuring dissolved inorganic carbon (DIC) repeatedly at a series of hydrographic/hydrochemical station along 15°E in the western North Pacific since 1994. At 30°N for example, salinity-normalized preformed DIC (= DIC - [117/170]*AOU) shows a significant trend toward increased concentrations of order +1.1 to +0.6 µmol kg−1 year−1 on isopycnals in NPISTMW and NPCMW, respectively. The rates of increase of preformed DIC are compatible with the rate of increase of atmospheric CO2 concentrations, and indicate that the large volume of waters in these density classes...
are absorbing and transporting anthropogenic carbon from the atmosphere into the ocean interior. A preliminary analysis of pCO$_2$ from the LEDEO database [Takahashi et al., 2009] for the NPSTMW formation region in winter also shows that CO$_2$ in surface water at 25.2σ$_{θ}$ is increasing at a similar rate to that of the overlying atmosphere. (Abstract ID 10130)

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**IMPACT OF AN EXTREME FLOODING EVENT IN THE HUDSON RIVER WATERSHED CAPTURED BY THE RIVER AND ESTUARY OBSERVATORY NETWORK**

Hurricane Irene passed through New York State on August 28, 2011, severely affecting the Hudson River ecosystem. The assorted automated sensors systems comprising the River and Estuary Observatory Network captured various impacts of this extreme episodic event at several locations within the Hudson River watershed. Water current increased substantially at all sites (e.g., from 30 cm/s to 2.5 m/s at Albany, NY), with water levels peaking near their historical highs. The high current briefly overwhelmed the tidal influence at a monitoring site in the Hudson River watershed and pushed the salt front downstream. Suspended sediment concentrations also increased dramatically (e.g., from 10 µL/L to 130 µL/L at Fort Edward, NY). The contribution of these extreme storm effects to the overall loading comparable to the long-term effects of sediment transport under ordinary conditions. Many climate change models predict increased severity and frequency of extreme wet weather patterns in the near future. This suggests that effects of episodic events should be considered as part of ecosystem management during activities such as navigational channel dredging, remediation projects, and long-term water usage and discharge control. (Abstract ID 10597)

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**A ROLE OF THE YELLOW AND EAST CHINA SEAS ON THE DEEPENING OF WINTER MIDLATITUDE CYCLONES PASSING OVER THE EAST ASIA**

To investigate whether or not the Yellow and East China Seas (YECS) play an active role on the SLP field over the East Asia during winter, a regional numerical atmospheric model validated carefully by observed SLPs is adopted to find conditions favorable for the development of midlatitude cyclones. The modeled SLP fields demonstrate that the midlatitude-cyclone activity is moderate over the YECS because areas with the lower-level baroclinicity enhanced above these oceans are transferred as far as the shelf break of the East China Sea due to intense northerly surface winds. Based on the numerical model results, it is found that northerly surface winds weaken in accordance with the decrease of upper-level wind speeds, and that this weak surface wind condition is required for the YECS to enhance the lower-level baroclinicity. However, the lower-level baroclinicity above these oceans alone is almost incapable of developing midlatitude cyclones. It does an efficient job for the winter East Asian weather only when the lower-level baroclinicity above the YECS is enhanced concurrently with that above the YECS. (Abstract ID 10830)

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**SELF-ORGANIZED SYSTEM OF JETS, WAVES AND EDDIES OFF CALIFORNIA**

The analysis of SSH altimetry observations (1992-2009) demonstrated that mesoscale flow off California presents a self-organized system containing quasi-zonal jets, bi-annual oscillations, annual and semi-annual Rossby waves as well as mesoscale eddies. This system was driven by near-resonance interactions between flow scales. Quartet (modulation) instability dominated and caused a non-local transfer of energy from waves and eddies to annual oscillations and the jets. Quartet instability required a certain level of dissipativity in the flow because it controls the number of near-resonance quadrants involved in the nonlinear energy transfer from fast to slower time scales. Inter-scale interactions stimulated phase synchronization locking at certain scales. The locking resulted in narrower and sharper mesoscale spectra, i.e. it was an effective nonlinear mechanism for scale selection and amplification. Although the quasi-zonal jets have a considerably weaker signature in SSH anomalies in comparison to Rossby waves, the jets seem to be a necessary dynamical component of ocean circulation: the jets actually act as a catalyst, helping waves and eddies to exchange energy amongst themselves. The role of jets as barriers for meridional transport in the CCS is secondary. (Abstract ID 10882)

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**DYNAMIC AND THERMODYNAMIC CONTROLS OF ENSO ASSOCIATED ANOMALIES OF THE UPPER OCEAN HEAT UPTAKE IN TROPICAL PACIFIC**

The upper ocean heat budget in Tropical Pacific is evaluated using results from an ultra-high-resolution global climate simulation with a development version of Community Climate System Model (CCSM4 - HR). First, the model upper ocean hydrography and ocean mixed layer (OML) temperature budget is validated via extensive comparison with Tropical Atmosphere Ocean (TAO) observations. The model is consistent with earlier studies where the mean annual upper layer thermal balance is dominated by warming from the atmosphere and cooling by the entrainment and upwelling of deeper waters. The changes in the upper ocean heat budget during different phases of ENSO cycle are analyzed via composite analysis of the budget components. The relative role of the thermodynamic (i.e. air-sea heat fluxes) and dynamic (i.e. ocean heat advection) processes for the upper ocean heat content anomalies is evaluated. The advantages of eddy-resolving ocean for the heat budget simulation is evaluated via comparison of the model results to the lower resolution version of the model (CCSM4-LR). (Abstract ID 12623)

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**BIOPROBES AND RECEIVERS IN THE OCEAN TRACKING NETWORK (OTN): GREY SEALS AS BIOLOGICAL AND OCEANOGRAPHIC SAMPLERS**

OTN Canada is a 7-year strategic research program using acoustic and other telemetry technologies to better understand species life histories and changing marine ecosystems across Canada. In the Atlantic, we are advancing the use of acoustic bioprobes: animals that carry tags which record movement paths, oceanographic data, and interactions with other tagged animals to complement measurements from fixed OTN arrays. Grey seals, which reliably return to Sable Island to breed (permitting tag recovery), allow beta-testing of VEMCO Mobile Transceivers (VMTs), coupled with Satellite-GPS transmitters, to study spatial-temporal patterns of social interactions and prey encounters by a wide-ranging, large marine predator, as well as their movements and foraging distribution in relation to fine-meso-scale seasonal oceanography in eastern Canada. Results are providing insights into foraging ecology, potential prey interactions, and predator associations at foraging grounds. Concurrently, sampled temperature and light data are being used to validate oceanographic models. With future development of fully-integrated VMTs (data uploaded in real time), this novel use of large animals as bioprobes can be extended to studying other ocean arenas and predators where tag recovery is uncertain. (Abstract ID 11999)

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**A REGIONAL AIR–SEA COUPLED MODEL ADOPTED OVER THE WINTER YELLOW AND EAST CHINA SEAS**

In regions of strong sea surface temperature (SST) fronts such as Yellow and East China Sea (YES) shelves, surface winds are positively correlated with SST. In the winter YES shelves, SST is also determined by surface winds due to the surface heat flux and wind-driven ocean currents over the shallow shelves. It is therefore anticipated that SST over these areas is determined by an air-sea coupled process, and so we have established a regional air-sea coupled model to examine how SST in the YES is controlled by the coupled process. The coupled model consists of MM5 and POM. The MM5 provides POM with surface heat, freshwater and momentum fluxes, while POM gives SST as a lower boundary condition of MM5. It is interesting that the SST in the coupled model is closer to the observed one than that computed in the uncoupled POM. (Abstract ID 10838)

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**VERTICAL DISTRIBUTIONS OF AGGREGATE PARTICLES AND IMPLICATIONS FOR ZOOPLANKTON FEEDING IN THE EUHOPHIC ZONE**

We have been sampling particle size distributions in conjunction with salinity, temperature, fluorescence, and backscatter in the upper 100 m of the water column off California at hourly intervals using the profiling SOLOPC float. We have been able to separate out an aggregate
component and follow its properties. The aggregate component differs from the fluorescence in its vertical distribution. There is a sharp decrease in aggregate concentration below its maximum, consistent with the particle consumption by flux feeders. We have preliminary indications of the presence of zooplankton in this region of decreasing particle concentration. Model results show quite different depth distributions of particles and zooplankton for grazing for filter feeders eating phytoplankton and for flux feeders eating falling particles. These modeling results help explain the observed vertical patterns. Our results contribute to a better understanding of processes affecting the flux of material, including carbon, out of the euphotic zone. (Abstract ID 12001)

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BIO-PHYSICAL INTERACTIONS BETWEEN THE AGULHAS CURRENT AND AGULHAS BANK, SOUTH AFRICA, IN SEPTEMBER 2010

The distribution of plankton and sediments on the Agulhas Bank is highly variable and can evolve quickly, most likely due to strong coupling with the Agulhas Current and other physical processes. The Agulhas Bank is a continental shelf that extends south from the South African coast. The bank intersects the Agulhas Current, a western boundary current, to the east and the Benguela Current, an eastern boundary current, to the west. Here we examine both physical (e.g., CTD and ADCP) and biological (e.g., fluorescence and nutrient) data collected on an oceanographic cruise in September 2010 as part of the African Coelacanth Ecosystem Program (Phase II). A Natale Pulse occurred during the cruise that brought the Agulhas Current onto the Agulhas Bank. This event had significant impacts on the physical and biological processes of the eastern Agulhas Bank by sweeping plankton from the bank into the open ocean. Linear internal waves were also observed within the stratified thermocline inshore of the Agulhas Current. These waves are within the euphotic zone and appear to concentrate phytoplankton at their crest. The formation of these internal waves and the impact they have on the Agulhas Bank ecosystem will be discussed. (Abstract ID 11152)

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SCALES, A NONLETHAL ALTERNATIVE TO MUSCLE TISSUE FOR OBSERVING 13C AND 15N STABLE ISOTOPES OF ATLANTIC CROAKER

Stable isotopic ratios of carbon (δ13C) and nitrogen (δ15N) were analyzed in fish scales and muscle tissue of Atlantic croaker, Micropogonias undulatus, to determine whether scales can be used as a nonlethal alternative for dietary reconstruction. Combined δ13C and δ 15N isotopic ratios can be used to investigate spatial and temporal dietary patterns of consumer species. Forty-eight juvenile Atlantic croaker were collected from estuarine habitats along the southern Texas coast. Paired analyses of muscle tissue and scale stable isotopic ratios for each fish indicated a positive linear correlation for both δ13C and δ15N. From measured δ15N values, a trophic level of 3.5 was estimated for the croaker when compared to published isotope values for common dietary items in the region. Through gut content analysis provided a shapshot of the Atlantic croaker's diet which included shrimp, isopods, crab, squid, and fish. Tissue stable isotopes provided a time-integrated measure of assimilated diets. Our results show that Atlantic croaker scales are a viable non-lethal alternative for food web studies using stable isotopic ratios to reconstruct trophic dynamics. (Abstract ID 10652)

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CIRCULATION AND MIXING IN GREENLAND'S GLACIAL FJORDS INFERRED FROM PATHWAYS AND TRANSFORMATION OF GLACIALLY MODIFIED WATERS

Recent studies indicate that the ocean plays a key role in the mass-balance of the Greenland ice sheet through submarine melting of outlet glaciers. These glaciers drain the ice sheet into deep, strongly stratified fjords, many of which are characterized by a subsurface layer of warm, Atlantic-origin water. Greenland's glacial fjords cannot be explained by traditional paradigms because significant density modification and forcing occurs at the glacier front from melting and from the addition of glacial runoff. Despite the importance of understanding the oceanic heat transport to glaciers, little is known about the basic dynamics of such fjords. Here we use hydraulic surveys of two fjords in southeastern Greenland (Sermilik and Kangerdlussuaq fjords, which drain Helheim and Kangerdlussuaq glaciers, respectively) collected from 2008 to 2011, together with continuous records from moored instruments, to identify glacially modified waters and trace their evolution into the ambient stratification. We then use these export pathways of glacially modified water to diagnose the circulation and mixing patterns within the fijords. (Abstract ID 10693)

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TURBULENCE CONTROL OF FLOC SIZE IN THE RIVER-ESTUARY TRANSITION ZONE (RETZ)

The RETZ plays a significant role in the formation and evolution of flocs whose properties vary on short temporal and spatial scales. Quantifying floc properties and floc dynamics in relation to the physical forcings is key in determining the transfer flux of SPM from the catchment to the coastal ocean. The transfer of SPM in the RETZ is a result of advection, resuspension and aggregation related to turbulence and salinity. Variations in the turbulence regime are one of the main determinants of floc properties, thereby having significant control on the fate of the transfer of terrestrially derived organic matter to the coastal ocean. (Abstract ID 10159)

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PREDICTABILITY OF FROGENESIS FILMAMENTS IN THE MIXED LAYER

One class of submesoscale features are upwelling filaments along the boundaries of eddies, and these features are on the order of 10 to 20 km across and hundreds of kilometers in length while persisting for days to weeks. The initial conclusion would be that these features are unobservable by typical observations and would be entirely unconstrained in ocean model predictions. However, the mechanism generating these filaments is frontogenesis involving the geostrophic flow advecting horizontal buoyancy gradients creating an ageostrophic upwelling that thrusts the mixed layer (initially described by Hoskins and others related to atmospheric frontogenesis). Because generation is deterministically linked to the mesoscale eddy field, these unobservable filaments are generated in the same locations if the eddy field is positioned correctly. A series of observation system simulation experiments is conducted with a 3km resolution ocean model from June 2004 through December 2005, a time with four operating altimeter satellites allowing for evaluation of relative error levels in deterministic and nondeterministic processes. The results show the frontogenesis filaments are reproducible if the mesoscale field is constrained. Dramatic effects on acoustic propagation are also demonstrated. (Abstract ID 11227)

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POPULATION GENETICS OF DEEP-SEA LIMPETS FROM HYDROTHERMAL VENTS IN THE SOUTHWESTERN PACIFIC

Hydrothermal vents are discrete and ephemeral habitats that support chemosynthetic communities. Marine invertebrates ensure gene flow and dispersal from one location to another through larval and other dispersive life-history stages. Barriers or filters that might impede dispersal include behavioral adaptations at local scales and, at regional scales, advection by deep-sea currents, obstruction by geomorphological features, and isolation by distance between sites. This study used partial sequences of the mitochondrial gene cytochrome oxidase 1 (COI) to test for population structure and gene flow at multiple spatial scales in the limpet species Oligasaris tommanni collected from Manus and Lau Basins (~3500 km apart) in the SW Pacific. Within Manus Basin, we tested for population structure within and among three discrete sites at scales ranging from a few meters to approximately 40 km. COI haplotypes were analyzed to determine nucleotide diversity, haplotype diversity, Tajima's D values, and pairwise FST. No evidence for genetic differentiation was detected at any spatial level considered. These findings suggest that the gene flow among O. tommanni populations is uninhibited within Manus Basin and between Manus and Lau Basin. (Abstract ID 10274)
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Copper is essential for the nitrogen cycle, being required for the enzymes associated with nitrous oxide and nitrite reduction and the first step in nitritation, ammonium oxidation. Recent studies have suggested that the demand for copper may be particularly high in some ammonium oxidizing archaebacteria, which also employ copper-dependent mechanisms for other processes. The organic speciation of copper was characterized in the eastern tropical South Pacific Ocean (ETSP), which is the site of one of the world’s largest oxygen minimum zones, and in Washington’s Hood Canal from late January to early March 2010 and in July 2011, respectively. Results indicate that free copper is exceedingly low in zones of high nitritation activity. In the ETSP, free Cu was much lower within the primary nitrite maximum than anywhere else, including the underlying, reducing oxygen minimum zone. This study compliments other work to study the Cu requirements associated with denitrification. The goal of these studies was to investigate the relationship between ammonium oxidation and the concentration of bioavailable copper. (Abstract ID 9942)

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INTENSIVE STUDY OF SWELLS IN THE SEMI-ENCLOSED SEA USING NUMERICAL MODEL AND MEASUREMENT DATA.

Abnormally large swells occurred on the coast of the East Sea on February 24, 2008 and caused a loss of three lives and also damaged several west coasts of Japan. The East Sea is semi-enclosed sea bounded by the west by Korea and on the East by Japan, and swells generated in the center of the East Sea are well recorded with time shift at both coasts. By analyzing these intensive wave observation data and wave prediction model results, detailed swell characteristics can be studied in the East Sea. SWAN model is tested with measurement data of wave directional spectrum as well as frequency spectrum for accurate forecasting of swells in terms of time and location. Transformation of swells from the center of the East Sea to the coasts are examined and used for the alarm system for large dangerous swells. Specially, wave directional spectrum comparison between model results and observation data finds the origin of swells. This study also introduces swell warning system being operated on the west coast of Korea. (Abstract ID 11265)

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ZOOPS-O: A COMBINED WIDE-BAND ACOUSTIC AND OPTICAL ZOOPLANKTON IMAGING SYSTEM.

To obtain abundance estimates of zooplankton in the upper 500 meters a new wide-band acoustic-optic imaging system has been developed. The system uses (4) sonar transducers that produce sound in the range of 1.5 – 2.5 MHz whose data is augmented with monochrome optical images from a system that uses a shadowgraphic technique. Wide-band acoustic offer superior range resolution (~1.5 mm) with the additional potential to measure organism thickness. High transmit power and low-noise receive electronics permit reflections from superior range resolution (~1.5 mm) with the additional potential to measure organism concentration of bioavailable copper. (Abstract ID 9942)

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DISOLVED IRON REDOX CHEMISTRY IN THE OXYGEN MINIMUM ZONE (OMZ) OF THE COSTA RICA UPWELLING DOME.

Disolved Fe and Fe(II) concentrations were measured in the Costa Rica upwelling dome along with oxidation rate studies of Fe(II) in the surface seawater and oxygen minimum layer in July 2010. The OMZ is a well-demarcated feature characterized by high rates of denitrification, and a deep nitrate maximum coinciding with oxygen levels below 1 mmol L-1. A Fe(II) maxima as well as a total dissolved Fe maxima coinciding with the secondary nitrate maximum and oxygen minimum layer was observed. The presence of a surface Fe(II) maxima was also reported. During the oxidation rate measurement studies, the OMZ Fe(II) signal behaved similarly to the added Fe(II) signal whereas the surface Fe(II) signal did not behave like the added Fe(II). Addition of EDTA led the OMZ Fe (II) signal to decay rapidly, the surface Fe(II) signal did not. This leads us to believe in the authenticity of the OMZ Fe(II) signal whereas the surface water signal could be a “tolumin- reactive” species. These results specify the importance of Fe redox status in understanding the relationship between nitrogen cycle and Fe distribution in the ocean. (Abstract ID 9958)

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ANNUAL DYNAMICS OF CARBON TO CHLOROPHYLL RATIO IN TEMPERATE COASTAL WATERS.

The seasonal patterns in the phytoplankton carbon to chlorophyll ratio (C:Chl) was analyzed in samples collected from 22 stations during 1990 to 2009. A total of 6100 samples were included in the analysis. C:Chl values were lowest during winter and displayed approximately the same values of about 12 regardless of season. During the spring season C:Chl increased and reached maximum summer values between 25 and 80 depending on the station. The maximal C:Chl values were highest at the open water stations and lowest at the estuarine stations. After the maximum summer values, the C:Chl returned to the general winter value of 12 in the early winter. The maximal C:Chl varied with environmental variables. The best correlation was found for C:Chl and the average annual mean total nitrogen concentration. A simoidal model was fitted by month to C:Chl to predict C:Chl from observed annual mean total nitrogen concentrations. We also show an increase in summer C:Chl of 1 during the past 20 years corresponding to reductions in nitrogen loadings as a result of national action plans to reduce nutrient loadings (Abstract ID 11993)

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MONITORING THE DIFFUSE ATTENUATION COEFFICIENT KD IN OPEN AND TURBID WATERS FROM OCEAN COLOR IMAGES USING A NEURAL NETWORK INVERSION.

The fine-scale study of the diffuse attenuation coefficient, Kg(λ), of the spectral solar downward irradiance is only feasible by ocean color remote sensing. Several empirical and semi-analytical methods were developed for the past three decades. However, most of these models are generally applicable for clear open ocean waters. They show limitations...
Waves and currents measured on a steep, reflective beach

A field experiment was performed on Carmel River State Beach, CA in June-July, 2011, to examine cross-shore exchange processes on a steep, reflective beach without subaerial bars, using a cross-shore array of co-located pressure and velocity sensors. The beach profile consisted of a 1:7.6 subaerial beach slope, 1:3 subaqueous beach step, and 1:19 subaqueous beach profile. The reflection (R) of shoreward surface gravity wave energy is approximately 0.65 for the sea-swell (0.05-0.15 Hz) frequency band, which increases for low amplitude, long period swell waves. Excluding long period waves, T > 11s, most of the E-variability is tidally related, which cannot be explained by changes in the beach profile steepness. The vertical structure of the cross-shore and alongshore currents associated with the “large swash zone” currents are similar to observations within dissipative “surf zones.” The undertow profile directly outside of wave breaking is non-existent. However, further offshore, the vertical velocity structure is similar to dissipative beaches and increases with increasing wave energy. The effect of wave reflection on cross-shore exchange will be presented. (Abstract ID 10221)

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Further statements about the consistency of the utilized observations and the quality of the applied forcings can be made. (Abstract ID 11137)

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Recent observations of warm and saline under-ice cross-shore transport on the Laptev Sea shelf

The Laptev Sea shelf is strongly impacted by the Lena River freshwater runoff and is an important ice formation and export region. In 2009, anomalously warm and saline waters likely with basin origin, were distributed over the shelf and changed the hydrography for > 1 year. In early 2010, oceanographic moorings recorded the arrival of the anomalies on the inner shelf in form of a near-bottom under-ice gravity current, as a response to offshore winds and ice drift. Sea ice linked with winds and currents, allows insight into the processes leading to cross-shelf and vertical transport. For instance, near-shore polynyas and enhanced ice drift in early winter lead to lateral and vertical buoyancy fluxes, mixing and redistribution of fresher surface waters.

Despite ice formation, bottom waters became less dense, which is opposite to the commonly observed dense water formation in other polar regions. Once landfast ice had established, ice drift was limited towards offshore, and currents were governed by near-bottom onshore flow. Our observations show a vigorous under-ice circulation with implications for heat and nutrient budgets on the Laptev Sea shelf. (Abstract ID 10165)

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Comparison of Bed Roughness and Hydrodynamics Observations for Four Tropical Reefs

Since the rugosity of coral reefs remains unchanged over hydrodynamically relevant timescales, measurements of fixed-bed roughness can be more suitable for modeling wave and current processes than the variable wave friction factor and hydraulic roughness typically obtained from water column observations. However, in coral reef environments, there are no dependable parameters that can relate physical length scales with hydrodynamic roughness scales. To further our understanding of the relation between seabed roughness and hydrodynamic processes, we have carried out observations of fixed-bed roughness, wave and current characteristics around four tropical reefs in Oahu and Palau. The reefs have diverse levels of bed roughness and are exposed to different wave and current forcing, ranging from high wave energy on Oahu’s North Shore to very low energy on Palau’s west coast reef lagoon. High resolution fixed-bed roughness measurements were collected using a narrow beam altimeter mounted on an AUV, while hydrodynamic observations were obtained using a combination of bottom mounted and AUV-based acoustic instruments. Here we focus on the AUV-based roughness measurements and address the spatial structure of the hydrodynamic response. Spectral and cluster analysis techniques are employed to try to identify relevant length scales that could be related to the hydrodynamic response through mechanisms such as wave dissipation and current boundary layer structure. (Abstract ID 11406)

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Snapshots of mixing over the East Flower Garden Bank under different flow conditions

The East Flower Garden Bank (EFGB) is a coral reef located near the shelf edge in the northeastern part of the Gulf of Mexico, and it is a part of the Flower Garden Banks National Marine Sanctuary managed by the National Oceanic and Atmospheric Administration. Major and minor axes of the bank are aligned with the longitude and latitude, respectively. The bank top rises from water depths of 100 – 130 m to about 18 m below the sea surface. In June and August 2011, the Naval Research Laboratory collected microstructure observations over the bank. Several sections, mainly along the minor axis, were completed to evaluate the spatial structure and strength of mixing under different flow conditions. These observations indicate that mixing strength and its spatial distribution depend strongly on the currents. For the similar flow conditions, the largest energy dissipation rates and eddy diffusivities were always found on the lee side of the bank. The strength of mixing was well correlated with current speeds. Weak currents, as those observed in August, were accompanied by significantly subdued mixing over the EFGB. (Abstract ID 10356)

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Demographic control in Mnemiopsis leidyi population dynamics revealed by high frequency observations

Growing attention has focused on frequent outbreaks of gelatinous carnivore zooplankton observed in coastal areas worldwide. Although these phenomena might have broad ecological implications, the triggering mechanisms of both the onset and the end of such events remain equivocal. Here we examine daily variations of the ctenophore Mnemiopsis leidyi abundance and its relation to environmental conditions and food availability. The period investigated encompasses the beginning and the decline of the population outbreak. We show a sharp succession in the population size structure and that the rate of change in developmental stages correlates with food availability, temperature and salinity. Concurrent with the population ageing (i.e. dominance of adult stages and large sizes) the zooplankton abundance markedly dropped. This is followed by an enhanced decline of M. leidyi abundance that increases along with the population size structure and strength of mixing under different flow conditions. These observations indicate that mixing strength and its spatial distribution depend strongly on the currents. For the similar flow conditions, the largest energy dissipation rates and eddy diffusivities were always found on the lee side of the bank. The strength of mixing was well correlated with current speeds. Weak currents, as those observed in August, were accompanied by significantly subdued mixing over the EFGB. (Abstract ID 10356)

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EFFECTS OF REDUCED SUMMER SEA ICE ON WALRUS DISTRIBUTION AND BENTHIC FORAGING PATTERNS

The Pacific walrus feeds on benthic invertebrates of the continental shelf and rests upon sea ice between foraging trips. However, the lack of sea ice over the Chukchi Sea shelf in recent summers has caused female and young walruses to use coastal resting grounds for periods of up to three months. We used satellite telemetry data to compare movements and foraging patterns of walruses using coastal haul-outs during ice-free periods with those of walruses using offshore sea ice haul-outs when ice was present. Walruses swim greater distances to prey patches when using coastal haul-outs than when using offshore sea ice. Both near shore and offshore foraging generally occurred in areas of high benthic biomass, but foraging associated with coastal haul-outs in northwest Alaska occurred in the coastal domain where the relative abundance of preferred prey and benthic production is low. These changes to walrus distribution and foraging patterns likely affect their bioenergetic and population growth and are a direct effect of sea ice loss. (Abstract ID 10764)

SEPARATING DECADAL-SCALE FLUCTUATIONS FROM LONGER-TERM TRENDS IN TIDAL PROPERTIES

Extraction of secular trends in tidal properties from tidal records has more in common with determination of mean sea level (MSL) trends than simply use of the same data. Both require ~50yrs of data to extract a valid trend and/or trend acceleration, and both suffer difficulties in trend extraction due to limited length of record (LOR) and the presence of multiple-scale “noise.” The simplest remedy is to lengthen the record. Thus, we have recovered data from 2-18 yr records from the mid-19th Century, and there are ~1500 station-years of tidal data in the Pacific and North America to be recovered. For extracting tidal trends, nodal cycle variability can be removed using admittances. Analysis then show a significant correlation between admittance and MSL anomalies that are (in part) related to climate fluctuations. Exploration of fluctuations in tidal properties on decadal time scales is vital, because their removal improves trend extraction, and because this exercise provides insight to the causes of secular trends. Finally, empirical mode decomposition provides a convenient method for separating scales of variability and defining trends. (Abstract ID 12045)

TRACING THE CIRCULATION AROUND FUKUSHIMA

Following the release of radioactive isotopes from the Fukushima nuclear power plants, we undertook a cruise to sample the ocean waters off the eastern coast of Japan. As part of this effort, 24 surface drifters were deployed and subsequently tracked. The trajectories of these drifters indicate that much of the contaminated water was being pulled away from the coast on the northern side of the Kuroshio Extension. However, some of the drifters stayed in the coastal region suggesting that some contaminated water may recirculate in this area before being washed off-shore. The absence of drifter crossings across the Kuroshio Extension core suggests that it inhibits the southward spreading of contaminated water, at least over the western Pacific ocean. Measurements of different radioactive contaminants seem to agree with our interpretation based on drifters. Using the drifter trajectories, we test and validate methods to extend the tracking back to the initial releases and into the future to track the fate of the contamination. (Abstract ID 10759)

THE WOODS HOLE PARTNERSHIP EDUCATION PROGRAM: INCREASING DIVERSITY IN THE OCEAN AND ENVIRONMENTAL SCIENCES IN ONE INFLUENTIAL SCIENCE COMMUNITY

A consortium of public and private institutions created the Woods Hole Partnership Education Program, or PEP, in 2008. Participating institutions are the Marine Biological Laboratory, Northeast Fisheries Science Center of NOAA/AS National Marine Fisheries Service, Sea Education Association, U.S. Geological Survey, Woods Hole Oceanographic Institution, the Woods Hole Research Center, and University of Maryland Eastern Shore. Aimed at college juniors and seniors, PEP is a four-week course and a six-to-eight-week individual research project under the guidance of a research mentor. Investigators from the science institutions serve as course faculty and research mentors. We listened to experts regarding critical mass, mentoring, adequate support, network recruitment, and built a program based on those features. We have a program that works with its own model for choosing applicants and for matching with mentors. We continue fine-tuning our matching process, enhancing mentoring skills, preparing students for a variety of lab cultures, and setting expectations high while remaining supportive. Our challenges are to keep it at, using leverage instead of capacity to make a difference. Collaboration, not competition, is key since a rising tide floats all boats. (Abstract ID 12171)

THE EFFECT OF OIL AND DISPERSED OIL ON MICROBIAL PRODUCTION AND CARBON FLOW

Oil from the Deepwater Horizon spill may have competing effects on microbial production in the Gulf of Mexico. On the one hand, oil may serve as a dissolved organic carbon source and might stimulate bacterioplankton production, especially by those organisms capable of direct degradation of hydrocarbons. In contrast, oil and dispersed oil may be directly toxic to microorganisms, both autotrophic and heterotrophic. Both of these processes may change microbial community structure and alter biogeochemical cycles. Direct effects of oil and dispersed oil on bacterioplankton (3H-leucine incorporation) and phytoplankton production (14C-bicarbonate production) were examined. In addition, we examined the effect of oil and dispersed oil on extracellular release of carbon by phytoplankton and subsequent uptake by bacterioplankton in three locations in the northern Gulf of Mexico. In general, phytoplankton production was more sensitive to oil and dispersed oil than was bacterioplankton production. While oil reduced carbon fixation, it had minimal effect on extracellular release of fixed carbon but bacterioplankton took up less of the released carbon, perhaps as a result of substrate
competition with oil carbon. (Abstract ID 10651)

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FROM LAB TO LAUNCH: INTEGRATING BIOMARKERS DERIVED FROM GENOMICS AND PROTEOMICS APPROACHES INTO REMOTE OBSERVING PLATFORMS

Genome-scale data from phytoplankton has rapidly increased in the last decade as a result of new sequencing technologies and funded efforts to sequence organisms important in marine biogeochemical cycles. More recently, new technologies are being used to profile expressed genes and proteins in biogeochemically important organisms under conditions that influence productivity and export (e.g. nutrient limitation). These methods provide an unbiased approach to identify biomarkers that can be used to indicate the physiological status of an organism in the environment. By taking advantage of the ability of phytoplankton to sense their environment, these methods can also be used as potential sensitive indicators of in situ chemical conditions. As remote observing systems come online, these methods can be combined with high throughput measurements of ocean chemistry and cell enumeration technologies to profile biological response over unprecedented temporal scales. We will discuss examples of potential biomarkers identified using new sequencing methods and speculate on approaches for integrating these into remote observing platforms. (Abstract ID 11862)

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COUPLED MODELING OF AIR-SEA INTERACTION IN THE INDIAN OCEAN DURING MJO EVENTS IN 2009

Application of a regional fully coupled atmosphere-ocean-wave modeling system (COAMPS) to the spring and fall of 2009 onset of the Wytville jet in the Indian Ocean is discussed. The atmospheric model covers the tropical Indian Ocean with a resolution of 27 km with an inner nest covering the area from 66°E to 85°E, 10°S to 5°N with a higher resolution of 9 km. The ocean model is the Naval Coastal Ocean Model (NCOM) with a 1/8° horizontal resolution, and 60 vertical levels. Using 0.5 m resolution in the upper 10 m enables the ocean model to have a well defined diurnal cycle in the mixed layer and capture barrier layer variability. Strong zonal easterly winds along the equator, associated with the Madden-Julian oscillation, cause the diurnal cycle of sea surface temperature to vanish and provide strong vertical mixing. Compared to global models such as the Navy Operational Global Atmosphere Prediction System (NOGAPS) for the atmosphere and the Global Navy Coastal Ocean Model (G-NCOM) for the ocean, the models used to provide lateral boundary conditions, agreement with observations is significantly improved. (Abstract ID 11465)

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IMPACTS OF OCEANIC CURRENTS ON THE M2 INTERNAL TIDE IN THE EAST/JAPAN SEA

The M2 internal tide in the East/Japan Sea is investigated using a high resolution numerical model (RIAM Ocean Model) which has been used for the real-time ocean forecasting system of the East/Japan Sea at RIAM. The model assimilates satellite-measured sea surface temperature and height every day, which produces realistic background fields of oceanic current and stratification. It includes tidal forcing estimated from NAO.99b regional ocean tide model along open boundaries. The study period is from September 2005 to August 2009. Surface tides reproduced in the model agree well with in situ measurements from coastal tidal gage, satellite altimetry, shipboard ADCP across the Korea/Tsuchima Straits, HF radar, and current moorings in the Ulleung Basin. Annual average of the first-mode M2 internal tidal energy computed using numerical model outputs is consistent with previous observation in the Ulleung Basin. Monthly-mean patterns of M2 internal tide distribution reveal close relationship with changes of background current and stratification fields. We present the impact of background fields on the energy transfer from barotropic to several modes of baroclinic M2 tide in the East/Japan Sea. (Abstract ID 10889)

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NEW FINDING OF THE NORTH EQUATORIAL UNDERCURRENT IN THE WESTERN PACIFIC OCEAN

Currents obtained from moored ADCPs were analyzed from October 2007 to May 2011. Three subsurface moored buoy systems are located approximately across the Subtropical Countercurrent (STCC), near the northern boundary of, and at the center of the main axis of North Equatorial Current (NEC), respectively, in the western Pacific Ocean. Under the prevailing westward-flowing NEC, the eastward-flowing STCC and the North Equatorial Undercurrent (NEUC) sometimes appeared in the surface and in the subsurface layers, respectively, with an intra-seasonal time scale. While STCC appears as the result of vertical shear in the STCC-NEC system due to local wind stresses, NEUC seems to appear as the result of the combination of equatorial current system and local geostrophic balance. However, it needs more systematic survey whether NEUC is totally fed from the convergence of the Luzon and Mindanao Undercurrents or not, what drives NEUC in a variable intra-seasonal time scale and how far it continues to flow eastwards, and under what condition it disappear in the western boundary region and so on. (Abstract ID 10158)

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OPEN OCEAN INFRARED AND NEAR-SURFACE OBSERVATIONS OF SST SPATIAL VARIABILITY

Open ocean observations of SST spatial variability have been limited by several challenges. Airborne measurements using infrared cameras can provide rich detail but are generally limited to coastal regions. Ship-based measurements can cover large distances but are generally limited to one-dimensional samples along the ship track. To overcome these limitations, a balloon-based infrared camera system known as LTARS (Lighter-than-Air Remote Sensing) is deployed with a towed near-surface CTD system known as SSSP (Surface Salinity Profiler) for deployment on the open ocean. This unique combination of measurements will be evaluated on a transit leg from W. Samoa to Hawaii, where conditions of low wind and high solar insolation are likely to result in significant spatial variability. Spatial scales of SST variability will be investigated using infrared images of roughly 100 m x 100 m and near surface temperature profiles from 0 to 2 m depth taken simultaneously for extended periods along the ship track. (Abstract ID 11715)

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The Alaska Department of Environmental Conservation (ADEC) and University of Alaska School of Fisheries and Ocean Sciences, Fairbanks (SFOS), established an Alaska Monitoring and Assessment Program (AKMAP) focused on conducting aquatic-resource surveys of Alaska’s waters. ADEC and SFOS conducted research cruises in the fall of 2010 and 2011 to survey and monitor the state of the Chukchi Sea coastal environment. The purpose of this survey was to assess the water quality and ecological status of waters of the northeastern Chukchi Sea, from Pt. Hope to Barrow, in waters 10–50 m in depth. The 2-year survey was conducted aboard the R/V Nornen II. We sampled 64 stations with the following methods: grab; beam and otter trawls; biological-contaminant samples; and sediment- and biological-isotope samples. We also conducted surveys for marine birds and mammals during transit between stations. The AKMAP assessment estimated the spatial extent of water quality based on stressors such as contaminants, water-quality parameters, and upper trophic level taxa. Findings are anticipated to be available by late 2012. (Abstract ID 9774)
VIRUS-MEDIATED TRANSFORMATION OF ORGANIC CARBON IN THE SURFACE WATER OF THE WESTERN PACIFIC

Marine viruses are known as consumers of their host microbes while viral lysis can release dissolved organic carbon (DOC) into the water as carbon sources for the survived populations to grow up for next cycle. To investigate the effects of this ‘double-edged-sword’ in the field, simulated in situ incubation experiments with natural microbial communities were conducted in the Western Pacific. Initial samples were filtered with 0.2 μm filters and then ultra-filtered (>30KDa) to obtain virus stocks and virus-free filtrates. Incubations were added with natural host bacteria and/or viruses, or added with inactivated-viruses as control. Bacteria, viruses and DOC were monitored for 7 days during the incubation time courses. The results showed that the net increases in bacterial production (BP) in the incubations with active viruses were the highest. Although the host bacteria were subject to high mortality due to viral lysis, BP may be stimulated by viral lysates. Meanwhile DOC concentrations fluctuated but finally increased by the end of the incubation, suggesting somewhat accumulation of refractory-like DOC in the systems. (Abstract ID 10994)

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SEASONAL VARIATION OF EDDY SHEDDING FROM THE KUROSHIO INTRUSION IN THE LUZON STRAIT

Altimeter data and output from the Hybrid Coordinate Ocean Model global assimilation run are used to study the seasonal variation of eddy shedding from the Kuroshio intrusion in the Luzon Strait. The results suggest that most eddy shedding events occur from December through March, and no eddy shedding event occurs in June, September, or October. About a month before eddy shedding, the Kuroshio intrusion extends into the South China Sea and a closed anticyclonic eddy appears inside the Kuroshio loop which then detaches from the Kuroshio intrusion. Anticyclonic eddies detached from December through February move westward at a speed of about 0.1 m/s after shedding, whereas eddies detached in other months either stay at the place of origin or move westward at a very slow speed (less than 0.06 m/s). The HYCOM outputs and QuikSCAT wind data clearly show that the seasonal variation of eddy shedding is influenced by the monsoon winds. A comparison between eddy volume and integrated Ekman transport indicates that once the integrated Ekman transport exceeds 2 × 10¹² m³ (which roughly corresponds to the volume of an eddy), the Kuroshio intrusion expands and an eddy shedding event occurs within one month. We infer that the Ekman drift of the northeasterly monsoon pushes the Kuroshio intrusion into the SCS, creates a net westward transport into the Strait, and leads to an eddy detachment from the Kuroshio. (Abstract ID 9467)

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DISSOLVED ORGANIC CARBON IN EDICARAN-EARLY CAMBRIAN OCEAN

The size and fate of the dissolved organic carbon (DOC) reservoir in late Neoproterozoic oceans and its relationship with the unusual paleoceanographic events remain debated. One of the uncertainties is the temporal evolution of an inferred DOC reservoir orders of magnitude larger than that of the modern ocean. Paired carbonate and organic C-isotope data from the Ediacaran-early Cambrian succession in south China reveal repetitive occurrences of depleted to coupled carbonate-organic C-isotope signatures at the basal Ediacaran (ca. 635 Ma), middle-late Ediacaran (>515 Ma), and basal Cambrian (ca. 542 Ma). In contrast, following these intervals organic C-isotopes are mostly stable. The C-isotope patterns suggest repetitive growth rather than terminal oxidation of the marine DOC reservoir in Ediacaran-early Cambrian oceans. Compilation of existing iron and sulfate data suggests episodic increase of sulfate and iron concentration in proximity of the negative C-isotope excursions but significant drop in iron, sulfate, and other trace element concentrations between these excursions. This phenomenon suggests that the episodic growth of DOC reservoir in Ediacaran-early Cambrian oceans was possibly driven by the switch from sulfate to iron reduction of organic matter in the ocean. The termination of significant DOC growth may have been associated with fundamental changes in marine ecosystems and the sulfate reservoir, which did not happen until the end of early Cambrian (<520 Ma). (Abstract ID 12390)

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COUPLED CIRCULATION AND BIOGEOCHEMISTRY MODELING SYSTEM IN THE CHINA SEA BASIN-SHELF-EstuARY INTERACTION

Semi-enclosed marginal South China Sea and shelf seas of Bohai, Yellow and East China Seas are linked together by Taiwan Strait to form the China Seas (CS). It connects with western Pacific Ocean by shelf break and Luzon Strait, and with terrestrial inputs by big Changjiang and Pearl River estuaries. The circulation in the CS is mainly driven by the south-east Asia monsoon, but largely modulated by intrusive current from Kuroshio on seaside, by buoyancy from the estuaries on landside and by highly variable current associated with flow-topography (effect) interaction over the shelf. This circulation imports chemical constituents of different properties from land and open ocean basin, mixes with waters in the CS and forms an active biogeochemical response. A new three-dimension, coupled physics-biogeochemistry modeling system, which dynamically links processes of heterologous biophysical characteristics and of different spatiotemporal scales in the marginal sea, shelf and estuary of the CS, has been developed to hindcast/forecast the regional ocean circulation and biogeochemical processes. The modeling results are scientifically validated and improved by our seasonal interdisciplinary field measurements, and more importantly by dynamic understanding of Kuroshio-Sea interaction, variable potential vorticity and momentum balances over shelf topography, interactive estuary-shelf process and their associated biogeochemical responses. (Abstract ID 10951)

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EROSIONAL FEATURE EVOLUTION OF FINE SEDIMENTS—CASE STUDY IN THE MODERN YELLOW RIVER DELTA, CHINA

This study was conducted in July 2008 to investigate the sediment erosional features and sediment properties of the modern Yellow River delta at 5 selected sub-deltaic lobes formed respectively in 1929, 1934, 1938, 1976, and 1996. Two typical study areas were selected to carry out detailed physical simulation experiments using a self-designed wave-producer device and a circulating flume in order to reveal the effects of wave loading on sediment erodibility. Sediments deposited in the study site derive from material sourced on the Loess Plateau region. However, going through different deposition history in marine environment, unique local characters appear in the sub-deltaic lobes formed at different times. This suggests that modifications occur in the deposits due to age and diagenesis leading to mechanical properties better resisting erosion, along with the decrease in fine-particle content, increase in sand content, and variation in physical properties of sediments. In the two sites where detailed experiments were conducted it was also observed the important role of the wave loading in changing the erodibility of the deposit. This is in part associated with a partial redistribution of the particles with finer ones moving upward from the underside of seabed and removed by flows. This may lead to increased erodibility of the changed deposits but the increased erodibility can be easily loosened under wave loading actions. (Abstract ID 11046)

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THE IMPACT OF AMBIENT STRATIFICATION ON FRESHWATER TRANSPORT IN A RIVER PLUME

The influence of ambient stratification on the river plume dynamics is studied numerically using ROMS. The shell flow is thermally stratified and retains a 15-m deep upper mixed layer. A buoyant inflow into the model domain is systematically varied in order to obtain buoyant plumes with different vertical structure. Surface-advected plumes spreading on top of the pycnocline are affected by the stratification. Bottom-advected plumes on the other hand deepen the pycnocline which in some cases triggers the instabilities. Initially, the formation of a frontal disturbance occurs downstream of the estuarine bulge, with more eddies developing later along the entire density front. More eddies develop either with a smaller inflow salinity anomaly or with a stronger stratification, while eddies are less developed with a gentler bottom slope. Frontal eddies triggered by the ambient stratification reduce up to 35% the freshwater flux in downstream direction and enhance it in the offshore direction compared to the corresponding nonstratified case. Energy transfer diagnostics indicate that eddies are likely to be produced through the baroclinic instability of the buoyancy-driven current. (Abstract ID 11294)

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SEASONAL VARIATION OF EDDY SHEDDING FROM THE KUROSHIO INTRUSION IN THE LUZON STRAIT

The HYCOM outputs and QuikSCAT wind data clearly show that the seasonal variation of eddy shedding is influenced by the monsoon winds. A comparison between eddy volume and integrated Ekman transport indicates that once the integrated Ekman transport exceeds 2 × 10¹² m³ (which roughly corresponds to the volume of an eddy), the Kuroshio intrusion expands and an eddy shedding event occurs within one month. We infer that the Ekman drift of the northeasterly monsoon pushes the Kuroshio intrusion into the SCS, creates a net westward transport into the Strait, and leads to an eddy detachment from the Kuroshio. (Abstract ID 9467)

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for the East China Sea and Changjiang Estuary has been established, which is comprised of three-domain WRF model and unstructured-grid FVCOM model with the implementation of FVCOM-SWAVE and FVCOM-SED modules to include full physical wave-current-sediment interactions. The unstructured triangle grids not only have the capability for excellent geometric fitting for irregular coastlines and steep topography, but also provide the common-grid method to make domain nesting with mass conservation guaranteed. The core FVCOM model of ECS-CE system contains three sub-models, including East China Sea FVCOM, Changjiang FVCOM and Deep Waterway FVCOM, to consider the regional shelf-scale Kuroshio Current, estuary-scale Changjiang Plume and local-scale small-size eddies within the groynes and dike in the river mouth. The model system has been validated with the observation data of surface wind, tide, wave, current and salinity to reveal correct dynamics around the ECS and CE. The model system is demonstrated with two realistic applications around the Changjiang Estuary, including a strong typhoon impact and the summertime saltwater intrusion within the North Passage of the CE. (Abstract ID 9565)

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LINKING PHYSICAL AND MICRABIAL OCEANOGRAPHY THROUGH PICOPLANKTON EXPORT TO THE DARK OCEAN

Photrophic picoplankton are the major contributors to primary production in the surface ocean, but are overlooked in the deep-sea carbon studies as they are known to be present only in the euphotic zone and are thought to be unsinkable due to their tiny cells. However, we observed abundant planktonic autocorvohphages including Prochlorococcus, Synechococcus and pico-eukaryotes at the depths of 200–2000 m in the South China Sea off the Western Pacific, during 2008-2011. Internal solitary waves and meso-scale eddies are found to be mainly responsible for the transportation of photrophic picoplankton to the dark ocean. Unlike the known mechanisms such as sinking of phytoplankton and aggregates or grazing-mediated transport, our findings suggest a novel mechanism for rapid vertical transportation of picoplankton carbon to the dark ocean where the picoplankton cells are subjected to strong viral lysis that will not only provide carbon sources to the microbial loop but also contribute to the microbial carbon pump through which the organic carbon is ultimately transformed to refractory phase carbon sequestration. (Abstract ID 10865)

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VALIDATION OF CESM ICE-OCEAN MODEL IN THE ARCTIC: UPPER OCEAN THERMOCLINE AND SEA ICE

The heterogeneous sea ice cover, strong haloline and various boundary currents present major challenges to climate modeling in the Arctic Ocean. The results of CESM ice ocean model (POP-CICE) run forced by NCEP reanalysis CORE2 data from 1992-2007 are analyzed and compared with ocean and sea ice observations. Besides validating against ocean temperature and salinity climatology and remote sensing sea ice area and extent, we also picked several time series of observables to check the seasonal cycle of the model performance and upper ocean mixing process. The observational data sets include SHERA 1997-98, and ice based profiling buoys (ITP, J-CAD and POPS) in 2000s are used to validate the simulated upper ocean temperature and salinity profiles and their changes from 1990s to 2000s. Sea ice drift, submarine and moored ULS measurements of ice thickness distribution are compared to sea ice model results. Several model experiments with different configurations of background viscosity diffusivity coefficients and with/without sub-grid scale brine rejection parameterization scheme we developed recently are discussed. Since this is an ongoing study, summary of conclusion will made at the presentation time. (Abstract ID 12451)

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CONTRIBUTIONS TO LARGE-SCALE SEA LEVEL CHANGES IN THE NORTH ATLANTIC OCEAN

Large-scale sea level in the North Atlantic region is studied by using sea surface height (SSH) from the TOPEX/POSEIDON/JASON altimeters and wind stress curl from the QuikSCAT scatterometer and from the European Center for Medium-Range Weather Forecasting (ECMWF). We model SSH changes owing to heating and wind forcing. The steric response to heating shows an annual cycle at low to mid latitudes. On interannual times scales surface heating is an important contributor to SSH anomalies in the eastern basin and is correlated with the North Atlantic Oscillation (NAO). Surface heating contributes to interannual changes, as seen in the first Empirical Orthogonal Function of SSH. Non-steric SSH consists of wind-forced anomalies from westward propagating waves south of 20N, from the baroclinic Sverdrup balance in the subtropics and from the topographic Sverdrup balance in the subpolar. The mean current path from the topographic Sverdrup balance tends to follow the Gulf Stream and the Azores Current, rather than the North Atlantic Current, implying the topographic Sverdrup is important west of the Mid-Atlantic Ridge and the Gulf Stream is constrained by both winds and topography. (Abstract ID 10739)

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DOWNSCALING LONG-TERM VARIABILITY OF SUBSURFACE THERMAL STRUCTURES OT REGIONAL SCALES IN THE SUBPOLAR NORTH ATLANTIC

The subsurface temperature anomaly (STA) were estimated using a multi-linear regression method based on the relations between changes in sea surface height anomaly (SSHA) and sea surface temperature anomaly (SSTA). The multi-linear regression coefficients in different depths were computed using monthly mean Argo data from 2005 to 2010 and applied to satellite altimetry and SSTA measurements from 1993 to 2010 to obtain STA for the same time periods. Then, the large scales of estimated STA and SSHA variability were downscaled to different scales using ensemble empirical mode decomposition method. We found that 1) STA warming trends and associated dominant frequencies are geographically different in the Labrador Sea and the Irminger Sea, resulting from interactions of different water masses from the Arctic Sea and the Gulf Stream, and 2) the decomposed time scales of SSHA and SST showed the southward coastal Kelvin waves, associated with the deep water formations in the Labrador Sea. It suggests that the coastal Kelvin waves generated in the Labrador Sea can be detectable in the regional scales of SSHA in the Mid-Atlantic Bight. (Abstract ID 12208)

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PARTNERING TO BUILD THE GULF OF MEXICO COASTAL OCEAN OBSERVING SYSTEM

The Gulf of Mexico Coastal Ocean Observing System (GCOOS) is designed to empower people, communities and businesses with data and information to improve their decision-making about our lives, work, and play within a healthy ecosystem along the Nation’s Gulf Coast. GCOOS is being built through a partnership of many entities—federal, state, and local governments, academia, NGOs, and private industry—engaging together to provide a sustained, integrated, operational network of observations, data and products for the greater benefit of our society. The GCOOS build-out began in 2007 through integration of an initial set of existing federal and non-federal resources and the development of the GCOOS Data Portal. Using results of discussions with a wide range of stakeholders on their needs for data, information, and products about the Gulf of Mexico, its resources, and its ecosystem, the key elements of the GCOOS Build-Out Plan were determined. The initial system is being enhanced by the integration of additional existing resources into the GCOOS, and the installation of new assets to fill the observational gaps identified in the GCOOS Build-Out Plan. (Abstract ID 10675)

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GLACIAL- INTERGLACIAL CHANGES TO THE AIR-SEA CARBON FLUXES: THE EQUATORIAL HYPOTHESIS

When forced with insolation from 115.000 years ago the new Community Climate System Model (version9) is able to reproduce ice and snow build-up that matches the reconstructions
in pattern and magnitude. We used this model together with the CCSM land and ocean biogeochemistry modules to understand the causes for the 100ppm difference in atmospheric carbon dioxide concentration between 115ka and preindustrial times. As suggested by the proponents of the Southern Ocean Hypothesis CCSM does indeed show a reduced Southern Ocean outgassing when forced with 115ka insolation. This is compensated by increased outgassing in coastal upwelling zones, so that CCSM does not reproduce the observed drop in atmospheric carbon dioxide concentration. However, by replacing the diffusivity based background mixing in the CCSM ocean model with an energy based mixing, we can reproduce the observed drop of approximately 1ppm in 100 years. It is shown that the increased tropical insolation 115 ka leads to an increased tropical stratification which inhibits the diffusion of dissolved inorganic carbon across the equatorial thermocline. This leads to an increased accumulation of abyssal carbon and reduced outgassing along the equator in general, but the equatorial Pacific in particular. We propose to replace the current paradigm of the Southern Ocean Hypothesis with this Equatorial Hypothesis. (Abstract ID 9306)

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NEAR-INERTIAL WAVE DRIVEN MIXING AND CLIMATE

Oceanic uptake in the fully coupled Community Earth System Model (CESM) is addressed through improved representation of near-inertial (NIW) driven mixing. This dynamic control is needed to better resolve some of the observed differences between observed and simulated key property distributions in the ocean, including CFCs. A novel technique to account for the underrepresentation of NIW energy input from wind through a simple modification of the K-Profile Parameterization (KPP) of ocean boundary layer mixing is developed for the latest version of CESM, as well as a parameterization for the NIW induced mixing beneath the mixed layer. The most important impact is a deepening of the mid-latitude mixed layers, and this increased model sensitivity to atmospheric storms increases the thermocline ventilation. The increase in ventilation and mixed layer depth represent a significant improvement of CESM and lead to a more realistic uptake of greenhouse gases in global warming scenarios. Furthermore, NIWs alter the Arctic temperature and nutrient concentration responses to global warming, because the loss of sea ice exposes the Arctic to more NIW induced mixing. (Abstract ID 12172)

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VARIATIONS OF THE DENMARK STRAIT OVERFLOW

Dense water enters the North Atlantic as overflows across the Greenland-Scotland Ridge, where the passage in Denmark Strait is the widest gap. The velocity of the Denmark Strait overflow has been measured in the Strait with two current profiling moorings since 1999 (with several interruptions). The calculated overflow transport exhibits variations on all time scales. Eddy variability dominates the high frequency variations, while interannual variability masks any possible long term trends. Only seasonal variations were found to be of no significance, in contrast to modeling results. The mean overflow transport is 3.3 Sv. Since 2006 data from moored temperature, conductivity and pressure recorders is available as well, monitoring the hydrographic variations of the overflow. In recent years the temperature time series of the Denmark Strait overflow revealed a cooling, while the salinity stayed nearly constant. Events of increased temperatures at the mooring location close to the Icelandic shelf indicated occurrences of Atlantic water intrusions. The deep flow therefore seems to be not independent from the upper ocean variability; the migration of the Inninger Current induces reduced overflow events. (Abstract ID 9695)

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THE BIOLOGICAL FRACTIONATION OF Fe ISOTOPES BY THE DIATOMS T. PSEUDONANA AND T. OCEANICA IN CULTURE

Iron is an important nutrient for life in the ocean, where low Fe concentrations often limit the growth of marine phytoplankton. Fe stable isotope ratios (δ56Fe) are a potentially valuable new tool to study the marine biological cycling of Fe. However, parameters such as the isotope effect for Fe acquisition by phytoplankton must be quantified in order to most effectively use δ56Fe as a tracer for biochemical processes in the ocean. We have measured the biological fractionation of Fe isotopes for the marine diatoms T. pseudonana and T. oceanica in culture. Phytoplankton were cultured in EDTA or NTA buffered media under varying Fe concentrations from Fe-sufficiency to Fe-limitation. Biological fractionation of Fe isotopes was determined by comparing δ56Fe in the media to filtered phytoplankton. The use of a cell wash allows us to distinguish between isotopic fractionation during extracellular adsorption and intracellular uptake. The biological fractionation of Fe isotopes is highly dependent on culture conditions with δ56Fe ranging from -0.1 ‰ to +0.6 ‰ depending on ligand composition, species, and Fe-limitation status. (Abstract ID 11620)

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DETECTION OF FISH BILE METABOLITES BY FLUORESCENCE FROM THE NORTHERN GULF OF MEXICO DEEPWATER HORIZON OIL SPILL

In April-July 2010, the Deepwater Horizon spill released almost 5 million barrels of crude oil into the Gulf of Mexico (GOM). Crude oil is composed of many compounds, including polynuclear aromatic hydrocarbons (PAHs) that fish metabolize and excrete in bile. Bile PAH metabolites can be detected and quantified via fluorimetry to assess PAH and oil exposure. From June 2010 to May 2011, several hundred commercially and recreationally harvested fish including Lutjanus campechanus (Red Snapper), Pagrus pagrus (Red Porgy), and Seriola fasciata (Amberjack) were collected from reefs along the Alabama and Florida coasts. Bile and livers were frozen until analysis. Bile was diluted in methanol and fluorescence was measured at excitation/emission wavelengths of 290/335, 341/383 and 380/430 nm to detect metabolites of 2, 4 and 5 ring PAHs, respectively. Samples were standardized to biliverdin and protein concentrations. Most fish had fluorescence signals consistent with naphthal (a metabolite of naphthalene) in bile indicative of oil exposure. Bile concentrations, in naphthal equivalents, ranged from 30-4000 μmol/l. Additional research on biochemical responses to oil exposure in these fish is ongoing. (Abstract ID 10561)

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RELATIVE CONTRIBUTIONS OF TEMPERATURE AND SALINITY TO SEASONAL MIXED LAYER DENSITY CHANGES AND HORIZONTAL DENSITY GRADIENTS

Temperature and salinity profiles from the Argo Program allow construction and analysis of a global, monthly mixed layer climatology including the effects of temperature and salinity on density. Temperature changes dominate the seasonal cycle of mixed layer density in most regions, but salinity changes are dominant in the tropical warm pools, the Arctic, and the Antarctic. Under the IFZ-C temperature and salinity work in concert to effect the seasonal density changes. In the eastern subtropics seasonal salinity changes partially compensate those in temperature. The times of maximum and minimum mixed layer density exhibit regional variations. For instance, the equatorial region is better aligned with Southern Hemisphere timing, and much of the North Indian Ocean has a minimum density in May and June. Outside of the tropics, the maximum mixed layer density occurs later in the winter, and the minimum earlier in the summer, approaching the poles. At the times of maximum mixed layer density, some, but by no means all, of the ocean has horizontal temperature and salinity gradients that
work against each other to reduce the horizontal density gradient. (Abstract ID 9732)

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**HOW PRECISELY CAN NET COMMUNITY PRODUCTION BE OBSERVED USING OXYGEN SENSORS ON PROFILING FLOATS**

Robust biogeochemical sensors, such as oxygen, simple bioptics and nitrate, now make it feasible to build a sensor network based on profiling floats that could operate on a global scale, similar to the Argo array. A global, biogeochemical network could monitor processes such as Net Community Production (NCP), carbon export to depth, transport of nutrients into the upper ocean, and inter-annual changes in the volume of suboxic water in the ocean. A community based effort to develop such a system, called GLOBE (Global Ocean Biogeochemical Experiment), is proceeding. Critical to the design of such a system and its scientific goals is an understanding of how precisely and accurately these processes can be observed. Continuous records of oxygen on profiling floats operating near Hawaii are now available for 10 years and nitrate records are available for four years. Here we use these records to assess the temporal variability in NCP near Hawaii. Our results indicate that oxygen sensors can constrain NCP to within 15% at the 95% confidence level, if the sensors are properly calibrated. (Abstract ID 10069)

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**UNDERSTANDING OCEAN CHEMISTRY AND BIOLOGY USING REAL-TIME DATA FROM PROFILING FLOATS**

Real-time data play an important role in science education by adding relevance to the learning experience, by enabling self-discovery and inquiry, and by providing opportunity for dialogue between students and researchers (Adams and Masumoto, 2011). Over the past decade, profiling floats (such as Argo) have proven to be excellent platforms for deployment of biogeochemical sensors. Data are available year round and sensors clearly resolve seasonal cycles. Seasonal changes in phytoplankton biomass, uptake of nitrate as an essential fertilizer, and the production of oxygen can all be observed. A global distribution of profiling biogeochemical floats allows students and teachers to contrast processes in the tropics with events at high latitudes. Data streams from profiling floats are well defined, enabling simple, point and click interfaces, such as FloatViz (http://www.oao.obs-vlfr.fr) or OAO (Oceanographic Autonomous Observations, http://www.oao.obs-vlfr.fr/). Examples using data easily accessed from the classroom will be presented. As networks of biogeochemical floats expand, the types of lessons will also expand. We will present our vision for incorporating using data easily accessed from the classroom will be presented. As networks of biogeochemical floats allows students and teachers to contrast processes in the tropics with those that relate to flexion. We extracted data from multiple species across divergent lineages in order to quantify the extent that propulsors exhibit flexile tendencies at or near their tips. Our results indicate an aggregate grouping of the values within restricted ranges for both the flexion angle and the inflection ratio, with low standard deviations within the samples. More studies must be done to evaluate further flexile-scale patterns of propulsor flexion; however, this data suggests that biological propulsion has converged upon similar limits for organisms inhabiting different fluid environments. (Abstract ID 10516)

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**OBSERVATIONS OF MESOSCALE EDDIES NEAR THE BERMUDA ATLANTIC TIME SERIES STUDY SITE AND IMPLICATIONS FOR THE LOCAL HYDROGRAPHY AND NUTRIENT BUDGETS**

Significant long term change in the hydrography of the upper ocean at the BATS site has been documented and appears to be locally forced. However, diagnosed changes in the depth integrated heat and salinity budgets over the sampling period can be much greater than the time integrated surface fluxes. This imbalance is likely due to mesoscale eddies meandering through the local region. BATS cruises typically have a small spatial component often highlighting the extent of this associated eddy variability in the surface mixed layer and underlying STMW. For example, STMW has been observed to vary from the more conventional 200m kbps to non-detectable over distances of 80km while mixed layer depths can vary by greater than 100m over similar distances. We analyze these spatial data in the context of SLA fields and demonstrate that closure of the local hydrography and nutrient budgets over monthly periods can be improved on consideration of upstream initial conditions. Comparisons with hindcast data from ocean assimilation models are also performed to assess the feasibility of a more robust approach for estimating advection at BATS. (Abstract ID 12498)

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**INVESTIGATION OF THE HYPOXIA TOLERANCE OF BLUE CRAB (CALLINECTES SAPIDUS)**

The Chesapeake Bay, one of the world’s largest estuaries, is currently experiencing hypoxia and anoxia. The Bay is the habitat for many organisms, including the blue crab. It was conceived that blue crabs were oxygen consumers and we unable to handle low oxygen environments. Using a respirometer, a crab’s metabolic rate was measured in low oxygenated water. The goal of the research was to identify the critical PO2 where the crab begins anaerobic breathing. Crabs that have been infected with the parasite Hematodinium were also used in the experiments because the disease is extremely prevalent in the species. Through this work, it was concluded that crabs are in fact, oxygen regulators above critical oxygen saturation. Metabolic rate can be increased by Hematodinium infection, feeding, and raised temperature. This research is critical to understanding blue crab conservation and the importance of habitat restoration. (Abstract ID 10851)

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**THE MOLECULAR DIVERSITY AND BIOGEOGRAPHY OF PROCHLOROCoccus, THE DOMINANT OPEN OCEAN PHOTOSYNTHETIC MICROBE**

The marine cyanobacterium Prochlorococcus is the most abundant photosynthetic microbe in tropical and subtropical open oceans and accounts for 5-25% of global marine primary production. This genus is comprised of two major clades, one that is high-light adapted and numerically dominant near the surface and a second clade that is low-light adapted and dominantly deeper in the euphotic zone. However, among these major groups, there are at least 7 genetically distinct clades that have unique environmental distributions and hence are considered ecotypes. Here we report on the distribution of these groups over vast regions of the Pacific and Atlantic Oceans using large scale pyrosequencing, aPCR and metagenomics-based approaches. We show that these distributions are structured along major environmental gradients such as temperature and light, but that there also exists significant molecular diversity within these clades that may further niche partition along theo...
The interpretation of the carbon isotopic composition of sedimentary carbonates and organic matter are central to our understanding of Earth history. For instance, Neoproterozoic carbonates contain dramatic negative isotopic anomalies within long intervals (100-1000 million years) of enriched compositions (roughly 5 permil). Classically, the isotopic composition of carbonates can be linked to atmospheric oxygen accumulation through the stoichiometry of primary production and subsequently, a tight coupling between the isotopic composition of carbonates and organic matter is expected. However, the demonstrable lack of isotopic covariance in Neoproterozoic successions has inspired alternative models for the operation of the Neoproterozoic carbon cycle: one such model posits the presence of a large marine reservoir of dissolved organic carbon (DOC). Here we present carbonate and organic carbon isotopic data from Mongolia, northwest Canada and Namibia that provides an alternative to the large DOC model. Importantly, these data and a new quantitative treatment do not preclude the presence of DOC in the ocean, but simply offer an additional mechanism for producing the observed records. (Abstract ID 9875)

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TUNA-DOLPHIN-BIRD FEEDING ASSEMBLAGES IN THE GALAPAGOS ISLANDS AND THEIR RESPONSE TO THE PHYSICAL CHARACTERISTICS OF THE UPPER WATER COLUMN

Tuna-dolphin-bird feeding assemblages are unique to the Eastern Tropical Pacific Ocean (ETP) and may be associated with oceanographic features. In the Galapagos Marine Reserve (GMR), intra-annual and interannual changes affect these features in the area, inducing mesoscale and fine scale temporal variability which may control the locations of these groups. Data were collected during three four-week cruises between the mainland of Ecuador and the GMR and one small boat survey within the GMR between September 2008 to October 2010. Marine mammal surveys were conducted during daylight hours and CTD casts were taken regularly. Data were analyzed to compare physical features of the water column to the sighting locations. Additionally, these data were used to predict where tuna would be most likely to associate with the presence of DOC in the ocean, but simply offer an additional mechanism for producing the observed records. (Abstract ID 12658)

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ELEVATED MIXING AT A FRONT

The meso-, submeso-, and microscale structure of a front in the California Current was observed using a towed vehicle outfitted with microconductive sensors. Thirteen 60-km cross-front sections from 0-350 m depth were covered in 3.5 days. Objectively-mapped changes under conditions of ocean acidification and that competition from faster growing strains might instead be a factor affecting the success of this ectopion in future oceans. High quality genomic sequence data is required to expand proteome coverage and confirm trends. (Abstract ID 14068)

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Understanding of harmful algal bloom processes through ocean observing – examples from the Southern California Coastal Ocean Observing System

The Southern California Coastal Ocean System (SCCOOS) provides a comprehensive set of....
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Eddy-induced transports. (Abstract ID 11832)

density structures and strongly coupling horizontal and vertical stratification. These findings resulting eddy-induced circulation locally sharpens PV fronts in the upper water column. At (PV) in the jet flanks. Using transformed Eulerian mean theory, we demonstrate that the and maintenance of multiple density fronts in the Southern Ocean. Tilted isopycnals in the isopycnal slopes, which extend from the surface to the abyss. We use an idealized, eddy- The density structure of the Southern Ocean exhibits persistent multiple fronts with steep

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MULTIPLE JETS AND DENSITY FRONTS IN AN IDEALIZED MODEL OF THE SOUTHERN OCEAN

The density structure of the Southern Ocean exhibits persistent multiple fronts with steep isopycnal slopes, which extend from the surface to the abyss. We use an idealized, eddy-permitting model with simple geometry and surface forcing to investigate the formation and maintenance of multiple density fronts in the Southern Ocean. Tilted isopycnals in the circumpolar current are baroclinically unstable, leading to eddy mixing of potential vorticity (PV) in the jet flanks. Using transformed Eulerian mean theory, we demonstrate that the resulting eddy-induced circulation locally sharpens PV fronts in the upper water column. At depths, eddies tend to homogenize PV along isopycnal surfaces, establishing vertically coherent density structures and strongly coupling horizontal and vertical stratification. These findings provide insights into the relationships between surface fronts, the interior PV distribution, and eddy-induced transports. (Abstract ID 11832)

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BIOPHYSICAL-STATISTICAL MODELING: A QUANTITATIVE METHOD FOR ADDRESSING UNCERTAINTY IN MARINE BIOGEOCHEMICAL MODELS.

Traditionally, deterministic models have encapsulated our knowledge of specific biogeochemical (BGC) processes, however, as our knowledge of physiological and systems processes increases, so too has the complexity of these models. This has resulted in an explosion in the number of unobservable, and in many cases, highly uncertain parameters. Many studies have questioned our ability to constrain these models given the spatio-temporal sparsity of observations, which often differ from the state variables being modeled. Bayesian Hierarchical Modelling (BHM) offers a robust statistical framework that embraces process models, whereby model error, parameter uncertainty and observation error are quantitatively represented through the use of probability distributions, hence Biophysical-Statistical Modeling. We have applied the BHM framework to a relatively simple BGC model, and investigate the uncertainty in the predicted state and parameters and identify what combinations of observations are required to adequately constrain the state and parameters in different environmental conditions. (Abstract ID 10710)

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THE EFFECT OF ENCRUSTATION ON THE TRACE ELEMENT COMPOSITION OF N. DUTERTREI IMPLICATIONS FOR RECONSTRUCTING PAST SEA WATER TEMPERATURE

Deep-dwelling planktonic foraminifera often develop a calcite crust when reaching a certain temperature during descent in the watercolumn at the end of their lifecycle. The composition of this layer considerably influences the whole test chemistry and therefore Mg/Ca-based reconstructions of past seawater temperature. We have determined intra- and intertest element variability of Neogloboquadrina dutertrei from sediment trap and sediment samples of modern and glacial age from the SW Indian Ocean. Trace element profiles confirm the presence of a low Mg/Ca and Mg/Ca crust covering the chambers. Crust thickness and composition vary systematically over the chambers, indicating a tight biological control, independent of temperature, on precipitation of this crust. Sediment data indicate that a significant part of the Holocene-Glacial change in whole-chamber Mg/Ca is due to changes in the composition of the crust. Conversion to temperature adds disproportional weight to these relatively minor Mg/Ca changes, thereby biasing the inferred Holocene-Glacial contrast. Similar mechanisms probably apply to other crust-forming foraminifera, thus highlighting the need to better understand crust formation and trace element incorporation for improved reconstructions of temperatures. (Abstract ID 11295)

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EVALUATION OF SOUTHERN OCEAN O2/AR-BASED NCP MEASUREMENTS IN A MODEL FRAMEWORK

The sea-air biological O2 flux assessed from measurements of surface O2 supersaturation in excess of Ar supersaturation (bioflux), is increasingly being used to constrain net community production (NCP) in the upper ocean mixed layer. In making these calculations, one generally assumes that NCP is at steady-state, mixed layer depth is constant, and there is no O2 exchange across the base of the mixed layer. The object of this project is to evaluate the magnitude of errors introduced by violations of these assumptions. Therefore, we examine the differences between the sea-air biological O2 flux and NCP in the Southern Ocean mixed layer as calculated using two ocean biogeochemistry general circulation models. In this approach, true NCP is known from the prognostic model and biological O2 flux is calculated from the models biological O2 supersaturation and the gas transfer velocity. We find that biological O2 flux gives an accurate picture of the regional-scale patterns and trends in NCP. However, on local scales violations of assumptions lead to significant, non-uniform differences between model NCP and biological O2. (Abstract ID 11270)

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RECONSTRUCTION OF THE DEEPWATER HORIZON OIL SPILL AND ITS POSSIBLE IMPACT IN MEXICAN COASTS AND WATERS

Based on the information of the amount of oil budget reported by the Federal Interagency Solutions Group and using a hydcast simulation with the Hybrid Coordinate Ocean Model (HYCOM) and a forecast simulation with the Weather, Research and Forecasting (WRF) model, a reconstruction of the oil concentration and its evolution along the period April 20-December 31, 2010 is done. The daily COAPS-FSU ocean circulation hyndcast was used for the ocean currents and the 3-hour winds from the numerical forecast of CCA-UNAM. Particular interest is considered on the concentrations in Mexican coasts and waters. (Abstract ID 11918)

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CLUSTER ANALYSIS OF WHITE SHARK DIVING PATTERNS: LINKING DISTINCT BEHAVIORAL MODELS TO OCEANOGRAPHIC PROCESSES

Tracking top predators in relation to oceanographic variables provides valuable insight into how their distribution correlates with a changing environment. However, understanding the underlying physical processes that predators are responding to requires knowledge of specific behavior such as foraging, mating or transiting. We used diving behavior of white sharks Carcharodon carcharias to discriminate between specific patterns linked to different environmental processes in the Northeastern Pacific. White sharks exert a substantial top-down effect on coastal ecosystems, particularly on pinipeded populations, but little is known of their importance in oceanic ecosystems where they spend a substantial amount of time. We applied clustering analysis to Pop-up Archival Satellite transmitted summary records to identify
dive modes exhibited throughout the Northeastern Pacific range. We found four distinctive behavioral clusters validated by previously described behaviors. We mapped behavior mode occurrence in space and time, and illustrate an important link between this apex predator and the deep scattering layer. This method can be broadly applied to tracking data to improve causal links between oceanographic variability and animal life history processes. (Abstract ID 12537)

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ACOUSTIC BACKSCATTERING FROM ROUGH SURFACES

When investigating properties of the seafloor using acoustic techniques, small-scale (sub-acoustic wavelength) variations of the topography can have a significant impact on the reflected acoustic field. If the effects of these variations, termed roughness, are not incorporated in a physical model, then there can be introduced a bias in inversions for seafloor topography and properties. A single interaction of a sound wave with a rough sea floor will be modeled here, with the aim of demonstrating the effects of roughness on the scattered acoustic field. A finite element model and a model based on the Kirchhoff approximation from optical scattering will be presented, as well as a discussion on the importance of three-dimensional roughness scattering. (Work supported by ONR. (Abstract ID 12889)

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A RE-EXAMINATION OF LIGHT LIMITATION AS A KEY FACTOR LIMITING PHYTOPLANKTON PRODUCTIVITY IN THE SOUTHERN OCEAN.

The influence of available macronutrients, iron and light in controlling primary production in the Southern Ocean are well established. In the Southern Ocean (~ >60s) light limits production in winter whereas Fe has been thought to be the main driver of the high nutrient low chlorophyll (HNLC) conditions found in summer. Exceptions occur at frontal regions, near islands and the marginal ice zone where enhanced stratification and increased iron supply alleviate iron and light stress. The nature of the interplay between iron and light limitation of phytoplankton productivity however remains open to debate. We use high resolution 802/ Ar data sets collected in the austral summers of 2007 – 2010 to investigate the response of net community production (NCP) to surface ocean mixed-layer dynamics. NCP observations from underway 802/Ar show a remarkable relationship with corresponding MLD and reveal the hitherto underexamined factor of light limitation as the main cause of the variability of net community production in the Southern Ocean. These findings and the derived relationships provide potentially useful constraints to rapidly developing process capabilities in biogeochemical models. (Abstract ID 11145)

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BARUM, IRON, COPPER, NICKEL, MANGANESE, COBALT AND NUTRIENT DISTRIBUTIONS IN THE WATER COLUMN AFFECTED BY THE DEEPWATER HORIZON OIL SPILL.

The impact of the oil spill on trace element and nutrient distributions was examined with data from early and late May and October 2010. Positive relationships between nutrient and DON anomalies in the subsurface plume (1000-1400 m depth) suggest the effect of microbial oil/gas consumption. In surface waters, metal-salinity relationships suggest a dominant river influence. In the subsurface plume, elevated metal concentrations were observed during late May. However, separating the inputs from crude oil, dispersant, drilling mud, and bottom water resuspension as well as biological removal is problematic. Correlation with percent methylmercaptan in the plume indicates the increased Co is due to leaching from crude oil. Spatially, Ba and Cu showed a peak within 10 km of the wellhead. Correlation between Ba and Cu anomalies and their low concentrations in the crude oil suggests that these elements were likely derived from drilling mud. We also observed a decreasing trend of Fe toward the wellhead, suggestive of uptake; however, the data can also be interpreted as indicative of benthic Fe input with the trend towards the wellhead being topographically-controlled. (Abstract ID 10462)

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BLOGGING FROM SEA

Student and professionally prepared blogs are being incorporated into the website of Sea Education Association (www.sea.edu). Transmitted daily from sailing research vessels at sea with classes of undergraduate students, these blogs include descriptions of scientific results and life aboard the vessels. This information is presented through daily slideshows, frequent video blogs and static content with scientific background information and links to other resources. Daily still images and blogs are produced by students describing their personal research and at-sea experience. Expanded video content on two cruises, Plastics at Sea, North Atlantic Expedition and Energy and the Ocean Environment, was fully produced and edited at sea by a dedicated videographer. Transmitted by satellite, these materials are incorporated into the SEA web page by a shore based staff member. These blogs have proven effective in translating the experience of research and discovery at sea to a wide audience as well as provide an effective means of providing accurate data in an accessible way to a large audience. User feedback, including journalists using these materials for their work, has been enthusiastically positive. (Abstract ID 1051)

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EXAMINATION OF THE INFLUENCE OF THE PATH OF KURUSHO ON MERIDIONAL EDDY TRANSPORT OF SENSIBLE AND LATENT HEAT IN THE TROPOSPHERE.

Previous studies of the relation between interannual changes in the path of the Kuroshio and Gulf Stream on the synoptic variability of the wintertime (FWM) atmospheric boundary layer (Joyce, Kwon, and Yu 2009) have been augmented by inclusion of the Oyashio path and extended into the troposphere using MERRA atmospheric reanalysis for the 24 year period of 1983-2006, inclusive. In addition, we have analyzed the intra-seasonal (8-90d) contribution of the transient eddy fluxes in the atmosphere as well as the synoptic band (2-8d). We find that at mid-latitudes, approximately 2/3 of the thermal flux in the atmosphere is due to sensible heat and 1/3 due to moisture. The intra-seasonal and synoptic bands contain approximately equal contributions to the vertically-integrated transient eddy signal, although they have distinctly different spatial characteristics. While the statistical dependence of atmospheric fluxes on path shifts of the Gulf Stream and Oyashio has been carried out, in this report we will focus on the relationship with the interannually-changing path of the Kuroshio Extension, which represents the most significant hemispheric influence of the ocean on the atmosphere. Accounting for as much as 10% of the record’s winter mean, zonally-integrated, transient thermal energy transport in the mid-latitude troposphere. (Abstract ID 9881)

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SOME NEW PERSPECTIVES ON EIGHTEEN DEGREE WATER FORMATION

Evolving ideas of Eighteen Degree Water (EDW) formation will be discussed including two quite different hypotheses on its formation by Worthington and Warren. Worthington’s concept of EDW formation was that it represented a shallow type of mean meridional overturning in the NW Atlantic in which tropical/subtropical characteristics of the near surface waters of the northereasterly-flowing Gulf Stream (GS) were transformed by intense air-sea exchange and returned southwards as a colder, denser water mass. Warren argued that since annual mean heat losses in the region occupied by EDW to the south of the GS were small, EDW was merely renewed locally with advection being unimportant. A recently completed field study of EDW (CLIMODE) is indicating that EDW formation within a given winter can have at least two different dominant physics and distinct locations: one type formed in the Sargasso Sea, largely away from the strong flows of the GS where 1D physics may apply, and a second type formed along the southern flank of the GS, in a region where the background vorticity of the flow and cross-frontal mixing plays a key role in the convective formation process. Because the latter process occurs within the GS frontal zone, cross-frontal fluxes of heat and salt can play a significant role in the GS mode of EDW formation, and impart different water mass characteristics compared to the EDW formed away from the GS in the Sargasso Sea. (Abstract ID 9707)

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INTENSE SEDIMENTATION TO THE SEAFLOOR FOLLOWING THE 2010 MACONDO BLOWOUT: GEOCHEMICAL COMPOSITION, MECHANISMS, AND MICROBIAL IMPACTS.

From April to July 2010, 4.5 to 6 million barrels of oil were released into Gulf of Mexico waters from the Macondo Blowout. Two million gallons of chemical dispersant were applied at the wellhead and sea surface to reduce the amount of oil deposited in the coastal zone. While the ultimate fate of the released oil remains debated, some fraction was deposited to the seafloor in a substantial pulse that occurred between June and September 2010. Concentrations of petroleum biomarkers and unresolved complex mixtures in seafloor samples were 2–10 times higher in September 2010 than in May 2010, with polyacrylamide hydrocarbons more abundant to the northwest of the wellhead. These results are consistent with the hypothesis that much of the released oil was deposited at the seafloor. The role of dispersants versus microbial processes in stimulating oil sedimentation were examined in laboratory experiments and both appear to play a role in oil sedimentation. Samples collected during a summer 2011 cruise are being analyzed to further identify and quantify microbiologically-mediated transformations of the oil-derived organic matter in these sediments. (Abstract ID 12777)

MULTISCALE AND MULTIPHASE LAGRANGIAN MODELLING OF THE RADIOACTIVITY DISPERSION IN THE SEA AFTER ACCIDENT AT THE FUKUSHIMA NPP.

The Lagrangian multiphase model of the radionuclide transport in the sea is applied to simulate dispersion of radioactivity released from Fukushima daiichi NPP due to the accident. The particle-tracking model describes transport and transfers of radioactivity between water, suspended and bottom sediments. The sediment transport model simulates deposition and re-suspension of non-cohesive, cohesive sediments and mixture of fractions of different size of cohesive/non-cohesive sediments. The Pacific Ocean currents are simulated using MOM3 model with resolution whereas coastal transport processes are described by coastal circulation model with high resolution. A number of scenarios of radioactivity release were simulated and results were compared with available observations of radionuclide concentrations. It was concluded that main problems in predicting radioactivity dispersion in the Fukushima NPP case are (i) correct estimation of source including air deposition and coastal run-off and (ii) accurate prediction of local currents because they are driven here by highly variable currents governed by Kuroshio/Oyashio system. The Fukushima NPP accident clearly demonstrated need in integrated regional system of forecasts of radioactivity dispersion in air, ground and marine environments to be used in comprehensive decision-support systems. (Abstract ID 9829)

SPATIAL STRUCTURE OF SIPHON FLOWS

The Siphon model of Mackay et al. (2009) is used to parameterize Siphon flows. The Siphon model is based on work by Marmoro (1976) and develops an algorithm for experimentally measured Siphon flows. The model is also used to investigate the effect of pipe diameter, pipe length, and pipe inclination on the flow. The model is validated against experimental data and shows good agreement.

Suction into capillary tubes (aka siphon flow) is widely used to create fluid dynamic stimuli in zooplankton experiments, induce bioluminescence in phytoplankton and measure mechanical properties of fibers and phytoplankton chains, as well as sample water. Many suspension feeders produce similar flows. For typical applications, flow just inside or just outside the capillary opening is of most interest. As climate change alters the vertical distribution of turbulence intensities, quantified flows will be even more important tools for experimentation. Uniform flow at a capillary entrance is almost universally assumed, becoming parabolic downstream. Entrance length is the distance from the entrance where axial velocity reaches 99% of its peak value. This entrance-length solution is very much like the drunk looking for keys under the streetlamp it is easily calculated but not very relevant. External, these same flows have been characterized as point, spherical sinks. The two idealizations conflict. Finite-element modeling in COMSOL Multiphysics (COMSOL, Inc., Burlington, MA) shows that both are particularly inaccurate at low pipe Reynolds numbers (Re). In general, entrance lengths are shorter and decay distances of velocities outside the capillary are longer than the idealizations suggest, and uniform entrance velocity is a poor approximation. External flows also vary widely but predictably in flow direction with Re. (Abstract ID 10981)

MICROBIAL IMPACTS.

The modelling system for oil spills consists of the oil spill model, circulation and wave forecast model with resolution whereas coastal transport processes are described by coastal circulation and wave model with high resolution. The Fukushima NPP accident clearly demonstrated need in integrated regional system of forecasts of radioactivity dispersion in air, ground and marine environments to be used in comprehensive decision-support systems. (Abstract ID 9829)

MASONCO BLOWOUT: GEOCHEMICAL COMPOSITION, MECHANISMS, AND MICROBIAL IMPACTS.

From April to July 2010, 4.5 to 6 million barrels of oil were released into Gulf of Mexico waters from the Macondo Blowout. Two million gallons of chemical dispersant were applied at the wellhead and sea surface to reduce the amount of oil deposited in the coastal zone. While the ultimate fate of the released oil remains debated, some fraction was deposited to the seafloor in a substantial pulse that occurred between June and September 2010. Concentrations of petroleum biomarkers and unresolved complex mixtures in seafloor samples were 2–10 times higher in September 2010 than in May 2010, with polyacrylamide hydrocarbons more abundant to the northwest of the wellhead. These results are consistent with the hypothesis that much of the released oil was deposited at the seafloor. The role of dispersants versus microbial processes in stimulating oil sedimentation were examined in laboratory experiments and both appear to play a role in oil sedimentation. Samples collected during a summer 2011 cruise are being analyzed to further identify and quantify microbiologically-mediated transformations of the oil-derived organic matter in these sediments. (Abstract ID 12777)
simulation showed quite well agreement. The simulations showed that even in the conditions of domination of tidal currents the wind and Stokes drifts play important role in the oil spill propagation. Therefore accurate prediction of the currents and waves is crucial for oil spill response actions. (Abstract ID 9830)

Determination of accurate ocean surface fluxes of heat, freshwater, and momentum is pivotal for understanding and modeling air-sea interactions. Oceanic reanalyses have been very useful in evaluating models, but the quality of these products has often been questioned for specific type of applications. Meteorological variables gained from ocean buoy stations and a fixed platform (leeds) in the Yellow Sea, East China, and East/Japan Seas are used to calculate the latent and sensible heat fluxes with COARE flux algorithm 3.0 (Fairall et al., 1996). The buoy-derived fluxes are compared with five atmospheric model reanalyses (NCEP1, NCEP2, CFSR, INTERIM, MERRA) and objectively analyzed data (OAflux). The Taylor diagram is used to assess which products are closer to those estimated from buoy data. Cross correlations are higher than 0.7 for all products mainly due to the strong seasonality. In terms of the standard deviation, the performance of the products is better in an order of MERRA-OAflux-INTERIM-CFSF-NCEP1-NCEP2. This order of performance is nearly same for all stations and different time scales such as synoptic (3-15days) and intraseasonal (1-4months) scales. More details on the evaluation of the reanalysis products will be presented. (Abstract ID 12844)

Abstract: Copepod nauplii are often the most abundant metazoans in pelagic ecosystems, and they can be important players in food web dynamics. However, little is known about the ecology of nauplii due to the challenges associated with quantitative sampling and identification to species. Here we present a quantitative real-time PCR (qPCR) based approach to identifying and enumerating copepod nauplii in field populations. We use DNA copy number of the target gene, mtCOI, in size-fractionated environmental samples to infer the number of nauplii present in the population. Laboratory experiments on DNA extraction methods, species-specificity of qPCR amplification, qPCR inhibition, changes in DNA copy number across developmental stage, and a direct comparison between the qPCR approach and microscopic enumeration of copepod nauplii have been completed in order to establish the accuracy of the method. Our initial work focuses on Parvocalanus crassirostris, a common planktonic copepod in subtropical coastal ecosystems. This approach will allow us to investigate population responses to environmental perturbations across all developmental stages, and could be extended to study other micro-metazoans in the sea. (Abstract ID 12605)

On the continental margin of central Oregon, upwelling, biological productivity, and remineralization drive tremendous variability in biochemistry over a range of spatiotemporal scales. In an effort to better understand the interplay between seasonal and event-scale dynamics, biological metabolism, and coastal carbon chemistry in this region, we deployed a shallow-water Slocum glider in conjunction with a larger-scale hydrographic survey of the U.S. west coast. The glider collected high-resolution (1 s^-1) observations of temperature (T), salinity, and optode-based dissolved O2 on five transects of the shelf at 44.2°N during August, 2011, a late-summer period of primarily upwelling-favorable conditions. In near-shore surface waters O2 undersaturations indicative of recent upwelling were persistent, while in mid-shelf surface waters O2 supersaturations in excess of 25% were observed, indicative of high rates of biological production. In bottom waters, hypoxia (O2 < 60 µmol/kg) was observed over much of the shelf. We use relationships between T and O2 derived for this region to determine pH and CaCO3 saturation state, to compare to concurrent ship-board measurements, and to evaluate the contribution of multiple stressors (biological/physical) to acidification of shelf waters over the deployment period. (Abstract ID 9538)

Idealized model simulations are carried out examining the effect of cross-shore winds on the mixing of a buoyant river plume system. After several inertial periods of wind forcing the plume is transported offshore and several plume properties (offshore distance, width, depth, density) reach a steady state dependent on estuarine outflow conditions. We used a traditional salt equation and a salinity coordinate analysis to examine this constant plume structure. The wind stress drives a vigorous cross-plume circulation that acts as a straining mechanism, stratifying the offshore side of the plume. This is balanced by the vertical mixing driven by the downstream Ekman velocities. In the salinity coordinate analysis, the freshwater volume in the plume is tracked in both time and salinity space. The structure of the freshwater volume in time and salinity space agrees with a critical Richardson number based mixing ratio, which clearly delineates regions of active mixing from regions where mixing is balanced by the advection of freshwater. This salinity coordinate analysis agrees with the traditional Cartesian coordinate analysis and is useful in examining plume wide processes. (Abstract ID 11954)
Electrochemical Phosphate Monitoring: First Steps to Create an Electrochemical Sensor With an Application in the OMZ Offshore Peru

Developing new sensors for improving our understanding of the coupled biogeochemical cycles constitutes an immense challenge. Electrochemistry promises promising reagentless methods by going further in miniaturization, decreasing the response time and energy requirements and thus increasing our observing capacities in the ocean. We present an electrochemical method for phosphate determination in seawater based on anodic oxidation of molybdenum in seawater in order to create molybdenum phosphate complex amperometrically detected on gold electrode with detection limit of 0.12 µM and an average precision of 2.2 %.

We propose a solution to address the silicate interference issue based on an appropriate ratio proton/molybdate and using an electrochemical cell with an adaptation of specialized membrane technology. We present an application of this method in the OMZ offshore Peru. The results show excellent agreement when compared to colorimetry with an average deviation of 5.1%. This work is a first step to develop an autonomous in situ sensor for electrochemical detection of phosphate in seawater. (Abstract ID 9683)

ELECTROCHEMICAL PHOSPHATE MONITORING: FIRST STEPS TO CREATE AN ELECTROCHEMICAL SENSOR WITH AN APPLICATION IN THE OMZ OFFSHORE PERU

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TRENDS IN THE SURFACE CHLOROPHYLL OF THE CALIFORNIA CURRENT: MERGING DATA FROM MULTIPLE OCEAN COLOR SATELLITES

Standard remote sensing reflectance products from four ocean color sensors (OC3S, SeaWIFS, MODISA, MERIS) and over 10,000 in situ measurements of surface chlorophyll-a (Chl-a) concentration in the California Current were used to create empirical algorithms that are consistent with in situ data as well as between individual sensors. Using these algorithms a merged multi-sensor time series of the surface Chl-a concentration in California Current region was created. The merged Chl-a time series (1996-2011) shows a significant trend of increasing Chl-a off central California and a decreasing Chl-a trend in the central North Pacific gyre. Although this 15-year time series is too short to separate interannual and multidecadal cycles from climate trends, both of the observed trends are consistent with the predicted effects of global warming that is expected to cause weaker vertical nutrient fluxes in the gyre due to stronger stratification of the water column but increased upwelling off central California due to stronger upwelling-favorable winds. (Abstract ID 9714)

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THE INTERACTION BETWEEN SHORT OCEAN SWELL AND TSUNAMIS - AN EXPERIMENTAL STUDY

Our objective is to investigate the effect of combined swell - tsunami interaction on the nature of the tsunami – in particular the surface elevation, the runup speed and the near-bottom velocities. Laboratory testing in the Tsunami Wave Basin at Oregon State University has been performed to simulate this interaction, with free surface elevations and near-bottom velocities measured at various locations over a plane sloping beach. Random wave trains with varying initial mean steepness were generated in concert with the tsunami. Preliminary analysis of the data using wavelet transforms reveals that high steepness ocean swell changes the spectral signature of the tsunami, particularly at high frequencies. There is also a significant difference in location of the breakpoint of the tsunami with overriding swell. Further analysis using wavelet coherence will be undertaken in order to untangle the interacting frequencies and shed further light on the nature of the interactions. Numerical modeling of the phenomena (using a nonlinear wave model) will be used to determine the dominant effects. (Abstract ID 11332)

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SCALES OF SST VARIABILITY IN GHRRST DATA

The Group for High Resolution Sea Surface Temperature (GHRRST) is an open international science group providing a global user community with Sea Surface Temperature (SST) products derived from satellite observations. A special focus of GHRRST is how spacial and temporal resolution can be optimally preserved in data products derived from merging various sensors of different resolution, and how the trade-off between smoothing and resolution is best communicated to the user. Even if only a single sensor is considered, the spacial and temporal resolution is important in connection with validation and error estimation. This talk will summarize the current status quo and possible ways forward for GHRRST to address the scales of SST variability. (Abstract ID 11662)

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CARBON UPTAKE AND RELEASE BY PHYTOPLANKTON COMMUNITIES IN THE AMAZON RIVER PLUME

The Amazon River Plume is a large, highly productive region and is thought to be a carbon sink in the Western Tropical North Atlantic Ocean, based on the riverine nutrient inputs. Phytoplankton utilize large quantities of atmospheric CO2 for photosynthesis, but part of this uptake is known to be released as DOC, affecting the flux into refractory carbon pools.

To determine uptake and excretion of different phytoplankton communities in the area of the Amazon River Plume we measured production and excretion rates by 14C uptake and release in form of DO14C. Rates were normalized to biomass determined by chlorophyll a. We found different production and excretion rates within different communities. A coastal diatom community excreted 92%, a Ceratium dominated community 38%, and a Trichodesmium dominated community 50% of the total carbon uptake of each community. These results show that carbon excretion in the Amazon River Plume depends on the composition of the phytoplankton community. Different areas with different communities in the Amazon River Plume might therefore have different effects on the carbon pools and carbon sequestration. (Abstract ID 11237)

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MOELED AND EXPERIMENTAL PREDICTION PREDICTIONS AND CAUTIONS FOR TYPE I AND TYPE II LIQUID CORE WAVEGUIDES
Liquid core waveguides (LCWs) have found use in analyses of liquids for a wide variety of applications. In the oceanographic community, LCWs are primarily used for measurements of chemical concentrations and quantification of colored dissolved organic matter (CDOM). Because LCWs are flexible and conduct light energy efficiently, long optical pathlengths are achievable, providing enhanced sensitivity over standard, shorter cuvettes. By their nature, however, the materials comprising the waveguide interact strongly with propagating light. Due to variations in LCW construction methods, light may not necessarily be confined to travel solely within the liquid sample. As a result, optical absorption measurements may exhibit offsets from absolute values. Currently, two main types of LCWs are employed: a) Type I, which is a tube formed solely from AF 2400; and b) Type II, which is made by coating a quartz tube with AF 2400. We developed optical models to predict the performance of the Type I and Type II waveguides. In this presentation, we discuss the optical performance of the Type I and Type II waveguides, highlighting how light travels throughout the different media comprising the LCWs. We also compare the Type I and Type II results to the performance of bare quartz tube. For the cases where an experimental setup was feasible, we provide a comparison between modeled and experimental data. (Abstract ID 11261)

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ROLE OF THE SOUTHERN OCEAN IN SETTING THE ATLANTIC STRATIFICATION AND MERIDIONAL OVERTURNING CIRCULATION
This study examines the importance of the Southern Ocean (SO) stratification in determining the upper cell of the Atlantic meridional overturning circulation (MOC) and stratification. Main results are based on a suite of numerical simulations of the SO-Atlantic System, intended to explore the importance of various dynamical factors. The results demonstrate that the density distribution at the SO-Atlantic boundary is the key factor controlling the Atlantic stratification and MOC, whereas the main importance of the Ekman and eddy (parameterized) exchanges is in setting the SO stratification. Among all aspects of the SO stratification, the position of the deep isopycnals near the western boundary of the Atlantic basin appears to determine the strength of the MOC for given isolocytropic outcrop positions in the North Atlantic. The interplay between the SO stratification and surface density in the North Atlantic is, however, important for MOC. In particular, the steady-state AMOC response to a negative

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CHANGES IN RUNOFF FROM THE GREENLAND ICE SHEET RECORDED IN RED CORALLINE ALGAE
The Greenland Ice Sheet (GrIS) contains the largest store of fresh water in the northern hemisphere, equivalent to ~7.4m of eustatic sea level rise, but its impacts on current, past and future sea level, ocean circulation and European climate are poorly understood. Recent estimates of GrIS melt from satellite observations and melt-models indicate increasing melt trends. There are however no runoff data >50y length with which to determine if recent changes are natural oscillations or step changes. Using marine coralline algae we have made the first reconstruction of runoff from a section of the GrIS over several decades. There is a trend to increasing GrIS runoff since the mid 1980s, with the largest annual runoff observed in 2002. There are however no runoff data <50y length with which to determine if recent

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EXTREME NITROGEN ENRICHMENT SUPPRESSES N-FIXATION AND DRASTICALLY ENHANCES DENITRIFICATION, BUT NOT ENOUGH
Anthropogenic nutrient inputs are a major concern in estuaries, and can lead to eutrophication and significant impacts on key nutrient cycle processes. Nitrogen (N) cycling is integral to ecosystem function, yet N-fixation and denitrification, which add or remove N, are not well studied, especially in heavily populated Mediterranean areas including edible fishes. Commercially, commercial farming is banned in Fukushima regions and the local fishery industry is severely damaged. We used a microcosm experiment to determine the role of diatoms in commercial importance of fish species, we will conduct a comprehensive survey of activity distribution in seawater, sediment, plankton, benthos, and fish species. Combining other available information, we will discuss radioactivity transfer in pelagic and benthic ecosystems in this region. (Abstract ID 9854)

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ADVENTURE IN THE SOUTH PACIFIC: UCLA’S MARINE BIOLOGY QUARTER
For the cases where an experimental setup was feasible, we provide a comparison between modeled and experimental data. (Abstract ID 9854)

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PROROCENTRUM MINIMUM MAINTAINS HIGH PHOTOSYNTHETIC ELECTRON TRANSPORT UNDER PCO2 STRESS (HIGH pH) BY REDUCING OXYGEN.
Bloom forming species often develop high biomass and conditions of high CO2 concentration, low CO2 concentration, and high pH during the daytime. Such conditions should lead to significant photosynthetic stress and down regulation of photosynthesis to avoid photoinhibition. Contrary to this expectation, cultured Prorocentrum minimum cells maintained high rates of photosynthetic oxygen evolution under high pH and low pCO2. Using membrane inlet mass spectrometry and 18O techniques it was determined that the high rate of gross oxygen evolution under pCO2 stress was balanced by a comparatively high rate of oxygen reduction. F minimum cells exhibited highly variable light-dependent oxygen uptake ranging from essentially no irradiance dependence to a near perfect 1:1 oxygen cycle at all irradiances, depending on pCO2. These results suggest that F minimum has an adaptation that maintains photosynthetic electron transport under bloom conditions to minimize photoinhibition. The high rate of oxygen uptake under low pCO2 may be related to the possession of Form II Rubisco, which has a higher tendency for photosynthetic oxygenase activity than Form I Rubisco. (Abstract ID 9522)

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CESIUM-137 DISPERSION AND BIOLOGICAL TRANSFER IN PELAGIC AND BENTHIC ECOSYSTEMS OFF THE COAST OF FUKUSHIMA
Following the release of radionuclides from the Fukushima Dai-ichi Nuclear Power Plant, radioactivity was detected in seawater, sediment and various marine organisms including edible fishes. Commercially, commercial fishing is banned in Fukushima regions and the local fishery industry is severely damaged. We used a microcosm experiment to determine the role of diatoms in commercial importance of fish species, we will conduct a comprehensive survey of activity distribution in seawater, sediment, plankton, benthos, and fish species. Combining other available information, we will discuss radioactivity transfer in pelagic and benthic ecosystems in this region. (Abstract ID 9854)

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Anthropogenic nutrient inputs are a major concern in estuaries, and can lead to eutrophication and significant impacts on key nutrient cycle processes. Nitrogen (N) cycling is integral to ecosystem function, yet N-fixation and denitrification, which add or remove N, are not well studied, especially in heavily populated Mediterranean areas including edible fishes. Commercially, commercial farming is banned in Fukushima regions and the local fishery industry is severely damaged. We used a microcosm experiment to determine the role of diatoms in commercial importance of fish species, we will conduct a comprehensive survey of activity distribution in seawater, sediment, plankton, benthos, and fish species. Combining other available information, we will discuss radioactivity transfer in pelagic and benthic ecosystems in this region. (Abstract ID 9854)
interpreting data. The MBQ partnered with COSEE-West to include an outreach component, instilling in young scientists the importance of communicating research. Students wrote research blogs and created a range of outreach products. COSEE-West ran a concurrent online workshop that connected MBQ scientists to professor, graduate, and undergraduate level to teachers and informal educators, and live webcasted the concluding MBQ Student Research Symposium. Evaluations showed immense value of these experiences for students, scientists, and workshop participants. Students learned “new ways to present my project to different groups of people in a clear way” and 82% rated blogging an A/B grade. One professor commented the online workshop “allowed me to bridge the gap between scientific research and public education,” and 94% of workshop participants learned content they could use in teaching. (Abstract ID 12323)

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SHORT-TERM VARIABILITIES IN THE TSUSHIMA/KOREA STRAITS

Short-term variabilities with a time scale from a couple of days to several weeks in the Tsushima/Korea Straits (TKS) are studied using Acoustic Doppler Current Profiler (ADCP) data along the ferry “Camellia” cruise line between Pusan and Hakata. In the cold period (December to April), the variabilities are dominant only in the western channel of the TKS, but spread into the entire TKS in warm period (May to November). The analysis of Empirical Orthogonal Functions (EOF) of the component of the short-term currents normal to the cruise line illuminates three dominant modes. One is a “transport” mode in charge of volume transports with a coherent structure in the entire TKS during a year. The second one is a “vortex” mode with strong locality and seasonality. In the cold period, the vortex mode develops only in the western channel with a dominant time scale of 5-7 days. In the warm period, it develops at the lee of the northern part of the Tsushima Islands and eastern channel with a dominant time scale of 16-17 and 15-16 days, respectively. The third mode is a “baroclinic coastal trapped mode” appearing from July to October near the Korean coast with a dominant time scale of 6-16 days. The transport and baroclinic coastal trapped modes respond to the atmospheric forcing, whereas the vortex mode depends on local geometry, stratification, current shear etc. (Abstract ID 9569)

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ON THE INTERANNUAL AND DECADAL VARIABILITY OF THE GULF STREAM

The Gulf Stream is a fast, intense western boundary current system in the Northwest Atlantic. It features energetic mesoscale activity in the form of meanders, rings and eddies with significant variability on seasonal and decadal timescales. We present results from a multi-decadal hindcast simulation (1958-2007) using a high-resolution regional ocean circulation model (ROMS). We quantify the variability in the meso-scale and mean flows and relate it large-scale climate indices. We also evaluate the biases in global climate models in this region and use our model to explore the implications of these biases. (Abstract ID 12538)

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INFLUENCE OF ESTUARINE BARRAGE ON SEDIMENT OXYGEN DEMAND AND DENITRIFICATION IN GO-SEONG ESTUARY, SOUTH SEA, KOREA

To investigate the effect of estuarine barrage on organic matter remineralization (sediment oxygen demand, SOD) and denitrification, intact sediment core incubation experiments were performed in small estuarines with (Go-Seong) and without (Gu-Man and Ma-Am). The barrage from August to September, 2011. SOD in the study sites tended to high (3.17 to 37.29 mmol O2mm-2d-1) but the influence of the barrage was not evident. On the other hand, denitrification decreased rapidly with the salinity (denitrification =0.01 to 3.35mmole N2m-2d-1). The degree of decrease was more evident in Gu-Man and Ma-am compared to Go-Seong, especially, the salinity effect was not observed outside of the barrage. Other than the salinity effect, overall denitrification was lower in Go-Seong compared to Gu-Man and Ma-Am probably due to the limited water movement or stagnance. The effects of photosynthesis by microphytobenthos on SOD and denitrification were high in low salinity. (Abstract ID 12738)

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PROPAGATION OF THE WIND WAVE WITH STRONG TIDE IN THE WEST COAST OF KOREA

Characteristics of the wind-induced surface wave propagation with strong tide in the west coast of Korea were studied using the buoy and wave radar data set and a simple numerical model. The period selected for this study was on Mar 4-7, 2007. During this period, there was a very high wave record over 9 m of wave height at KyuckYulBee-Do (outside bay), and 6 m at DuckJeuck-Do (inside bay) on Mar. 5, 7:00-8:00 am. Wave-tide interactions were occurred only during the high wave activity period, and time variation of wave height showed tidal period modulation at the inside of bay displaying that high wave energy for the high water and low wave energy for the low water. No tide at outer side bay. The direction of wave propagation was also affected by tide, and peak wave period was increased during the flood tide and decreased during the ebb tide inside of the bay. From diagnostic model runs, the dominant factor to affect the wave height during wave propagating into coastal area was the wave depth change by tide, which was also a key factor to make the tidal modulation of wave height variation, especially at the shallow area. A discussion about how much of wave height can be changed by tidal current, wind or the combined factor, and how can directional wave energy spectrum be deformed, will be included a little bit detail. Keywords: surface wave characteristics, wave-tide interactions, directional wave energy spectrum (Abstract ID 11236)

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QUANTITATIVE EVALUATION OF IRON AND NUTRIENTS IN SEA ICE IN THE SOUTHERN SEA OF OKhotsK

To elucidate roles of the sea ice in biogeochemical cycle in the Sea of Okhotsk, the concentrations of nutrients and iron were measured for the sea ice, overlying snow and seawater samples collected in the southwestern region by using clean technique in early February 2010 and 2011. The concentrations of major nutrients in the sea ice, except for NH4-, were lower than those in underlying seawater. Iron in the sea ice was heterogeneously distributed and enriched relative to the underlying seawater. We consider that sea ice melting tends to induce the dilution of the nutrients concentration of surface water, while it might be significant source of iron to surface water in this region. We estimated total iron flux into surface water from melting sea ice as 666±197μmol Fe m-2 event-1 (one seasonal melting). The flux is comparable to reported amount of annual atmospheric iron flux (267-929μmol Fe m-2 yr-1) in the northwestern Pacific. Therefore, our results indicate that sea ice has a significant impact on macro-, micro-nutrient conditions in this region during the melting season. (Abstract ID 10768)

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GLIDER FLEET-BASED MULTI-PARAMETER OBSERVATIONS IN THE TROPICAL NORTHEAST ATLANTIC

To study the coupling between physical and biogeochemical parameters, high-spatial resolution, multi-parameter measurements are required. This poses a challenge to ocean observing systems. We present results from a study in the tropical Northeast Atlantic, employing simultaneous observations from 5 gliders. Each glider recorded temperature, salinity, chlorophyll, oxygen and turbidity for the duration of 50 days. A 45 by 45 km wide area was sampled using butterfly-shaped courses, to optimize the area coverage and the intercalibration of the gliders. Our aims included (i) the quantification of the spatial scales of variability in the recorded parameters, (ii) the demonstration of coupling between physical and biogeochemical parameters, and (iii) detectability of deposition of Sahara dust from seawater turbidity. The gliders observed significant variability in form of changes of thermohaline properties, internal waves, and meso-scale features. The scale-dependence of the different parameters is presented. Below the mixed layer, changes in oxygen, and salinity imply spatio-temporal variability of the ratio of North to South Atlantic waters. Pronounced submesocale variability is found, which might be important for the vertical fluxes of nutrients and oxygen. (Abstract ID 11064)

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MONITORING THE WESTERN EQUATORIAL PACIFIC SALINITY FRONT USING HIGH-RESOLUTION AQUARIUS SATELLITE MEASUREMENT

Taking the advantage of using global ocean salinity data from Aquarius/SAC-D mission, we are able to obtain the repeated and fully covered salinity maps. The sea surface salinity from satellite measurement has high-resolution both spatially (150km or higher) and temporally (monthly...
to weekly). Western equatorial Pacific is an ideal region to study the salinity variations using the initial measurement of Aquarius. First, in the open ocean, the salinity data is less contaminated by the land. Second, the Aquarius has higher accuracy in salinity retrieval in the tropical region. The reason is that the salinity is more sensitive to the brightness temperature where the sea surface temperature is higher. Third, the existence of a salinity front near the eastern edge of western Pacific warms pool results in large horizontal salinity gradient. Scientifically, analyzing the evolution of western Pacific salinity front could improve our understanding for the formation of barrier layer and the mixed layer heat budget related to the freshwater flux. This presentation analyzes the first look of regional salinity study using the Aquarius satellite salinity measurements. (Abstract ID 12528)

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ESCAPE OF TERRESTRIAL ORGANIC PARTICLES DRIVEN BY HYPERPYCNAL FLOW

Tropical cyclones in western Pacific bring torrential rainfall to mountainous islands across Oceania resulting flushing floods, which might play a significant role in the transport of terrestrial organic carbon into deep sea. These processes are particularly effective across the western Pacific. Hyperpycnal delivery occupied 35% of total clastic load yet happening only in 0.7% of time. Here we present organic geochemistry data for a sediment trap deployed at 600 m depth in a submarine canyon off southwestern Taiwan over a period of flood. 13C/TOC and 14C/TOC characteristics of trapped sediments reveal that an enriched organic layer was carried by turbid flow escaping oxidation in shallow water immediately after a flood. The organic-rich layer is recently-fixed organic carbon (90% modern) from terrestrial system. This process should be common in active continental margin where river, narrow shelf and canyon is tightly connected acting as a express gate delivering fresh terrestrial OC into deep sea for burial. (Abstract ID 12534)

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IMPROVING THE SUSTAINABILITY OF LONG-TERM UNCABLED HYDRATE OBSERVATORIES: TECHNOLOGIES FOR EFFICIENT DATA RETRIEVAL AND RENEWABLE POWER

Uncabled seafloor observatories are a crucial technology in monitoring local chemical variability induced by hydrate deposits. Often these observatories are deployed for durations of up to a year and are only recovered for data retrieval, refurbishment, and redeployment. Accordingly the primary cost of operation after initial deployment is the infrastructure required for data collection and power supply servicing. Our work aims to improve both the data collection and operational endurance of seafloor moorings by demonstrating two new technologies on a seafloor mooring at the Mississippi Canyon 118 hydrate observatory. The first is an optical modem communication system for easy and efficient data retrieval. In

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EFFECTS OF ELEVATED CO2 CONDITIONS ON PARALARVAL LONGFIN SQUID (LOLIGO PEALEII) DEVELOPMENT AND EARLY LIFE

High CO2 emissions since the industrial revolution have reduced ocean pH by 0.1 units, with further reductions predicted for the year 2100. Studies have explored the potential effects of ocean acidification on diverse marine taxa; however, research on cephalopods has been limited. This is surprising due to the central role squid can play in ocean ecosystems. These investigations reared paralarval longfin squid Loligo pealeii from eggs to hatchlings in ambient (~390 ppm) and high (~2200 ppm) CO2 conditions to examine potential effects of ocean acidification on this commercially and biologically important species. Responses were heterogeneous across the experimental trials. Squid raised in high CO2 demonstrated later hatching time (~24 hours) and shorter mantle length at hatching (t=2.381, p=0.018, df=158) in trial 1 but not trial 2. Aragonite statoliths, used for balance and acceleration, were significantly shorter and more porous in high CO2 reared larvae (t=3.086, p<0.007, df=16). While clear differences were found between ambient and high CO2 animals, biological impacts are uncertain. Results suggest concern for the need for further research regarding ocean acidification impacts on squid. (Abstract ID 10572)

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OCEANOGRAPHY MAGAZINE AS A VEHICLE FOR COMMUNICATION IN THE OCEAN SCIENCES

The Oceanography Society (TOS) was founded in 1988 with a primary mission to disseminate knowledge of oceanography and its application through research and education, to promote communication among oceanographers, and to provide a constituency for consensus-building across all the disciplines of the field. The principal way that TOS accomplishes this mission is through quarterly print and online (open access) publication of OCEANOGRAPHY. Through peer-reviewed articles written in a less-technical style than most other journals, and insistence on high-quality color graphics, major programs use OCEANOGRAPHY to communicate their accomplishments to a broader audience, including academic oceanographers from all disciplines, program managers, and policy makers. OCEANOGRAPHY also advances cross-disciplinary communication through thematic special issues, for example, the June 2011 volume on sea level. Occasional publication of supplements to the magazine, such as "Scientifically Speaking" and "Education and Public Outreach: A Guide for Scientists" are additional ways that TOS contributes to promoting excellence in communication within and outside of the ocean sciences community. (Abstract ID 9929)

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POP/DART: AN ENSEMBLE DATA ASSIMILATION SYSTEM FOR THE OCEAN COMPONENT OF CESM

At the National Center for Atmospheric Research, a 48-member ensemble adjustment Kalman filter (EaKf) is being used to assimilate daily subsurface temperature and salinity data into the POP 1x1° global ocean model. The new ocean assimilation system dovetails with an existing EaKf system for CAM, the atmospheric component of CESM: each ensemble member of the ocean model is forced at the air-sea interface by a unique sample of the atmospheric state as it was implemented for that multidecadal climate prediction effort. We have a continuous analysis from Jan 1, 1998 to Dec 31, 2005, which serves both as initial conditions for the decadal ocean assimilation system for CAM, the atmospheric component of CESM. The development of an ocean analysis at NCAR was originally outside of the ocean sciences community. (Abstract ID 231)
circulation, and meridional heat transport. (Abstract ID 10388)

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LOW OXYGEN EDDIES IN THE OPEN NORTH ATLANTIC OCEAN

We report on sporadic events of extremely low oxygen values at the northern rim of the North Atlantic Oxygen Minimum zone, based on observations from multiple platforms (glider, float, mooring). The low oxygen conditions occur just below the mixed layer and are associated with mesoscale eddies. By utilizing satellite altimeter data to reconstruct the eddies’ pathways we find that they have been generated by the instability of the eastern boundary current in the high-productive Mauritian upwelling region, off West Africa. Within the eddies, the degree of oxygen depletion is consistent with consumption rates found in the upwelling region. The efficiency of oxygen consumption seems to be influenced by eddy dynamics and simple, conceptual models for consumption scenarios for different ’types’ of eddies (cycloic, anti-cycloic, mode water) are presented. The implications of these extreme low oxygen conditions for the North Atlantic OMZ are discussed. (Abstract ID 11175)

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IMPACT OF ICE COVER ON WIND-FORCED EXCHANGE IN THE ALASKAN BEAUFORT SEA

The Alaskan Beaufort shelf is fed by Pacific water emanating from Bering Strait, and is strongly wind-forced in fall and winter due to the passage of synoptic storms. The pack-ice tends to be fast on the inner shelf and more mobile farther offshore, modulating the water column response to such storms. Here we use data from the first-ever mooring array extending from the inner shelf to the continental slope to investigate the cross-shelf exchange and water column properties during two wind events characterized by differing ice conditions. In the first event (early December 2008) the ice was mobile everywhere, while much of the shelf was covered by fast ice during the second event (early February 2009). The salinity, temperature and velocity response strongly depended on the ice-free shelf region near the shelfbreak where the ice remained mobile throughout the event. The connectivity between the inner and outer shelves and resulting cross-shelf transport is assessed in each case. (Abstract ID 9941)

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PREDICTING WAVE-CURRENT INTERACTIONS AT THE MOUTH OF THE COLUMBIA RIVER, OR

The wave conditions at the mouth of the Columbia River (MCR) are modeled using the spectral wave propagation model SWAN, and a forecast is developed as a navigational safety tool. The waves at the entrance to the MCR are strongly affected by the tidal currents as strong ebb flows can significantly steepen the waves and induce localized breaking. Included in the model are offshore wave conditions obtained from a 30 arc-second resolution WaveWatch3 forecast and current fields obtained from a river circulation forecast. Comparing the model results to the Catstop Spt buoy, located in 25 m water depth just south of the inlet, shows the forecast is skillful at predicting the general wave height trends. For a 6-week period in Summer 2011 when wave heights ranged between 1.0 and 3.1 m, the forecast had an rms error of 29 cm. Results also show that the influence of the tidal current is limited to the area within the 25 m contour line, but within this area, the wave heights during ebb tide can be as much as 2.5 times the slack tide wave height. (Abstract ID 12374)

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ONTOGENETIC PROPULSIVE TRANSITIONS FROM VISCUS TO INERTIAL FLOW REGIMES

Among marine organisms, the influence of flow regimes on swimming strategies is largely unknown. As an approach to examine this issue, we quantified how transitions from viscous to inertially dominated flow regimes, which commonly occur during the development of marine animals, relate to changes in swimming strategies. We used the hydromedusa Sarsia tubulosa as a model organism for this investigation because its morphology and propulsive actuation mechanism are radially symmetric. This feature allows for determination of three-dimensional fluid quantities from two-dimensional flow measurement techniques. Digital particle image velocimetry was used to quantify the flow fields created by free-swimming hydromedusae and calculate the kinetic energy, circulation, and impulse generated by their swimming pulses at different life stages. Swimming strategies were evaluated by quantifying the relationship between impulse production and hydrodynamic swimming efficiency. The use of impulse theory enables us to generalize our findings to the swimming strategies of other aquatic animals that swim in similar flow regimes. (Abstract ID 11739)

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THE VARIATION OF THE NORTH PACIFIC TROPICAL WATERS IN ITS FORMATION REGION, 2003−10

The monthly mean gridded temperature and salinity data based on Argo profiling float observations in 2003−10 were analyzed to investigate the variation of the North Pacific Tropical Water in its formation region. The formation region, namely the sea surface salinity maximum at 20°−30°N, 160°−140°W, is narrow in the middle due to the persistent existence of a local salinity minimum near 20ºN, 170ºW, and is separated into eastern and western parts. The characteristics of the mixed layer salinity variation are different between the western and eastern areas. Interannual variations are dominant in the western area, while seasonal variations are dominant in the eastern area. The estimation of mixed layer salinity budget shows that evaporation and precipitation dominate other factors in both areas, except that entrainment becomes important in fall to winter in the eastern area. The mixed layer salinity in both areas has increased since 2008, at a higher rate in the western area. This is likely to be caused by a decrease in the Southern Annular Mode index. (Abstract ID 10836)

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AN INVESTIGATION OF MODIFIED CIRCUMPOLAR DEEP WATER THROUGH AUTONOMOUS GLIDER MEASUREMENTS IN THE ROSS SEA

The Ross Sea's high biological productivity and variable conditions make it an important component in the global marine carbon cycle. Autonomous sea gliders deployed in the Ross Sea provide a means for resolving highly variable phenomena, such as Modified Circumpolar Deep Water (MCDW) intrusions onto the continental shelf. These gliders more easily assess the temporal and spatial extent of MCDW intrusions in the Ross Sea than traditional measurement platforms, e.g., cruise samples, CTD casts, and satellite observations. Two gliders deployed within the Ross Sea in late November 2011 made over 1590 dives and collected data (salinity, temperature, fluorescence and oxygen) for approximately two months. These temperature and oxygen data can locate intrusions of MCDW in the Ross Sea. Preliminary analyses of these data indicate a positive correlation in space between the presence of MCDW intrusions and high fluorescence, suggesting a biological effect on summer plankton blooms. Further comparisons to contemporaneous cruise and satellite data highlight the capacity of gliders for resolving correlations between fluorescence and MCDW and providing insights into the mechanisms of the relationship. (Abstract ID 10767)

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SEASONAL VARIABILITY OF EXCHANGE CIRCULATION AND HYDROGRAPHY IN A FJORD ESTUARY: A NUMERICAL MODEL STUDY

A three-dimensional hydrodynamic model is used to study seasonal variability of circulation and hydrography in Hood Canal, Washington, an estuarine fjord that develops seasonally hypoxic conditions. The model is validated with data from Year 2006, and is shown to be capable of quantitatively realistic simulation of hydrographic variability. Sensitivity experiments show the largest causal factor for seasonal variability to be that of salinity at the mouth of the fjord. Variability of fresh water input from the watershed also causes significant, but secondary, changes; local wind stress has little effect over a seasonal timescale. Further experiments, in which one forcing parameter is abruptly altered while others are kept constant, show that outflow changes are significant but also that upwelling feedbacks can influence the rate of water exchange.

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AN ANALYSIS OF COPEPOD FEEDING USING FLOWCAM

Two copepod species dominate the zooplankton in the Upper San Francisco Estuary during summer, Pseudodiaptomus forbesi and Limnomena tetraspis. These copepods are an important food source for many fish species, including the endangered Delta Smelt. Little is known about their feeding and in particular whether they compete for food. This study aimed to identify the types of prey that these copepod species consume and quantify their feeding rate. Copepods were collected from the Upper San Francisco Estuary and incubated for 24 hours in surface water from the collection site, which contains their natural prey. Microplankton from incubation bottles with and without copepods are counted, measured, and grouped.
into broad taxonomic categories (cilates, flagellates, diatoms, etc.) using a FlowCAM imaging particle analyzer. The FlowCAM combines features of a flow cytometer, including fluorescence trigger, with an optical system similar to a microscope that captures digital images of particles. The FlowCAM software takes automated measurements of the particle images which were used to help categorize different types of plankton and estimate their biomass. This project demonstrates the utility of this instrument for rapid, accurate measurements of feeding rate. (Abstract ID 9894)

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PROGRESS OF NOAA’S CLIMATE DATA RECORD PROGRAM

The Climate Data Record (CDR) Program is entering its 3rd year of funded activities at NOAA’s National Climatic Data Center (NCDC). The CDR Program has already promoted and is maintaining 8 global satellite-based CDRs in an operational state within NOAA. The Program has conducted two competitive award cycles which has funded 18 awards totaling over $13,000,000. Several are ocean Thematic CDRs while others are Fundamental CDRs upon which ocean products are based. Standards for the transition of research-grade code to an operational environment, data set formatting and documentation, processing transparency, and the quantification of the CDR’s maturity have been developed by the Program through coordination with partners in the scientific community. The Program is exploring the application of these standards to many CDRs not captured through the competitive awards program to secure them and thus facilitate assessments, adaptation, and mitigation of climate change. Future directions include definition of maintenance profiles to ensure transition to a fully operational state for each CDR and the application of the operational CDR algorithms to new data streams to aid in climate monitoring activities. (Abstract ID 11939)

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STOCHASTIC SUPERRESOLUTION OF THE UPPER OCEAN FLOW FIELD ESTIMATED FROM SATELLITE ALTIMETRY

Attempts to monitor eddy transports in the ocean are strongly limited by the sparseness of available observations, the strong nonlinearity of the underlying dynamics, and the fact that eddy transport is particularly sensitive to unresolved submesoscale dynamics. In this study, a suite of stochastic data assimilation methods for estimating eddy transport are tested in idealized simulations of quasigeostrophic turbulence at high and low latitudes under a range of observation scenarios. A novel feature of these strategies is the use of computationally inexpensive stochastic forecast models with model parameters that can be learned adaptively from the observations themselves. We demonstrate the feasibility of a simple technique for deriving “stochastically superresolved” velocity fields with a nominal resolution increase of a factor of two or more. This is achieved by extracting high-wavenumber information that has been aliased into the low wavenumber band and combining it with a model for the unresolved kinetic energy spectrum. We show that estimates of the time-mean poleward eddy heat transport estimated in this way are significantly closer to the true value when compared with standard estimates based upon optimal interpolation. Implications for measuring poleward eddy heat transport using current and next-generation altimeters are discussed. (Abstract ID 10737)

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BENTHIC POPULATION DYNAMICS AND DIVERSITY IN THE WARMING CHUKCHI SEA

The Chukchi Sea is currently exposed to increasing temperatures and experiencing major reductions in seasonal sea ice cover. Changes in the sea ice extent, thickness and duration are critical for influencing annual primary production of ice algae and phytoplankton and therefore for benthic populations, ecosystem function, trophic dynamics and organic carbon cycling. The main aim of this study was to examine structure, function and diversity of benthic infaunal organisms in the high biomass/diversity “hot spot” areas of the Chukchi Sea with a goal of assessing biological vulnerability to increasing temperature and sea ice reduction as well as implications for marine food web changes. A collection of approximately 100 van Veen grabs was taken (35 – 130 m depth) to assess benthic diversity, abundance and biomass at the same stations in both 2010 and 2011. The results are presented in relation with physical and chemical data and compared to selected time series results from the past 30 years. This study is a part of the Distributed Biological Observatory (DFO) program and represents a continuation of benthic time series collected since the 1980s. (Abstract ID 9865)

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OPTICAL ESTIMATION OF BREAKING WAVE INDUCED DISSIPATION

Depth-induced wave dissipation is directly related to radiation stress gradients which drive circulation within the surf zone. Optical remote sensing methods are able to detect this temporal and spatial distribution of energy due to the increased bubble production and the associated increase in reflected light. The goal of the present research is to understand how these changes in radiance and depth induced wave dissipation are related. Using the Battjes & Janssen (1978) time averaged dissipation equation as a framework, it is proposed that the dissipation is related to the radiance through the fraction of breaking. A relative radiance quantity (L = L_LT, Target) is derived, which relates the local radiance to the radiance produced from a target Lambertian surface. Remote sensing derived dissipation estimates are then compared with one-minute time averages of in situ dissipation collected by a fixed Aquadopp over six days within the surf zone. Both long time scale variations associated with tide level changes and sub-minute variations associated with wave groups are investigated. (Abstract ID 9847)

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THE ESTABLISHMENT OF AUTONOMOUS SHIP BASED OCEAN COLOR OBSERVATIONS ON AUSTRALIAN RESEARCH VESSELS

As part of Australia’s Integrated Marine Observing System, a “Dynamic above water radiation and irradiance collector” (DALEC) was commissioned in August 2011 on the RV Southern Surveyor to provide a continuous stream of hyperspectral information from Australian waters. The DALEC is a radiometrically calibrated spectroradiometer which measures above-water-leaving radiation, sky radiation and downwelling irradiance. Designed for autonomous ship deployment, the DALEC incorporates a passive 2 axis gimbal, solar azimuth tracking, embedded GPS, compass and accelerometers for recording sensor geometry. Dynamic integration time selection ensures optimum signal to noise ratios throughout deployment. The deployment system on the vessel’s forecastle allows the instrument height to be adjusted for safe cleaning and servicing, whilst reducing the effect of bow waves and ship superstructure on the measurements. Radiometric data streams from the DALEC are collected in real-time and recorded over the ship’s local area network, allowing for future integration into onboard data management systems. Preliminary results will be presented from the DALEC test deployments carried out in the Southern Ocean and Indian Ocean. (Abstract ID 11156)

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SIMULATING THE ESTUARY TURBIDITY MAXIMUM WITH AN ADAPTIVE MESH CFD MODEL (GERRIS)

We are studying the impact of material properties (e.g., density and viscosity), channel morphology, and boundary conditions on the estuary turbidity maximum (ETM) with a computational fluid dynamics (CFD) code that uses adaptive mesh refinement (Gerris). Our analysis of the lock-exchange problem suggests that dimensionless simulations must be carefully defined because of the changing nature of the flows. We are completing tests that evaluate the relative contribution of buoyancy–driven and tidal currents to mixing in the ETM. This includes a generation of turbulence at the bed using direct numerical simulation (DNS) of flow over bed forms for comparison to turbulence parameterizations. The large change in water depth over a tidal cycle is also a factor because the straightforward application of the 2DV CFD model with a rigid surface cannot be justified for very long. This factor is being examined using the VOF module. The VOF approach has allowed the simulation of tidal flow for water depths ranging from 0.5 to 2.5 m. We are further investigating a hybrid method using VOF and CFD calculations of flow in the ETM. (Abstract ID 11559)
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NORTH ATLANTIC OCEAN CONTROL ON SURFACE HEAT FLUX AT MULTIDECADAL TIMESCALES

Nearly 50 years ago Bjerknes suggested that the character of large-scale air-sea interaction over the mid-latitude North Atlantic Ocean differs with timescales: the atmosphere drives directly most short-term – interannual – sea surface temperature (SST) variability; while the ocean contributes significantly to long-term – multidecadal – SST and atmospheric changes. Although the conjecture for short timescales is well accepted, understanding Atlantic multidecadal SST variability (AMV) remains a challenge, due to limited ocean observations. Here we construct long-term (1980-2010) time series of surface turbulent fluxes in the North Atlantic using exclusively Voluntary Observing Ship (VOS) data. The reconstruction makes extensive use of probability distributions of surface fluxes and censored sample theory for minimization and homogenization of time dependent sampling errors. Using these data we provide the first compelling observational evidence that in the mid-latitude North Atlantic and at timescales longer than 10 years, surface turbulent heat fluxes are driven by the ocean and force the atmosphere, while at shorter timescales the converse is true. This result is strongest in boreal winter, but is found in all seasons. These results are also contrasted against those of ocean and coupled model simulations. Our findings indicate that the predictability of mid-latitude North Atlantic ocean could extend beyond the ocean to the climate of surrounding continents. (Abstract ID 11511)

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COMPARATIVE ORGANIC GEOCHEMISTRY OF SINKING PARTICLES COLLECTED USING NET TRAPS DEPLOYED IN Oligotrophic, Coastal and fjord SETTINGS

Sediment net traps were deployed for short periods (1-3 days) in a variety of world ocean environments. Samples from the Azorean Sea (2007), Glacier Bay (2008), Clayquot Sound (2006-present), the Washington Margin (2010), HOTS (2010) and BATS (2010) have been evaluated for their amino acid, lignan, phthalate, carbonate, opal and lithogenic mineral compositions. These samples range from well oxygenated to fully anoxic. The goal is to evaluate organic-mineral coupling and the impact of different mineral sources and oxygen tensions on organic matter reactivity and flux. We observed, as has been seen frequently in other suboxic zones, a relatively less attenuated flux through the suboxic waters than is commonly observed in oxic waters. As expected, allochthonous compounds such as lignin (terrestrial organic matter) and phthalate esters (plasticizer) have concentrations and compositions that are strongly correlated with proximity to land. Conversely, autochthonous materials such as amino acids are strongly correlated with local primary production. An in situ incubation system was used at several locations to correlate attenuation rates estimated from trap fluxes to organic matter degradation rates measured in situ. (Abstract ID 12524)

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BUILDING A HIGH-POWER AND HIGH-BANDWIDTH CABLED OBSERVATORY ON AN ACTIVE UNDERWATER VOLCANO AXIAL SEAMOUNT

Axial Seamount is the most active volcano on the Juan de Fuca Ridge, erupting in 1998 and 2011. It is both seismically and hydrothermally active, and hosts diverse biological communities. It is a long-term NOAA-PMEL observatory where long-term co-registered fluid chemistry-temperature-microbiological measurements have been made that begin to quantify the microbial evolution at the decade scale of seafloor eruption cycles. Because of these characteristics, Axial was chosen as the US first cabled observatory at a submarine volcano. This 5-year construction and 25-year operational project is part of the NSF’s Ocean Observatories Initiative. The OOI-RSN provides high power (8 kW) and bandwidth (10 Gbps) connectivity to a state-of-the-art full (3 kW; 1 Gbps) water column mooring (3000 m water depth) with two instrumented profilers at the base of the volcano and an array of seafloor sensors in the caldera including a thermistor, high definition camera, an array of seismometers, and fluid-DNA samplers installed in 2013-2014. In concert, this infrastructure will provide unprecedented real-time data flow to a global user community and response capabilities to seismic-eruptive-megaphane events. (Abstract ID 12507)

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BACTERIAL COMMUNITY COMPOSITION AND HYDROLYTIC ACTIVITY IN ARCTIC NEPHELOID LAYERS

Nepheloid layers (NL) constitute an important mechanism for cross-shelf transport of particulate-organic carbon (POC) in the Arctic and other oceans. Despite the potential for microbial attenuation of POC during transport, evaluations of microbial communities in NL are rare. Bacterial community composition (BCC) and extracellular enzyme activities (EEA) of free-living and particle-associated microbes were examined in NL transiting the Mackenzie Shelf region of the Beaufort Sea in winter and spring, 2008. BCC in spring NL was similar to BCC in chlorophyll (Chl) maxima, with free-living communities being the most similar and BCC associated with sinking and suspended particle fractions showing greater differences from shallower counterparts. Bacterial communities in NL differed seasonally, possibly due to differences in organic matter source and availability. EEA in nepheloid layers was related to measures of organic lability, especially particulate nitrogen. Contrary to expectation, cell-specific EEA in deeper NL was not significantly lower than that in Chl maxima, indicating that microbial hydrolysis continues in NL at a level that can reduce the amount of POC eventually exported offshore into deeper regions of the ice-covered Beaufort Sea. (Abstract ID 11900)

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TEMPORAL VARIABILITY OF VERTICAL HEAT FLUX FROM THE MAIN ENDEAVOUR FIELD, JUAN DE FUCA RIDGE

Hydrothermal vents, and the fluids that emanate from them, are the seafloor expression of a magma body that is undergoing convective cooling. The magnitude of heat that can be extracted through these convective processes is dependent on many factors of the subseafloor geosystem, i.e. heat content of the magma body, thickness of the conductive boundary layer, and the permeability of the fluid network. Changes to this geosystem are reflected in the vertical flux of the buoyant plume. We report on the first comparable repeat measurements of vertical heat flux from a hydrothermal vent system, the Main Endeavour Field (MEF) on the Endeavour Segment. Autonomous underwater vehicle surveys of heat flux from MEF measured a decrease of ~50% between samplings (2000: 538 ± 57 mW → 2004: 278 ± 28 mW). In addition to an estimate of the heat flux from the whole field, we estimate the heat flux on the cluster, or structure, scale as well. Relative differences on the cluster scale are likely indicative of inflation rates in the underlying axial magma chamber. (Abstract ID 11900)

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CONTRIBUTIONS TO EIGHTEEN DEGREE WATER INTERANNUAL VOLUME ANOMALIES

The processes contributing to the formation and dissipation of Subtropical Mode Water in the North Atlantic, or Eighteen Degree Water (EDW), are the subject of the CLivar MOD Water
Dynamics Experiment (CLIMODE). To complement the field program with a perspective of interannual-to-decadal variability, we used a simple box model to hindcast observed EDW volume anomalies in two regions: the formation region and an adjacent region where EDW does not outcrop. Formation by air-sea fluxes was estimated explicitly using OAFlux fields for 1985-2007. The relative contributions of Ekman and geostrophic advection and lateral mixing are examined by using proxy variables derived from winds, SST, hydrography and altimeter. The importance of each process is evaluated by its contribution to reproducing observed EDW volume anomalies in the two regions. Volume loss in the formation region is apportioned between subduction (35%) and mixing (65%). Air-sea heat fluxes account for more than 25% of the interannual volume variance. Other important contributors are lateral mixing parameterized by the meandering Gulf Stream and anomalous oceanic circulation. (Abstract ID 10508)

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COUPLING EQUATIONS FOR LINEAR TIDES

Internal tides are generated, reflected, scattered, and dissipated along the continental margins. The relative vigor of these processes determines the strength and location of internal-tide currents and tidally-driven mixing. By approximating continental slopes as two-dimensional, we have developed a new and efficient analytical method for quantifying the interaction of surface and internal tides in regions of arbitrary stratification and topography. Our method decomposes topography and stratification into discrete sets of regions that are locally flat and have horizontally-uniform stratification. We then match the amplitudes and phases of “flat-bottom” vertical modes in the adjoining regions at each discontinuity. The matching conditions result in a set of coupling equations for linear tides (CEL), which are solvable via a single matrix inversion. We show that solutions to CELT agree with analytical and numerical solutions over smooth topography. We then apply CELT at several locations in the ocean. Preliminary results suggest that we can quantitatively estimate (i) directional energy fluxes in 2D partially-standing waves, (ii) two-way energy transfer between the surface and internal tides, and (iii) the efficiency of internal-tide scattering to high wavenumbers. These analyses provide new perspective on the cascade of tidal energy from large- to small-scale motions. (Abstract ID 9497)

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ORBITAL FORCING CONTROLS ON ANTRCTIC POLAR FRONT MIGRATION AND DEEP CIRCULATION CHANGE OVER THE PAST MILLION YEARS

The paleoceanographic record of Southern Ocean variability has the potential to provide insights into the key mechanisms and thresholds of change in ocean circulation that have strongly influenced overall ocean system behaviour. Ocean deep circulation is known to undergo radical restructurung during glacial-interglacial cycles and this has been attributed to the role of migration of the mid-latitude westerlies in driving changes in deep-ocean ventilation and hence atmospheric CO2 concentration. During the longer time scale of the mid-Pleistocene transition there is evidence that insolation-forced changes drove deep ocean circulation into a sustained “interim state” during which there was a reduction in the strength of deep circulation and incomplete ventilation of the deep ocean even during interglacial periods. Using the history of migration of the Antarctic Polar Front we provide a synthesis of the sequence of events that tracked these systematic changes in earth system behaviour in relation to external forcing and review consequences for the carbon cycle. We also give the results of preliminary intermediate complexity modelling to provide insights into some of these events and processes. (Abstract ID 11178)

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WHAT DRIVES CHAOS IN MODELLED PHYTOPLANKTON COMMUNITIES?

The vast number of phytoplankton species in the ocean is often explained in terms of a chaotic response to the environment. This response is investigated here using two similar, but not identical, ecosystem models by Huisinga and Weissing (1999 HW) and Follows et al. (2007) for a well mixed box. The existence of chaos is verified by diagnosing the maximal Lyapunov Exponent and a 0-1 test for chaos, based on model integrations for a long-term equilibrium. A contrasting response has been observed; the HW model exhibits a variety of responses: competitive exclusion, oscillations and chaos. The Follows model does not show chaotic behaviour: The different response turns out to be due to HW including a parameterized nutrient supply rate depending on the background nutrient conditions, which is not included in the Follows model. Omitting this feedback removes the chaotic response in the HW model. We discuss the relevance of model resource boundary conditions to the real environment, and the consequences for chaotic behaviour in real phytoplankton communities. (Abstract ID 10205)

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A VERTICAL MODEL APPROACH TO LONG BAROCLINIC ROSSBY WAVES OVER TOPOGRAPHY

The dynamics of long baroclinic Rossby waves over large topography is investigated using a new theory, idealized modeled, and GCM results. The theory was developed by decomposing the conservation laws of mass and momentum into standard vertical modal components in the presence of steep topography. Each vertical mode Rossby wave propagates along contours of (Coriolis parameter) / (corresponding equivalent depth), modified by topographic interactions between vertical modes that alter the phase speed and vertical structure. The normalized gradient of (Coriolis parameter) / (water depth) provides the magnitude of topographic effects relative to planetary beta effects, neglecting wave directionality. The theory was applied to zonally-varying, meridionally-periodic one-dimensional modeling with realistic zonal bathymetry and Ekman forcing. The results suggest that the barotropic and first baroclinic Rossby waves interact strongly and tend to travel together, with the phase speed close to that of the first mode. This result is compared to more realistic ocean GCM results, which suggest the existence of additional factors that cause strong interactions of the first and second baroclinic modes. (Abstract ID 11077)

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ANTHROPOGENIC RADIONUCLIDES IN THE ATLANTIC: GEOTRACES SECTIONS A11 AND A02

We are focused on determining the total concentrations of the anthropogenic radionuclides 239Pu, 240Pu, 237Np, and 137Cs in depth profiles from 2010 Atlantic GEOTRACES sections. Data from the equatorial region (A11) compared to GEOSECS data indicate water column inventories of 137Cs have increased over the last 40 years, whereas those of Pu are variable. By comparison, Pu and 237Np water column inventories are similar to regional soil core inventories, whereas 137Cs inventories are significantly higher, further suggesting continued supply of 137Cs to the open ocean. Water column Pu/237Np inventory ratios are indicative of regional fallout (~0.18). Deviations of the water column 237Np/240Pu inventory ratio from the average global fallout value (~0.08) can be used to estimate Pu-particulate fluxes, which are comparable to sediment trap data and may be used to assess scavenging at different locations along the cruise track. Data from mid and high latitude regions (A02) will be compared to GEOSECS data; inventories and ratios will be used to identify additional contaminant sources, as water mass tracers, and to elucidate important processes such as scavenging and remineralization. (Abstract ID 11526)

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Jenneke Westerink, , University of Notre Dame, , Mark Hope, , University of Notre Dame, Urbah Gravios, , University of Florida, Brian Zachry, , AIR Worldwide, , FORERUNNER SURGE AND SHELF WAVES IN ADVANCE OF TROPICAL CYCLONES

Large increases in coastal water levels, called forerunners, have been observed well before
tropical cyclone landfall when winds are not strong and may even be blowing offshore. We present observational and computational results from Hurricane Ike showing the geostrophic nature of its forerunner, the nearly 2m shelf wave that travelled in advance of the storm, and the large water level increase in inland bays attributable to the forerunner. Simple analytical models show the surprising result that the time required to generate the currents driving a forerunner decreases with increasing wind speed, thus not only will forerunners for strong storms be more severe, they are also more likely to reach their maximum possible size. (Abstract ID 9669)

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CURRENT-METER PERFORMANCE COMPARISON IN HIGH CURRENT CONDITIONS IN DRAKE PASSAGE

Previous current-meter intercomparisons suggest that Aanderaa RCM11s are biased low in the speed range 0-35 cm s\(^{-1}\). A short near-bottom (4000 m depth) mooring deployed in Drake Passage revisits this bias. The mooring consisted of seven current meters representing four models (two VMCMs, two RCM11s, two Aanderaa SEAGUARDS, and a Northek Aquadopp). Two high-current events occurred (>35 cm s\(^{-1}\)). All current-speed measurements agreed within about 5%. The VMCMs, chosen as the reference, were found to measure the median current-speed. The RCM11 and SEAGUARD current speeds did not differ significantly from 1:1 relationship with the VMCMs, and all three types tended to agree best at higher speeds (35-70 cm s\(^{-1}\)). The Aquadopp current speeds were about 5% higher than the VMCMs but because of a short record this comparison only extended over the range 0-40 cm s\(^{-1}\). (Abstract ID 9471)

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COSEE-WEST OCEAN OBSERVING INSTITUTE: USING ONLINE DATA IN THE CLASSROOM

During a five-day COSEE-West Summer Institute K-12 teachers learned about a variety of Ocean Observing systems (OOS), such as buoys, gliders, ROVs, and satellites, and engaged in field sampling and hands-on activities for teaching about ocean observing. The workshop was designed to connect teachers with scientists who use OOS in their research, and provide resources and instruction for using OOS data and graphics in the classroom. Participants visited five different research institutions where they had opportunities to use CTDs and other instruments, build and operate ROVs, view a satellite control room, and participate in model classroom activities. Teachers explored ideas with each other about how to teach using online data and were required to develop lesson plans incorporating OOS. Evaluations from the workshop were very positive. 97% of participants agreed or strongly agreed the workshop enhanced their professional expertise, 95% intend to implement material in the classroom, and 97% felt workshop activities would be effective for students’ learning. One participant wrote, “I will use so much of what I learned in my classroom to help enrich learning for my students.” (Abstract ID 12220)

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TRAJECTORIES IN DIATOM SIZE STRUCTURE IN RESPONSE TO RECENT WARMING

The size structure of phytoplankton communities influences food web structure and elemental cycling. There is evidence that climate warming causes a decrease in the average cell size of phytoplankton communities. For example there has been a decrease in the average size of the dominant fossilized diatom community in the ocean over the Cenozoic and a decrease in the average size of diatoms from lake Tahoe over the last decades. Here we show that in a sub-arctic lake that the average size of diatoms is relatively stable over the last two hundred years. The stability in the average size of the diatom community is maintained by a balance between an increase in abundance of small centric species which are becoming smaller and an increase in cell volume in the four numerically dominant larger-sized Aulacoseira species. We propose that over decadal to millennial timescales the trajectories in diatom community size structure in response to climate change may differ between high and lower latitude systems due differences in the timing and types of changes in the associated physical and chemical conditions. (Abstract ID 9636)

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MODELING TURBULENCE AND SEDIMENT TRANSPORT NEAR SEVERAL SCOUR HOLES WITHIN A TIDAL INLET

Indian River Inlet is the only waterway connecting two Delaware inlets deep to Atlantic Ocean. The US Army Corps of Engineers constructed twin jetties in late 1950’s to prevent the inlet infilling. Following stabilization, significant channel-bed erosion has occurred. Tidal velocities can exceed 2.5 m s\(^{-1}\) in the constricted channel with Reynolds numbers exceeding 10\(^7\) during peak flood and ebb tide velocities. Sediment transport processes have caused scour holes over 30 m deep (compared to roughly 10 m background depth) to form on the landward and seaward sides of in-water bridge piers that support a major coastal highway. A multilayer non-hydrostatic numerical model (NHWAVE) including turbulence and sediment transport modules is used to investigate the evolution pattern of scour holes inside the channel. Predicted bed shear stresses are used with a sediment pickup function to evaluate sediment suspension. Suspended sediments are then traced by an advection-diffusion equation. Finally, estimated channel-bed evolution is compared with known morphologic variability. (Abstract ID 10353)

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CIRCULATION OF THE CORAL SEA FROM MAPPED ARGO TRAJECTORIES

Coral Sea circulation is described using QC-ed, objectively-edged Argo parking-depth trajectories that reference climatological geostrophic shears, defining absolute velocity at all levels above 2000m. Transports are diagnosed in the context of the linear Island Rule, and property advection is compared to along isopycnal velocity fields; several discrepancies are noted. Three currents: the Coral Sea; the shallow North Vanuatu Jet (NVJ; 9 Sv) and the much thicker and narrower North (NCL126 Sv) and South (SCJ; 85 Sv) Caledonian Jets. These last two have maxima near 300m, and significant magnitude below 1000m. Surprisingly, much of the NVJ turns north into the Solomon Sea before reaching the western boundary. The East Australian Current begins as a shallow southward flow near 15°S, marked by low-oxygen water from the NVJ. Conversely, northward flow begins as far south as 26°S below 1000m, fed by high-salinity, high-oxygen water from the SCJ and especially the NCJ. Narrow property tongues trace the boundary current around the Gulf of Papua, showing two separate connections from the South Pacific gyre to the Solomon Sea: one via the western boundary; the other in the interior. (Abstract ID 11566)

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POTENTIAL OF GEOSTATIONARY OCEAN COLOR OBSERVATIONS FOR THE RETRIEVAL OF THE DIEL VARIABILITY OF OCEANIC OPTICAL PROPERTIES

Numerous studies were performed since the 1990s on the diel variability of optical properties in various oceanic regimes. It is a well established phenomenon, which is observed in situ and can be replicated in the laboratory. Previous works essentially focused on the particulate beam attenuation coefficient, \(c_p\), with very few experiments concerning the particulate backscattering coefficient, \(b_p\), and the apparent optical properties (AOPs). The latter are the ones that contribute to the satellite signal that can be recorded with ocean color sensors. This variability has been investigated using in situ measurements of optical properties performed at high frequency at a fixed mooring site in the Mediterranean Sea (BOUSSOLE site). We observed a diec cycle in \(c_p\) and \(b_p\), with minima generally near sunset and maxima near sunrise. The transfer of this variability to the AOPs, such as the reflectance, has been also investigated. This is a preliminary step to evaluate the possibility to retrieve the diec cycle of optical properties from ocean color observations taken from the geostationary orbit (including uncertainties introduced by the atmospheric correction process). (Abstract ID 10984)

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THE IMPACT OF THE INDONESIAN THROUGHFLOW AND TIDAL MIXING ON THE SEASONAL CYCLE OF THE SEA SURFACE TEMPERATURE IN THE INDONESIAN SEAS

A numerical model is used to investigate how the Indonesian Throughflow (ITF) and tidal mixing are affecting the seasonal cycle of the Sea Surface Temperature (SST) in the Indonesian
Seas. We find the ITF to play a major role on establishing a region of weak variability in the west and along the Nusa Tenggara parts of the Indonesian Seas. During Austral summer, the ITF warms the SST when the Northwestern Monsoonal wind would otherwise cool the SST through coastal upwelling. This results in weak SST variability and hydrographic observations support such heat balance in the western half of the Indonesian Seas. Tidal mixing is found to cool the SST during austral summer and winter. The Monsoonal winds are stronger in these seasons and the upper thermocline water, which is more effectively cooled by tidal mixing because of its stronger stratification, upwells to the surface. The Northwestern Monsoonal wind during summer also spreads the cooled SST water around the interior of the Indonesian Seas through Ekman transport and enables the strong impact of tidal mixing felt throughout the Indonesian Seas. (Abstract ID 10800)

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PHYTOPLANKTON GROWTH IN THE AUSTRALIAN SECTOR OF THE SOUTHERN OCEAN, EXAMINED BY OPTIMISING ECOSYSTEM MODEL PARAMETERS.

The HNLC regime of the Southern Ocean is potentially important in controlling ocean-atmosphere CO2 fluxes. The causes of HNLC conditions has been the subject of much debate, with much attention focussing on availability of iron. The phytoplankton photosynthetic parameters of a simple NPZD model were optimised at three sites in the Australian sector of the Southern Ocean, spanning the Sub-Antarctic Zone, the Polar Frontal Zone and the Antarctic Zone. The optimised parameters give a good fit to SeaWiFS chlorophyll data and realistic ecosystem dynamics. The optimisations indicate that phytoplankton growth rates in the PFZ and AZ are limited by some process not explicitly included in this model, with iron availability being the most likely candidate. The effect of changes in algal growth rates outweigh the effect of changes in photosynthetic efficiency on the biological model solution, thus differences to the ecosystem functioning caused by iron availability are of greater consequence than differences in surface irradiance and MLD. Based on these optimisations we support the contention that iron availability is a primary cause of the HNLC conditions in this region. (Abstract ID 10932)

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TWO-DIMENSIONAL WATER SURFACE TOPOGRAPHY MEASUREMENTS IN THE FIELD WITH THE REFLECTIVE STEREO SLOPE GAUGE

A new optical instrument for the measurement of surface wave slope and height properties was recently developed at the University of Heidelberg. The abilities of this Reflective Stereo Slope Gauge (RSSG) to measure the two-dimensional surface topography will be demonstrated. The RSSG overcomes the usual inaccuracies of stereo triangulation at specular surfaces by using properly positioned artificial light sources. The stereo images of a water surface patch with a size of about 1 m$^2$ are filled with specular reflections that are very similar to sun glitter. An algorithm was developed that precisely determines the water surface elevation for all specular reflections and interpolates over image areas without visible reflections to yield two-dimensional surface topography. Results from both a test on a pier near Lamont-Doherty Earth Observatory and the OSSPRE 2011 expedition on the Kilo Moana in the Pacific Ocean are presented to demonstrate the wide range of environmental conditions under which measurements are possible. (Abstract ID 11367)

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DECADAL VARIABILITY OF LABRADOR SEA WATER FORMATION INFERRED FROM CHLOROFLUOROCARBON TIME SERIES

For almost two decades we have chlorofluorocarbon (CFC) measurements from repeated hydrographic surveys spanning major parts of the subpolar gyre. The data set is extensive enough in space and time to create individual time series for key regions of the North Atlantic. The CFC-based time series reveal the formation history of different modes of Labrador Sea Water (LSW) since the early 1990s. Here, we investigate the temporal variability of CFC penetrating into the water layers associated with light and dense modes of LSW. We follow the propagation of the CFC signal in different modes of LSW from the formation region to the southern and eastern parts of the subpolar gyre by means of time series analysis in the respective regions. Interannual variability of CFC is in close agreement with changes in T and S. The correspondence of physical parameters and CFC is particularly well noted in the Labrador and Irminger Seas, the source regions of intermediate waters responsible for ventilating the deep ocean. Observed changes are discussed in the light of changing activity of deep convection in the LSW formation area throughout the years. (Abstract ID 10676)

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TRANSCRIPTIONAL PROFILING OF IN SITU FIXED ZOOPLANKTON – TRANSCRIPTOME OF A COPEPOD DIAPAUSING IN THE OXYGEN MINIMUM ZONE

Marine invertebrates are exposed to low pO2 and high pCO2 in oxygen minimum zones (OMZs). We developed a strategy to study physiological acclimations to these conditions using an in situ fixation procedure combined with high-throughput transcriptome sequencing. Bioinformatic analysis of the respective transcriptomes then allows identification of acclimation (and adaptation) mechanisms to the respective conditions. We first compared diapausing copepods (Calanus borealis) from the Namibian OMZ (low pO2, high pCO2) with C. similis samples taken at the Ocean surface (high pO2, low pCO2). This first large scale transcriptome analysis of a marine organism, diapausing in the OMZ provides strong evidence for metabolic reduction, negative regulation of transcription and translation, as well as increased molecular replication and repair in diapausing copepods. Transporter activity, energy-, lipid-, amino acid- and carbohydrate metabolism, as well as digestion are enhanced in active animals. These results are largely consistent with expectations based on published physiological research of C. similis. Compared to active animals, a strong respiration rate reduction of 80 - 90 % and dominance of catabolic processes were observed for diapausing animals. Our results confirm that in situ fixation is a suitable strategy to study acclimations and adaptations to OMZ conditions. (Abstract ID 10217)

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XCTD HYDROGRAPHIC MEASUREMENT DURING UNCLOS 2011 CRUISE

The importance of the Arctic Ocean circulation to the global thermohaline circulation has been recognized, but the circulation scheme of the Arctic Ocean is still highly uncertain. In August-September 2011, CCGS Louis S. St-Laurent had a cruise from the Canadian Arctic coast toward the Lomonosov Ridge in tandem with USGC Healy (UNCLOS 2011 cruise). During UNCLOS 2011 cruise, 78 hydrographic profiles were collected by expendable conductivity, temperature, and depth data acquisition and processing equipments (XCTD). Using these data, we examined distribution, characteristics, and mixing processes of these water masses in order to understand the circulation scheme of the Arctic Ocean. One of the interesting points is that Pacific-origin water masses can be found at the north of the Chuikhi Rise in September 2011, although no signal of these water masses was there in 2008 and 2009. According to the previous publications, Beaufort Gyre circulation was intensified in a recent couple of years. However, the XCTD data in 2011 might suggest a relaxation of the intensified circulation and a change of water mass distributions around the Mendeleev Ridge and the north-western Canada Basin. Interannual variability is discussed in the context of changes in atmospheric circulation pattern and recent sea ice reduction. (Abstract ID 11086)

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SOUTHERN OCEAN FINESTRUCTURE: SPATIAL AND TEMPORAL VARIABILITY OF NEAR-INERTIAL WAVES AND MIXING

Over the first 3 years of the DIMES tracer release experiment, 12 finestructure profiling floats (EM-APEX) have been deployed both upstream and downstream of Drake Passage in the Antarctic Circumpolar Current. Initial conclusions from the upstream (Southeast Pacific) tracer diffusion have revealed mixing rates only moderately enhanced above the low values typically found in the deep ocean (e.g., 1-1.5 × 10^-3 ms^-1). The profiling floats have identified enhanced shear from downward-propagating wind generated near-inertial internal waves as primarily responsible for this enhancement, with the resulting diapycnal diffusivity profile inferred from shear finestructure decreasing away from the surface. In contrast, within and downstream of Drake Passage, diffusivities are an order of magnitude larger (2 × 10^-2 ms^-1 at the tracer isopycnal) and increase towards the bottom. The increase is due to a combination of (a) stronger wind forcing and near-inertial wave variability in Drake Passage and (b) topographically-generated lee waves and internal tides. Ongoing measurements and analysis of the DIMES results are focusing on these processes, as well as on improving the spatial and temporal description of the internal wave and mixing fields. (Abstract ID 12048)

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A SYNTHESIS OF CARIBBEAN PROXY SEA SURFACE TEMPERATURE RECORDS SINCE THE LATE MEDIEVAL PERIOD

Accurate reconstructions of past climate variability are needed to help understand the causes of variability and to test data to check the validity of predictive climate models. Three records of Caribbean sea surface temperature (SST) from different paleoclimate archives have been combined to make a regional Caribbean sea surface temperature index that extends back to the year 1356 C.E. The signal to noise ratio can be raised by averaging, effectively canceling some of the non-climatic noise and local variability present in each proxy record. The Caribbean regional record correlates significantly with instrumental SST over the modern period and contains distinct late medieval and Little Ice Age temperature regimes similar to global and hemispheric temperature reconstructions, but of larger magnitude. Caribbean temperatures were ~0.6°C cooler during the Late Medieval period compared to the 20th century whereas the Little Ice Age was ~1.4°C cooler than the 20th century. The timing and magnitude of variability suggests that this region contributes significantly to the global mean conditions on centennial timescales, supporting modeling results indicating the global climatic importance of this region. (Abstract ID 11392)

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THE ROLE OF TURBULENCE STRESS DIVERGENCE IN DECELERATING A RIVER PLUME

Turbulence controls the composition of river plumes through mixing and alters the plume's trajectory by diffusing its momentum. In this study, finely-resolved density, velocity and turbulence observations are used to quantify terms in the momentum budget in the Columbia River's near-field plume during ten tidal cycles that encompass both high and low river flow. Turbulent stress varies by 2-3 orders of magnitude, both within a given ebb and between ebbs with different tidal or river forcing. Inter-ebb stress magnitude is related to the strength of an ebb outflow: high-stress occurs during the peak flow of strong ebbs. At these times turbulence stress divergence balances plume deceleration. Furthermore, the deceleration time scale based on plume stress is less than the half tidal period (6h), indicating that stress divergence plays a fundamental role in decelerating the plume. (Abstract ID 12732)

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PRELIMINARY FEASIBILITY STUDY OF CHARACTERIZING IN-FLOW IN A POTENTIAL TIDAL POWER SITE

Tidal Energy is a promising alternative energy resource. Tidal current turbines convert tidal energy into electrical power. An essential step in developing this technology is characterizing the flow environments in which turbines are deployed. Specifically, both mean flow and turbulence statistics are required. This study summarizes our recent effort to characterize the flow in a potential turbine deployment site in Puget Sound (Northern Admiralty Inlet) from an engineering point of view. In addition to their usefulness in site operation and assessment, these data can be used to produce numerical simulation tools which help turbine designers more accurately predict hydodynamic loads on their devices. This study will help accelerate the development of tidal energy technology. (Abstract ID 12852)

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GLOBAL OCEAN TIDES FROM GRACE SATELLITE ACCELERATIONS

Models such as FES2004 are routinely used to remove the effects of global ocean tides from GRACE data, but errors in ocean tide models alias into monthly GRACE solutions. Fortunately, GRACE inter-satellite ranging data can be used to solve for these tides directly. Nine years of GRACE inter-satellite acceleration data are inverted using a mascon approach to solve for residual amplitudes and phases of major solar and lunar tides relative to FES2004. Uncertainty estimates are derived from tidal solutions over land, and by subtracting two independent solutions that each use 4.5 years of data. Ocean loading corrections are applied to facilitate comparisons with tide gauge data. (Abstract ID 11649)

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ATMOSPHERIC EKMAN PUMPING ABOVE AN SST FRONT

The impact of midlatitude SST fronts on the atmospheric Ekman layer is examined in idealized experiments with the Weather Research and Forecasting (WRF) model. Bottom Ekman layer concepts are applied to the mechanisms proposed by Lindzen and Nigam (1987) and Wallace et al (1989), in light of satellite observations showing the sensitivity of wind stress, cloud cover, and precipitation to SST fronts. The role of stratified spinup in modifying the atmospheric response to SST fronts, yet to be explored, is of particular interest. (Abstract ID 10929)

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AN APPLICATION OF OPTIMAL INTERPOLATION TO SATELLITE OBSERVED CHLOROPHYLL-A AND ITS SPATIAL-TEMPORAL VARIATION

The East/Japan Sea which located in North-western Pacific shows high primary production due to its rapid turnover circulation. Related with global warming, the East/Japan Sea took a large attention as a potential carbon sink. Recent development of the satellite ocean remote sensing technology made wide area monitoring of chlorophyll-a with high resolution and high frequency available. Still, blank satellite data due to atmospheric condition is a problem to be solved. We filled the blank data using optimal interpolation method and analyzed reconstructed data. Chlorophyll-a data in the East/Japan Sea were achieved from July 2002 to July 2011. Using the data, spring and fall bloom initiation timing and location were identified and its spatial and temporal variations were analyzed. (Abstract ID 10905)

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TIDAL EFFECT IN PREDICTIONS OF OIL SPILL TRAJECTORIES IN THE YELLOW SEA

The Hebei Spirit oil spill accident on 7 December 2007 was economically one of the largest ocean disasters in the Korea. Multi nested prediction system for the YS using the Regional Ocean Modeling system (ROMS) has been developed to predict the movement of oil spill for the Hebei Spirit. A suite of nested computational domains is implemented from the Northwest Pacific model to the coastal zones of interest. The oil spill trajectories at the surface predicted by model considering tide were comparable to the observation for one month experiment, whereas the trajectories predicted without tide is remarkably faster than the observation. The bottom current flowing northward without tide is also faster than that with tide in the interior of the YS. Increased bottom friction by strong tidal current results in decrease of vertical shear between the surface and bottom currents, whereas the relatively active bottom northeaster current which could act as a compensation flow may enhance the surface current without tide. Strong tide might reduce upwind flow and recirculation in the YS. In tide dominant area such as the YS, tide must be included to predict accurate trajectory not only for tidal period but also longer period. (Abstract ID 10874)

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PHYSICAL AND BIOLOGICAL RESPONSES DURING THE 2009-2011 ENSO EVENTS IN THE SOUTHERN CALIFORNIA CURRENT

Atmospheric teleconnections of tropical El Niño [La Niña] events typically generate cyclonic [anticyclonic] wind anomalies in the northeast Pacific, which result in weakening [strengthening] of coastal upwelling in the California Current. The high resolution NCEP North American Regional Reanalysis (NARR) dataset confirms that upwelling favorable winds...
weaken in spring/summer 2009, the onset of the 2009-2010 El Niño, and strengthen in spring/summer 2010, the onset of the 2010-2011 La Niña. Consequent changes in chlorophyll (CHL) were observed in summer 2009, the onset of the 2009-2010 El Niño, and strengthen in spring/summer 2010, the onset of the 2010-2011 La Niña. Details of the link between physical forcing and primary production will be examined using continuous multidisciplinary mooring data in addition to NARR and remote sensing data. (Abstract ID 11505)

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NEURAL NETWORKS ON THE OCEAN EFFECT ON HURRICANE INTENSITY

We investigate the oceanic effect on hurricane intensity numerically using Hurricane Weather Research and Forecasting (HWRF) model. An initial approach taken is a comparison of simulated hurricane intensities from non-coupled HWRF where sea surface temperature is held constant in time, and from coupled HWRF to the 3D HYCOM (Hybrid Coordinate Ocean Model). Analysis of 77 forecasts for Hurricane Gustav 07L (2008) and Ike 09L (2009) showed that a full interactive ocean coupling reduces the positive intensity bias by 20 – 25% than the non-coupled simulation. Both the coupled and non-coupled simulations used the same surface flux formulations implemented in HWRF, to compute momentum and enthalpy fluxes. In the first part of the presentation, we will explore the sensitivity of the HWRF-to-HWRF parameterization. The second part will present an analysis of experiments designed to address the following questions: 1. How does sea surface temperature variability encountered by translating footprint of the hurricane affects intensity? 2. Under what circumstances is the ocean feedback significant?; and 3. What are the necessary attributes of a coupled model to represent adequately a hurricane? (Abstract ID 11792)

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VARIABILITY OF SUMMERTIME DENITRIFICATION RATES AT THE...

We present the result of temporal variation of the denitrification rates at the “Dead Zone” of the northern GOM during July 1995–2007 (except for July of 1988–1990), estimated by the extended Optimum Multi-parameter (OMP) analysis. The estimated denitrification rates at the bottom waters (<1 m above the sea floor) range from 1.36±0.58 to 7.40±4.17 Gg N mon⁻¹ (only for the July and for the mean study area of 3.2±10¹⁰ m²). The denitrification rates have gradually decreased from 1985 to 1997, and then increased during the 1998-2007 period, with somewhat large variation. The bottom waters on the Texas-Louisiana inner shelf were mainly composed of Texas-Louisiana Coastal Water (TLCW) and Subtropical Underwater (SUW), with much smaller volume contributions from the Mississippi and the Atchafalaya Rivers. Our results indicate that the composition of TLCW for the bottom water has increased gradually by as much as ~25% since ~1997, and this appears to have influenced the increase of benthic denitrification rates in the study area. The benthic denitrification rates at the bottom water of the northern continental shelf of GOM are not only influenced by the organic matter supply (biogeochemical factor: remineralization), but also by the relative contribution from different water masses (e.g. TLCW vs. SUW) to the area (physical factor: stratification). (Abstract ID 9329)

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DISOIILED ORGANIC CARBON (DOC) IN THE SOUTHWESTERN EAST/JAPAN SEA

In the summer of 2008 and 2011, the vertical and horizontal distributions of dissolved organic carbon (DOC) were measured in the southwestern East/Japan Sea (EJS). In 2008, the concentrations of DOC ranged from 58 to 104 μM in the upper 200 m, and 54 to 66 μM in the deep water (200 – 1500 m) which were higher than those in the major oceans. A correlation between apparent oxygen utilization (AOU) and DOC in the deep ocean of the EJS revealed that the contribution of sinking DOC to the total biological degradation is relatively small (<10%). In a warm eddy region occurred in the upper 0 – 20 m in 2011, the concentrations of DOC were similar to those observed in 2008, while the concentrations of total dissolved nitrogen were lower toward the eddy center. The concentrations of DOC in the surface layer were unusually higher than those in the subsurface layer in these two periods, which seem to be due to the significant inputs of terrestrial DOC from the land. (Abstract ID 10937)

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SPATIAL AND TEMPORAL PATTERN OF RIVER FLOW AND VERTICAL STRATIFICATION ACCORDING TO SEA GATE OPERATION IN THE YEONGSAN RIVER, SOUTH KOREA

Eutrophic circulation system has been changed in Yeongsan-river estuary, South Korea, since the construction of sea-dike. The sea-dike blocked a tidal effect, and artificial freshwater discharge reduced the tidal flat area and estuary width. To understand vertical stratification formation mechanism, physical properties of water such as, river flow, current, salinity and DO was observed using ADCP and CTD for 13 hours on 10th and 15th, August 2011. The strong fresh water discharge took place on 10th August 2011, only Maximum current reached more than 3.0 m/s on the day of strong river discharge (10th). Even this strong discharge from sea-gate at upper region, the bottom water flow upstream (0.5m/s) so that obvious 2 layer system was formulated. Although downstream freshwater tried to transfer its momentum to bottom for mixing, the salinity in bottom water maintains 30psu for the whole period. Similarly, the distribution of DO at surface indicates higher concentration than bottom. When the freshwater is weak (15th, August 2011), salinity at surface is 24-26psu and 30psu at the bottom. Maximum tidal velocity is about 05m/s during the normal condition. (Abstract ID 12894)

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OBSERVATIONS ON FRONTAL-SCALE SECONDARY CIRCULATION ASSOCIATED WITH DRIFTING SUBMESOSCALE EDDIES

Two episodic events of secondary vertical circulation associated with drifting submesoscale eddies are presented with submesoscale current [O(1) m depth] derived from shore-based high-frequency radars (HFRs) and in-situ vertical profiles of the current and temperature within the spatial coverage of HFRs. In order to detect eddies from surface current maps, the winding-angle based approach based on flow geometry is applied to the calculated stream function. A cluster of nearly-enclosed streamlines with persistent vorticity in time is identified as an eddy. About 700 eddies were detected for each rotation (clockwise and counter-clockwise) from two-year surface current observations. The two rotations show similar statistics with diameters in the range of 5 to 25 km and Rossby number of 0.2 to 2. They persist for 1 to 7 days with weak seasonality and migrate with a translation speed of 4 to 15 cm/s advected by background currents. Considering the local wind events and surface kinematic and dynamic quantities (velocity potential, stream function, divergence, vorticity, and deformation rates), the vertical movement of thermoclines are more related to drifting submesoscale eddies instead of local upwelling. (Abstract ID 10900)

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INCREASING N ABBUNDANCE RELATIVE TO P IN THE NORTHWESTERN PACIFIC OCEAN DUE TO ANTHROPOGENIC NITROGEN DEPOSITION

The relative abundance of nitrate (N) over phosphorus (P) has increased significantly over the period since 1980 in the marginal seas bordering the northwestern Pacific Ocean, located downstream of the populated and industrialized Asian continent. The increase in N availability within the study area was mainly driven by increasing N concentrations, and was most likely due to deposition of pollutant N from atmospheric sources. Atmospheric N deposition had a high temporal correlation with N availability in the study area, except in selected areas wherein riverine N load may be of equal importance. The increase in N availability caused by atmospheric deposition and riverine input has switched extensive parts of the study area from being N-limited to P-limited. (Abstract ID 9822)

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DISOIILED ORGANIC CARBON (DOC) AND NITROGEN (DON) IN THE EAST/JAPAN SEA

Vertical and horizontal distributions of dissolved organic carbon (DOC) and dissolved organic nitrogen (DON) were measured in the East/Japan Sea (EJS), a marginal sea of the Pacific, during four periods from 2007 to 2009. The concentrations of DOC (8 ± 6 μM) in the surface layer (upper 200 m) of the EJS fall into the range in the major oceans, but those (58 ± 4 μM) in the deep layer (200 – 5500 m) were significantly higher than those in the Pacific Ocean (34 μM). The EJS stores approximately 0.9 Pg (10¹² g) of potentially bio-reactive DOC, which is about 12% of the bio-reactive DOC pool in the entire Pacific Ocean. This strikingly large storage is likely due to their rapid deep-water overturning and low DOC re-mineralization rates in the deep EJS. In contrast, the concentrations of DON in the entire depth were lower than those
in the major oceans. These high DOC:DON ratios seem to be due to the preferential uptake of DON by picophytoplankton in this extremely N-depleted EJS environment. (Abstract ID 10994)

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ON THE SELECTIVE REGIONAL RESPONSE OF THE ANTARCTIC CIRCUMPOLAR CURRENT FRONTS TO ATMOSPHERIC AND OCEANIC VARIABILITY

The Antarctic Circumpolar Current (ACC) is well known for its multiple bands with large meridional property gradients in the upper waters as well as narrow deep-reaching current cores. A revised 17-year time series (1992-2009) of altimeter data from CNES/CLS AVISO is analyzed to identify and trace the spatial distribution and temporal variability of the multiple ACC fronts and its southern boundary. Specific contours of sea surface height (SSH) closely follow the observed multiple bands of maximum SSH slope. Their correspondence to ACC fronts is validated in the South West Antarctic Ocean using concurrent high-resolution data from hydrographic stations and ARGO profiles. Jets associated with the Subantarctic, Polar and southern ACC fronts have all experienced large seasonal to interannual variability from hydrographic stations and ARGO profiles. Jets associated with the Subantarctic, Polar and southern ACC fronts and its southern boundary. 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together in 2010 to establish COSEE China. Our goals are to (1) improve ocean literacy and awareness at the K-12, public, and university levels, (2) foster relationships between ocean scientists and educators, both internationally and domestically, and (3) bring marine sciences to the forefront of national development strategies and promote its protection. In order to achieve this, we hope to partner closely with COSEE centers across the United States so that ideas may be exchanged. Each university (or region) will function as a branch office under the COSEE China network and develop localized outreach programs. National level outreach will be coordinated jointly by Xiamen University and Ocean University of China. In the long run, we will work with relevant governmental agencies to develop nation-wide standards for ocean science education. Here we provide an overview of COSEE China and examples of outreach programs being developed by the Xiamen branch, encouraging citizenry to “Think Blue.”

(Abstrat ID 9500)

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ESTIMATING MID-WATER HYDROCARBON Fluxes WITH An AUTONOMOUS UNDERWATER VEHICLE AND AN IN-SITU Mass SPECTROMETER

Following reports of deep hydrocarbons from several investigators working near the yet-uncapped Deepwater Horizon well, we estimated the hydrocarbon flux in mid-water plumes using a CTD rosette and the Sentry Autonomous Underwater Vehicle (AUV), both equipped with the Tethys in-situ mass spectrometer. We first operated Tethys on the CTD in a “bow-yo” mode at a 6km radius around the leaking well, locating hydrocarbons at approximately 1100 m-depth in the southwest quadrant. Subsequent Sentry dives, in which we programmed the vehicle to fly outward from the well in a zig-zag pattern, tracked the plume nearly 30 km to the southwest of the well. Mass spectrometer data, transmitted to the surface vessel in real-time by the AUV’s acoustic modem, showed that the vehicle encountered hydrocarbons on each pass and this data informed where to deploy the CTD for obtaining samples for laboratory analysis. Estimates of overall mass flux were determined using the vehicle’s navigation system and the on-board acoustic doppler current profiler. Hydrocarbon concentrations were determined from the mass spectrometer data and from laboratory analysis of rosette samples from the CTD. (Abstract ID 12317)

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THE WIND-DRIVEN CURRENT AMPLIFICATION OVER THE EASTERN FLANK OF STANNA TROUGH: OBSERVATIONAL DATA AND RESULTS OF NUMERICAL MODELING

St.Anna Trough in the northern Kara Sea is the region that is strongly affected by water exchange with adjacent areas. The knowledge on the water dynamics in this area is critical for understanding of interaction between these branches and their impact on the Arctic marine climate. However the current measurements have been absent up to now. We present the results of a year-long current measurements obtained at the eastern flank of St.Anna Trough in 2009-2010. It was found that the mean northward flow (of 17-22 cm/s) exhibits the pronounced low-frequency variability with amplitude of 20-25 cm/s over the depth range of 134-472 m. These changes are correlated with the south-western winds (+0.48) including the ice-covered period. The wind-driven alteration of the sea-surface height pattern is the probable mechanism that controls the geostrophically adjusted current amplification in the eastern part of the trough. High-resolution simulations confirm this basic concept, although the model current amplification is about three times less than the observed changes in the current velocities. (Abstract ID 1385)

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OBSERVATIONS OF THE ROLE OF REYNOLDS STRESSES IN ACROSS-SHELF EXCHANGE DYNAMICS.

Over the continental shelf, turbulence plays a primary role in determining momentum through the water column. In the inner shelf, where surface and bottom boundary layers overlap, the magnitude and vertical structure of turbulent momentum flux, often described as Reynolds stresses, is thought to have a controlling influence on the circulation and exchange. Recently developed analysis techniques have documented ways to account for wave-induced biases, allowing in situ observations of turbulent stress profiles from commonly-deployed acoustic Doppler current profilers (ADCPs). Applied to the 10+ year ADCP record from the Martha’s Vineyard Coastal Observatory (MVCO), estimates of the intrusions, from coastal to oceanic, hydrographic, and wind observations, to examine how inner-shelf processes interact to determine the across-shelf exchange. By using the long-term dataset, this work is able to separate the incremental effects of along-shelf winds, across-shelf winds, and surface gravity waves on Reynolds stresses, and relate variations in momentum transfer due to these processes to variations in across-shelf exchange. (Abstract ID 11338)

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THE ACTIVITY OF ANAMMox AND DETRIFYING BACTERIA IN THE SUBOXYGEN ZONE OF THE BLACK SEA

Fixed nitrogen loss from marine systems exerts long-term controls over primary productivity, climate, and the effects of anthropogenic inputs. Both known microbially-mediated N loss pathways, anammox and denitrification, require nitrite. However, heterotrophic denitrification relies on organic C, while anammox requires ammonium. In the Black Sea, a model system, there has been little consensus as to the relative contributions of these two processes. We show that both of these groups were active but their distributions are fundamentally different, with denitrification activity being much more variable. Our results, based on analysis of dissimilatory nitrite reductase (nirS) expression over several seasons, reveal that denitrification was quite variable over time and space while anammox was more stable and consistent. Shallower depths where anammox bacteria were not active showed considerable variability in dissolved N2 as well as in the activity and community structure of denitrifying organisms. This suggests that the role for these organisms in the geochemical cycling of N is temporally variable, explaining some of the disparities between studies that have come to opposite conclusions regarding the dominance of one pathway over the other. (Abstract ID 12625)

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USE OF AN EM3002 MULTIBEAM SONAR IN UNDERWATER ARCHAEOLOGICAL RESEARCH

Multibeam sonar has recently been applied to underwater archaeological research, with surveys in 2011 in Italy, Albania and Montenegro. R.P.M Nautical Solutions utilizes an EM3002 multibeam sonar on board the R/V Hercules to scan large areas of mostly unexplored nearshore coastal regions within the Adriatic Sea. Raw data are actively fed through a suite of post-processing software, including CARIS HIPS & SIPS and Fledermaus. Once data are cleaned, the company’s archaeological team examines 3-d images of the data and, based on certain parameters such as object height and shape, determines targets or possible ancient ship wreck sites. An ROV is then deployed to examine these possible ship wreck sites. Ancient treasures such as amphora, battle rams and roman helmets have been retrieved by using either the manipulator hands of the ROV or by divers. These treasures belong to the countries in whose coastal waters they are found, and will be displayed in museums. Such archaeological finds enrich the general population that often knows little of the cultural treasures that lie beneath waters adjacent to their shoreline. (Abstract ID 10138)

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HOW DOES MEGA-EARTHQUAKE AND TSUNAMIS DISTURB CONTINENTAL MARGIN ECOSYSTEMS?: LESSON FROM TOHOKU MEGAQUAKE MARCH 11, 2011

Continental margin is one of active areas both for biodiversity and biogeochemical cycles. The continental margin ecosystems are basically sustained by photosynthesis-based food chain. Chemosynthesis-based community should also be an important component. However, it is difficult to explain why continental margin ecosystems are so diverse in comparison to other marine ecosystems. Ecosystem disturbances due to vigorous tectonic event should be one of reasons why diverse ecosystems are mixing at continental margins, from coastline up to trench. On March 11, 2011, huge earthquake with Magnitude 9.0 was taken place off northeast Japan. Big tsunamis took place and swept out everything from the coasts to seas. What kinds of disturbances do actually take place in the sea at continental margin areas, from coastline up to trench? Three major disturbances are expected to take place at the continental margin. They are big wooden gavages transfer from land, submarine landslides and methene and hydrogen sulfide gases and liquids squeeze out from sediment. We would like to discuss above disturbances through our cruise including HOV Shinkai 6500. (Abstract ID 9872)
along with warm water intrusions at depth. (Abstract ID 11841)

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A SHORT-TERM IN SITU CO2 ENRICHMENT EXPERIMENT AT HERON ISLAND (GBR) CAUSED DECLINING CALCIFICATION OF CRUSTOSE CORALLINE ALGAE

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FOOD SOURCES UTILIZED BY HERRING IN RELATION TO OTHER JUVENILE FISHES REARING IN NURSERY HABITATS DURING THE HIGH LATITUDE WINTER

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A CAUSE OF INTER-MODEL VARIATION IN 21ST CENTURY MERRIDIONAL OVERTURNING PROJECTIONS

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Climate models used in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change provide a wide range of projections for the amount of decrease in the Atlantic Meridional Overturning Circulation associated with a standard scenario of increasing greenhouse gas concentrations. Here, it is shown that 65% of the variation in Atlantic overturning decline among seven such models may be explained by the variation in winter surface density difference between the northern North Atlantic and other high latitude regions. Much of the variation in density is due to a wide range of northern North Atlantic salinity responses to climate change, ranging from almost unchanged salinity to a freshening that lowers density much more than high-latitude warming does. Surface density is highly correlated with indices of both North Atlantic and South Atlantic overturning, but not to the Atlantic streamfunction maximum, a commonly used overturning index. Overturning response to wind, and control–run decadal variability, are also compared among different models. (Abstract ID 11894)
Eddy transport across mean currents is a central element in many phenomena, such as for example in the poleward movement of warm waters in the Southern Ocean. Previous work on eddy mixing has been inconclusive on whether eddy mixing is enhanced or suppressed across the Antarctic Circumpolar Current. In this study we use a velocity field representing a region of the ACC to estimate eddy diffusivities from tracer releases and Lagrangian floats. We find that eddy mixing is suppressed in the core of the ACC from the surface down to 1500m, while it is larger on its flanks and at depth. These results are consistent with the mixing length arguments proposed by Ferrari and Nikurashin (2010). Previous discrepancies found in the literature, which were derived using Lagrangian floats, are the result of poor statistics, rather than any fundamental difference in the various approaches. These results are then discussed in the context of DIMES, a field experiment with one major goal being to estimate eddy mixing in the Southern Ocean through releases of an anthropogenic tracer and 150 isopycnal RAFOS floats. (Abstract ID 10326)

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BIO-ACOUSTIC OBSERVING SYSTEM AT BASIN SCALES PART OF AUSTRALIA'S INTEGRATED MARINE OBSERVING SYSTEM.

Bio-Acoustic data from ships of opportunity are now part of Australia's Integrated Marine Observing System (IMOS) providing a link between ocean physics and the structure and function of ecosystems. This data complements ocean colour, continuous plankton recorders, fish tracking and passive acoustic biological observations. Within IMOS active bio-acoustics is being used to monitor ocean basin scale secondary productivity. These basin scale measurements are being used to initialise and assimilate with ecosystem models to map the biomass and distribution of organisms from crustaceans to small fish. Both single and multi-frequency acoustic methods are being used to determine acoustic species groups and biomass. In the context of climate change and variability this monitoring is being designed to detect decadal signals at basin scales. Implementing a sustained bio-acoustic observing system with appropriate calibration, data quality; data management and meta-data standards is required. Development of an international meta-data standard is ongoing within the ICES Fisheries Acoustic Science and Technology working group. We overview the development of the bio-acoustic observing program and highlight issues for further development (http://imos.org.au/ basoop.html). (Abstract ID 10762)

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RECENT OBSERVATIONS OF HYPOXIA IN GREEN BAY, LAKE MICHIGAN AND POTENTIAL LONG TERM CLIMATE CHANGE IMPACTS

Green Bay, Lake Michigan has a nearly century long history of hyper-eutrophic conditions with excessive nutrient inputs representing 1/3 of the total nutrient loading to the Lake Michigan basin. The bay acts as an efficient particle trap accumulating organic rich sediments that quickly become anaerobic. During late summer stratification, bottom water dissolved oxygen drops below the 5 mg/L standard, and episodes of hypoxia (<2 mg/L) are common. Future climate scenarios project warmer and wetter conditions with shorter winters, reduced ice cover, increased winter runoff, increased frequency of heavy precipitation events, and an extended stratified period, all of which can impact hypoxia. In the last 2 decades, a more frequent, systematic southerly shift in the prevailing summer storm track through the Great Lakes region has also altered circulation and increased particle trapping and retention. Downscaled regional climate projections, watershed loading models, and hydrodynamic and biogeochemical models are being used to assess both current and future conditions in the bay and the efficacy of nutrient abatement strategies to mitigate hypoxic events. (Abstract ID 9756)

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INFLUENCE OF MISSISSIPPI RIVER PLUME ON DISTRIBUTIONS OF DIAZOTROPHS IN THE GULF OF MEXICO

Diazotrophy is an important N source in subtropical ecosystems affected by river plumes. Diatom symbioses have been found to be the major diazotrophs in the mesosaline area of the Amazon plume followed by Trichodesmium in areas of higher salinities and temperatures. We hypothesized that the Mississippi River, a major source of freshwater, nutrients and sediments to the Gulf of Mexico, has a similar effect on the distribution of diazotrophs. We examined this relationship in July, 2011 during a flood outflow of the Mississippi River. The low salinity plume was characterized by a high >10 µm chl fraction as it extended W and SE into the Gulf. Preliminary data indicates Heni濉ius spp (dominant symbioses) was more abundant west of the delta outside the plume; Trichodesmium increased in abundance in 1-30 col L-1 at 15 PSU to 25+ col L-1 at 34 PSU within the plume. Trichodesmium abundance decreased 10-fold crossing from the low salinity plume to the Loop Current. Patterns in the Amazon plume were not replicated in the Gulf of Mexico; the reasons for this are unclear. (Abstract ID 12002)

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QUANTIFYING THE IMPORTANCE OF NITRATE AND N2 FIXATION AS SOURCES OF NEW N FOR EXPORT PRODUCTION IN THE EASTERN TROPICAL SOUTH PACIFIC USING N ISO TOPE BUDGETS

Carbon and nitrogen fixation rates were measured on two cruises to the Eastern Tropical South Pacific (ETSP) during El Nino (January-February 2010) and La Nina (March-April 2011) conditions. Measurements were made across large spatial and biogeochemical gradients, along 10º & 20º S from strong upwelling to highly oligotrophic conditions at 100º W, and included estimates of incubation-based nitrogen fixation rates, export production from floating and moored sediment traps, and net community production from dissolved oxygen mass-balances. Nitrogen isotope (δ15N) measurements of water column nitrate and sediment trap material were used to construct δ15N budgets to evaluate the quantitative importance of nitrogen fixation as a source of new nitrogen to export production. In all cases, euphotic zone δ15N budgets imply that nitrate is the dominant source of new nitrogen supporting export production. Nitrogen fixation rates estimated from the δ15N budgets largely agree with euphotic zone incubation-based nitrogen fixation rate measurements, which are typically low. However, spatial and temporal variability in both carbon and nitrogen fixation rates imply that the importance of nitrogen fixation in supporting export production varies throughout the ETSP (Abstract ID 9617)

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FLOOD DEPOSITION ON THE WAIPAOA SHELF, NEW ZEALAND

Fluvial sediment can create preservable deposits in coastal waters. Depocenter location and shelf sediment budgets are sensitive, however, to many factors including sediment settling velocities, wave and current energy, and accommodation space. Post-depositional reworking can modify the initial deposit, obscuring the relationship between the flood and the depositional product. Few studies have monitored the evolution of flood beds at high-resolution time scales. Early into a fifteen month field experiment on the Waipaoa River Shelf, a 10-year recurrence interval flood delivered an estimated 0.1 Mt of sediment to the coastal ocean with concentrations exceeding the threshold for hyperpycnal plume formation. To
characterize the initial deposit, sediment cores were collected from the shelf two weeks later. Analyses indicated that recent deposition extended alongshore to the north and south from the river mouth and offshore to at least 100 m water depth. Terrestrial signals were preserved in flood sediments located directly offshore, and to the north, of the river mouth. Ongoing work will compare the signature of this flood to samples from the site taken shortly before the flood and several months later. (Abstract ID 11851)

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Benthic Fauna of the Northeastern Chukchi Sea, 2008–2010

In 2008 to 2010, an interdisciplinary study evaluated benthic communities in the vicinity of three proposed oil and gas exploration areas (Burget, Klonkide, and Statoll) in the northeastern Chukchi Sea. This study was sponsored by ConocoPhillips, Shell Exploration and Production Company, and Statoil USA E&P to collect information on the ecosystem in these areas prior to exploration and to provide environmental data useful for permit applications and post-development comparisons. Sediment-dwelling macrofauna and megalafauna were collected at up to 82 sites with a van Veen grab in August, 2008 to 2010, and at 37 sites with a plumb staff beam trawl in 2009 and 2010. The fauna found in 2008 to 2010 were numerous and large. Abundance, biomass, and the number of taxon found were significantly higher in the Burger study area as compared to Klonkide, with the Statoll site reflecting intermediate values. Spatial variations were associated with physical gradients and temporal variations with oceanographic conditions reflecting climatic variability. These results indicate strong associations of benthic communities with seafloor geomorphology and environmental gradients, as well as water column characteristics. (Abstract ID 11953)

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A Model for Scientist Involvement in Online Resource Development

There are many models for engaging scientists in education and outreach activities that can assist them in achieving broader impacts of their research. Discovery of Sound in the Sea (DOSITS) and Hurricanes: Science and Society (HSS) are high-quality online science resources developed in partnership with a multidisciplinary panel of scientists, education and outreach professionals, and educators. In addition to the website, both projects produce a 16-page publication for policymakers and other stakeholders along with an accompanying CD-ROM. Scientists participate in DOSITS and HSS through an Advisory Panel composed of 6-10 members. Advisory Panel members participate in semiannual meetings, which include project planning and review of new material. Scientists may also engage in the project through activities such as: proposal of topics to develop, develop topic materials, production or distribution to digital assets, and participation in seminars and workshops for educators, the public and stakeholders. The model used to provide the participating scientists with an opportunity to contribute their expertise in such a way that there are long lasting effects and/or useful products from their engagement is discussed. (Abstract ID 11838)

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A Long-term Ocean Forecast Experiment for Gulf of Mexico Applying IASNFS

The Gulf of Mexico has one of the most productive fisheries; it also has the largest offshore nature gas and oil production in US. To support those activities, a real-time ocean prediction is needed. The BP spill in 2010 shows the importance of having such a prediction. Since 2003, NRL has been operating in real-time an Intra-Americas Sea Nowcast/Forecast system (IASNFS) that covers the Gulf of Mexico. IASNFS is an integration of a data-assimilating, dynamical ocean model, a statistical data-analysis model, and various data streams. The system assimilates satellite data and in-situ measurements to produce a nowcast and is forced with a meteorological forecast to produce an ocean forecast. During 2010 Gulf oil spill, one was of the backbone models that provided surface current for oil trajectory prediction. IASNFS produces only short-term (under a week) forecast, a longer term (months) forecast, however, is desirable in particular to support offshore gas/oil operation. An experiment (GOMEX) was commenced to study the feasibility of long-term ocean prediction for the Gulf that includes IASNFS. Several experiments have been conducted, here we evaluate 12 sets of monthly 3-month long forecast for 2010 against satellite altimeter analyses. The evaluation shows IASNFS has a forecast skill to 1 month or longer that is better than persistence. Month by month variation exists that mainly falls Loop Current/Eddies evolution. (Abstract ID 11902)

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Long-term Variations of Surface and Intermediate Waters in the Southern Indian Ocean Along 32S

Variations of water properties in surface and intermediate layers along 32S in the southern Indian Ocean were examined using a 50-year (1960-2010) time series reproduced from historical hydrographic and Argo data by using optimal interpolation. Salinity in 26.7-27.3 sigma-theta decreased significantly over the whole section, at a maximum rate of 0.02 per decade at 26.8-26.9 sigma-theta, for the 50-year average. Three deoxygenating cores were identified east of 75E, and the increasing rate of apparent oxygen utilization in the most prominent core (26.9-27.0 sigma-theta) exceeded 0.05 ml/l per decade. The pycnostad core of SAMW and the salinity minimum of AAIW shifted slightly toward the lighter layers. Comparisons with trans-Indian Ocean survey from 1936 suggest that the tendencies began before 1960. Interestingly, cores of many prominent trends were located just offshore of Australia in the SAMW density range. A spectrum analysis revealed that two oscillation components with time scales of about 40 and 10 years were prominent. Our results are fairly consistent with, and thus support, the oceanic responses in the southern Indian Ocean to anthropogenic climate change predicted by model studies. (Abstract ID 10796)

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Evolution of the Horizontal Density Compensation: A Modeling Perspective

We assess the capability of the Hybrid Coordinate Ocean Model (HYCOM) to develop horizontal density compensation as observed in the upper ocean. Two idealistic scenarios with identical horizontal, partially compensated density fronts in the mixed layer are examined in subsomenscale-resolved run-down simulations. One scenario has a front dominated by temperature and the other scenario has a front dominated by salinity. In both scenarios, density compensation decreases with time simultaneously with the restratification of the mixed layer by subsomenscale eddies. Submesoscale fronts tend to be more compensated than mesoscale fronts. A sensitivity analysis shows that the density compensation of subsomenscale fronts is particularly sensitive to the horizontal diffusion rate. The lack of the model skill to develop and maintain compensated thermohaline variability is due to the sameness of the horizontal turbulent diffusion parameterization for temperature and salinity used in HYCOM. Results suggest that current numerical model dynamics cannot develop and maintain compensation as found in ocean observations. Some suggestions on improving horizontal diffusion parameterization that would differentiate between temperature and salinity are given. (Abstract ID 9992)

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Natural Radiation Modifies the Structure of Organic Matter in Aqueous Systems

Accumulated doses of natural ionizing radiation can be substantial over geological time scales. Based on the natural abundance of radionuclides, we calculated a typical dose rate of 0.04 Gy/ky in sea water, and 3.2-9.3 Gy/ky in marine sediments. We conducted a series of irradiation experiments using peat pore water and marine water and sediment samples. Fourier-Transform Ion Cyclotron mass spectrometry and lipid analysis was applied to elucidate changes in the molecular composition of organic matter by radiation, in dependence of dose and irradiation environment. While we find that the direct effect of radiation in the deep-sea is negligible even over the 5,000 years typical water residence time of organic matter, we see significant chemical changes, such as an increase of the average molecular oxygen content, after radiation doses that correspond to only several 10,000 years in marine sediments. We conclude that modification of organic matter by natural radioactivity is an important process over geological time scales, which affects the structure of any fossil organic matter older than several 10,000 years in a systematic way. (Abstract ID 11608)

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CYCLE-NH4 AMMONIUM MEASUREMENTS FOR LONG-TERM MOORED APPLICATIONS WITH HIGH-TEMPORAL RESOLUTION SAMPLING: VALIDATION AND DEMONSTRATION

Ammonium levels can affect phytoplankton communities, formation of harmful algal blooms, and contribute to eutrophication. Identifying sources can point to pollution or elucidate remineralization processes and redox gradients. The dynamics of ammonium are difficult to resolve because biological pathways span temporal scales and sampling methods are susceptible to contamination. Cycle-NH4 is an autonomous in-situ instrument designed for long-term moored deployments (months) with high resolution sampling. A modified fluorescence method is used to determine ammonium. Detection is performed in a thermostated cell and has a range from 0.1-10 micromolar. The instrument can run over 1000 samples worth without maintenance. Reagents and an on-board standard for quality control are delivered from click-in cartridges. A rapid field service (0.5 hr) minimizes measurement gaps. The CYCLE-NH4 realizes a sufficient sampling frequency, 0.5 hr, to monitor in-situ nutrient variability over relevant time scales including tidal cycles, runoff events, die-cycling, and phytoplankton blooms. An estuarine time series of ammonium combined with complimentary measurements is examined to demonstrate the utility of the Cycle-NH4 and validation of system performance using traditional methods is also presented. (Abstract ID 12822)

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DOES O2 CONSUMPTION DIFFER WITH COMPOSITION OF FAECAL PELLETS?

The goal of the present study was to investigate whether structural differences of doliolid copepods and copepod faecal pellets (volume, carbon content, composition, condensation) affect their oxygen consumption rates and change with ageing (freshly ejected vs aged pellets). Faecal pellets were produced by gonozooids of Dolioletta gegenbauri and females of the calanoid copepod of Eucalanus pileatus offering either a mixture or a monoculture of algae (Thalassiosira weissflogii, Rhizosolenia sp. flagellates) at environmental conditions. Ageing of pellets was performed in 3 μm filtered seawater. The individual oxygen consumption rates of O–2 h old doliolid pellets (average volume of 0.028 mm³) varied between 0.025 and 0.075 % O2 a.s. pellet−1 h−1 and were about 260% higher than those of O–18 h old copepod pellets (average volume of 0.003 mm³). Average numbers of total bacteria per doliolid pellet reached values of up to 3 x 10⁵, while bacterial numbers per copepod pellet approached 8 x 10⁴. Preliminary data revealed that O2 consumption rates were related to the volume and age of faecal pellets and their bacterial colonization (total and respiratory active bacteria, size spectrum). (Abstract ID 9399)

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APPLYING THE TA METHOD FOR THE EVALUATION OF THE CACO3-CYCLE IN OCEAN MODELS

Ocean biogeochemical models are routinely applied to assess the net global impact of ocean acidification and warming on pelagic CACO3 cycling. As with respect to the net change of global air-sea carbon fluxes affected by the reduced calcification under future CO2 conditions, these models diverge by a factor of four. The standard method to evaluate modelled CACO3 cycles is to compare alkalinity and CACO3 saturation states with observations. In general, state-of-the-art models do feature strong deviations and it is unclear if, or to what extent, these are driven by a deficient representation of physics (ocean circulation) or a deficient representation of biogeochemistry. Here we apply the TA method (developed to separate the signals of CACO3 production and dissolution from the large, conservative alkalinity background in oceanographic data) to model output. The aim is twofold. First, to assess the method using additional explicit representations of preferred alkalinity, accumulated CACO3 dissolution, and organic matter remineralisation. And second, we aim to disentangle deficiencies in the physical and biogeochemical module of an ocean biogeochemical model. (Abstract ID 10625)

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TEMPORAL VARIABILITY OF NEAR-INERTIAL WAVE ENERGY IN THE ATLANTIC DEEP WESTERN BOUNDARY CURRENT AT 16°N

The generation processes of internal waves and the evolution of the wave field are studied in the region of the Deep Western Boundary Current at 16°N in the Atlantic using mooring data supplemented by shipboard measurements. Shipboard measurements show strongly increased finestructure variability during times of a pronounced DWBC. Mooring data of the MOVE array are used to address the temporal variability of internal wave energy and its dependence on the observed velocity in the DWBC, tides and stratification. Temperature and velocity data from five deployment periods (2000 - 2005) are analysed. Spectra of vertical displacement and available potential energy of the timeseries show significant temporal variability and contain dominant spectral contributions from the major tidal constituents as well as the inertial frequency. Increased spectral energy levels, especially in the frequency range between semi diurnal tide and near inertial frequency, occur during times of high background velocities. Intensified baroclinicity during this times suggests an interaction of the DWBC with background topography as a possible generation process of the observed internal waves. (Abstract ID 12885)

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SMALL SCALE VARIABILITY OF THE CROSS SHELF FLOW OVER THE OUTER SHELF OF THE ROSS SEA

The importance of cross-shelf transport across the Ross Sea on local and remote processes has been well documented. Models and coarse observations in time and space have identified the roll cross-shelf transport plays in both the offshore movement of dense newly formed bottom water and the onshore movement of Modified Circumpolar Deep Water (MCDW). These intrusions of MCDW are hypothesized to deliver micro nutrients to the surface layers, impacting ecosystem processes. The bottom topography over the outer shelf is dominated by a series of banks and troughs that likely focus these shelf exchanges. In 2010-2011 we deployed multiplatform technologies to sample MCDW and its role in ecosystem processes across the shelf. The high-resolution time and space sampling provided by the underwater gliders, a short-term mooring and a ship based survey highlight the scales over which these critical cross-shelf transport processes occur. We will use these data to characterize the variability in the cross shelf flow along the bank/trough topography over spatial scales smaller than previously measured (typically 1-10s of km) and time scales of hours to days. (Abstract ID 12112)

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AUV RESEARCH AND EDUCATION IN THE ROSS SEA: SCIENTISTS SHARE RESEARCH EXPERIENCE WITH MIDDLE SCHOOL TEACHERS AND STUDENTS

In 2010-2011 we completed a rigorous field campaign to examine the impact of upwelled Modified Circumpolar Deep Water (MCDW) on the Ross Sea ecosystem. The intrusions of MCDW are hypothesized to deliver micronutrients to the surface layers, impacting primary productivity on the shelf. As an extension of valuable ship surveys in this harsh environment, we integrated electric gliders as a key component for successfully locating and mapping this critical water mass as it moves along the shelf. Fully integrated with this science plan was a comprehensive education program designed to introduce new audiences to the experience of Antarctic research and the AUV technology used. It was a multi-tiered program that included teacher engagement, professional development, daily activity blogs with incredible images and sounds developed by our on-board science writer and photographer, and scheduled live phone calls from the ship by members of the science team and ship's crew to classrooms back in the US. This presentation will focus on the implementation on this integrated science and education plan from the perspective of the scientific team in the field. (Abstract ID 12185)

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SPATIAL VARIABILITY OF PROTISTAN MICROPLANKTON DIVERSITY ALONG the KUROSHIO CURRENT ANALYZED BY 18S RIBOSOMAL DNA CLONE ANALYSIS

Biodiversity of protistan microplankton along the Kuroshio Current was revealed by 18S rRNA clone libraries. One hundred and thirty three clones derived from S18 library supplemented by shipboard measurements. Shipboard measurements show strongly increased finestructure variability during times of a pronounced DWBC. Mooring data of the
was virtually non-reactive in the sediments, and had a Δ14C value of -640‰. The benthic DOC flux of this 14C-depleted, poorly-reactive DOC fraction may represent a source of pre-aged epipycnal nutrient flux along the jet from the upstream region and the upward diapycnal flux of benthic DOC fluxes has been recognized, but their biogeochemical significance remains unclear, because the composition and reactivity of porewater DOC are not well characterization. To address this problem, we determined the Δ14C and δ13C signatures of porewater DOC and DIC in surface sediments of Santa Monica Basion, and analyzed them using a selective degradation model. The data were best described by the presence of 3 kinetically- and isotopically-distinct DOC subcomponents. The most reactive fraction, which supported 75% of the DIC production, had a Δ14C value of +40‰. The intermediate fraction had a Δ14C value of -50‰ and accounted for most of the porewater DOC standing stock. The least reactive fraction only where intruding warm currents deposited larval in localized areas. After settlement, maturing crabs appeared to exhibit ontogenetic migration toward deeper, warmer water. Cold temperatures excluded key predators, but decreased fecundity by restricting females to small body size (with associated small clutches) and to breeding only every 2 years. Migration to warmer water may allow females to breed annually, and to encounter more adult males needed to fertilize subsequent clutches. Because older males also emigrate, remaining adolescent males are probably important for insemi-nating newly maturing females. Without localized intrusion of warmer currents, snow crabs might not persist at high densities in such cold waters. However, they are currently very abundant, and export many pelagic larvae and adults. (Abstract ID 9484)

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RADIOCARBON SIGNATURES OF DISSOLVED ORGANIC CARBON (DOC) IN SANTA MONICA BASIN SEDIMENTS AND IMPLICATIONS FOR THE ROLE OF SEDIMENTS IN THE OCEANIC DOC CYCLE

Most DOC produced in sediments during organic matter degradation is efficiently remineralized to dissolved inorganic carbon (DIC), but some fraction accumulates in porewaters and supports an efflux of DOC into the water column. The quantitative importance of benthic DOC fluxes has been recognized, but their biogeochemical significance remains unclear, because the composition and reactivity of porewater DOC are not well characterized. To address this problem, we determined the Δ14C and δ13C signatures of porewater DOC and DIC in surface sediments of Santa Monica Basin, and analyzed them using a selective degradation model. The data were best described by the presence of 3 kinetically- and isotopically-distinct DOC subcomponents. The most reactive fraction, which supported 75% of the DIC production, had a Δ14C value of +40‰. The intermediate fraction had a Δ14C value of -50‰ and accounted for most of the porewater DOC standing stock. The least reactive fraction was virtually non-reactive in the sediments, and had a Δ14C value of -640‰. The benthic DOC flux of this 14C-depleted, poorly-reactive DOC fraction may represent a source of pre-aged DOC to the oceans. (Abstract ID 9700)

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FORMATION MECHANISMS AND BIOGEOCHEMICAL IMPACTS OF THE NUTRIENT STREAM IN THE KUROSHIO JET REGION

An intensive observation and historical data analysis detected the nutrient maximum located along the Kuroshio jet in spring on the isopycnal surface of 24.5-26.0σt, in the western North Pacific. It is analogous to the characteristic structure well-known as Nutrient Stream in the Gulf Stream. The observation was conducted at intervals of 10 miles along the 5 lines crossing the Kuroshio using the CTD with other sensors, the shipboard/lowered ADCP and the microstructure profiler. It clarified that the structure is formed by the synergetic effect of the epipycnal nutrient flux along the jet from the upstream region and the upward diapycnal flux due to the strong turbulent diffusivity enhanced around the jet. The high nutrient is supplied efficiently into the euphotic layer through the epipycnal diffusion in the frontal side owing to the strong baroclinicity. Their total nutrient flux amounts to 100mgC m-2 d-1 or more and contributes significantly to the spring new production in the frontal region. Moreover, the historical data revealed the relation between the nutrient structure and the cyclic decadal change of the productivity in the Kuroshio region. (Abstract ID 11051)

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COUPLING COEFFICIENTS AROUND THE MID-LATITUDE SST FRONTS IN A COUPLED ATMOSPHERE–OCEAN AND A STAND-ALONE ATMOSPHERIC GCMS

Recent high-resolution satellite observation have revealed positive correlation between spatially high-pass filtered surface winds and sea surface temperature (SST) around the SST fronts, indicating that the ocean affects the atmosphere at small scales. It has been also found that divergence (curl) of wind stress correlates with downwind (crosswind) SST gradient. Their regression coefficients are often regarded as a measure of the strength of their coupling and called “coupling coefficients”. In this study, coupling coefficients as simulated in a high-resolution coupled atmosphere–ocean and a stand-alone atmospheric general circulation models (CFES and AFES, respectively) are examined. To examine its spatial distributions, we calculate local coupling coefficients at each grid point rather than area-averaged ones often focused in the previous studies. It is found that coupling coefficients do not have their maxima over the mid-latitude SST fronts and their spatial patterns strongly reflect large-scale wind field in both CFES and AFES. While previous studies have focused on static stability effects on spatial and seasonal variability of area-averaged coupling coefficients, this study suggests that the variability of the coupling coefficients can also be attributed to large-scale variability of wind, and we need to distinguish the contributions to coupling coefficients from the local efficiency of vertical momentum transfer and from the large-scale available momentum. (Abstract ID 10289)

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OCEAN MIXING LAYER VARIATION AS INDICATED BY THE MEASUREMENT OF THE DISSIPATION RATE IN THE KUROSHIO EXTENSION REGION

We conducted the measurement of the surface turbulence on two cruises in the Kuroshio Extension (KE) region in January and October in 2009. Microstructure Profilometer was used to obtain the dissipation rate of the ocean. With use of the bulk surface turbulent flux corrected by the eddy covariance technique, the turbulent energy balance in the surface layer was evaluated. The first cruise was done in the middle of the KE recirculation gyre and the second in the north of the KE jet. The result shows the discrepancy between the variation of the ocean mixed layer and that of the turbulence. The mixed layer depth was relatively stable, whereas the mixing layer defined by the dissipation rate over 10 W kg-1 was likely to be deepened according to the synoptic atmospheric disturbance. A comparison of the observational results of two cruises suggests that the surface stratification condition can affect the turbulent energy balance in the ocean, and therefore change the process for deepening the uniform density layer. (Abstract ID 11122)

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Ocean-to-atmosphere flux exchange mechanisms, with an emphasis on mesoscale processes that govern interactions between sharp sea surface temperature (SST) gradients and surface winds at ocean fronts, are analyzed in the Kuroshio Extension region using the high resolution (0.1 deg) Weather Research and Forecasting mesoscale atmospheric model in climate and weather type configurations. We used three sets of SST estimates with different horizontal resolutions and focused on cold-air outbreaks (CAOs) causing intense ocean heat loss to the atmosphere, surface wind intensification, changes in the atmospheric stability, and turbulence in the marine boundary layer. Preliminary results for winter 1999-2000 showed complex evolution of air-sea coupling in the surface heat and moisture fluxes during CAO episodes that affect Pacific climate. Compared to the simulation results with coarser resolution (0.6 deg), the results with finer (0.1 deg) resolution improve the sensible (latent) heat fluxes by 90 (60) W/m², making them more similar to the aircraft observations over the KE region. (Abstract ID 12865)

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OPTICAL PROPERTIES OF COASTAL WATERS: ASSESSING THE ROLE OF RIVERINE INPUT ON THE TRANSPORT OF DISSOLVED CARBON TO THE COASTAL OCEAN OFF THE DEL

Since an important source of colored dissolved organic material (CDOM) is riverine input to the coastal ocean, the concentration of CDOM typically displays an inverse relationship to salinity. Particle matter can be transported from rivers into the ocean by biological processes. CDOM and particles effectively attenuate a beam of light, making optical measurements a useful means of determining the presence of these materials. We present observations of in-water optics using a WET Lab long-tube absorption meter (AC-9), along a cross-shelf transect from the Delmarva Peninsulas seaward to the 30-meter isobath. Our objective was to relate the presence of dissolved and particulate light attenuation to the hydrographic and bio-optical properties of the water column, in order to infer their sources and origins. This project is significant in analyzing the transport of organic carbon from the land to the ocean, and to provide a deeper understanding of the ocean’s carbon cycle. (Abstract ID 11654)

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SEASONAL VARIATIONS FROM A COASTAL OASIS: SIX YEARS OF HIGH-RESOLUTION DATA

The VENUS cabled observatory, located in the coastal waters of British Columbia and a partner within the NANOOS family, has been making continuous measurements of various oceanic parameters since February 2006. These high-resolution time series are revealing complex features of the coastal ocean that are either aliased or only partially resolved in periodic vessel surveys or limited duration moorings. In the six year record we have found that although the over-all seasonal patterns repeat, they clearly show the influence of El Nino, La Nina, warm or cool and wet or dry seasons, regional deep-water renewal events, and fortnightly forcing and modulation of the water properties. Several seasons of inverted echo-sounder data has also revealed variations in the dynamics of the zooplankton populations and their response to varied environmental conditions. An overview of the system and some of the key findings will be presented. (Abstract ID 10061)

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MULTI-PROXY CHARACTERIZATION OF SUSPENDED PARTICLE SIZE AND COMPOSITION IN THE SANTA BARBARA CHANNEL, CALIFORNIA

Understanding coastal ocean particle assemblages has important biogeochemical and remote-sensing applications. Here, the Plumes and Bloom’s bio-optical data set is used to characterize the size structure and composition of the surface particles in the Santa Barbara Channel, California. Multiple particle assemblage proxies are derived from observations of the particle beam attenuation and backscattering coefficients, HPLC pigment concentration, chlorophyll and POC concentration, particulate and phytoplankton absorption coefficients, and laser particle size observations. Comparisons among these proxies are generally consistent. Correlations among chlorophyll concentration, POC, HPLC pigments and proxies sensitive to the entire particle assemblage such as LISST data indicate that in spite of its coastal character, variability in the particle assemblage of the Santa Barbara Channel is dominated by its marine biogenic component. Positive correlation of chlorophyll, estimates of the bulk real index of refraction and lithogenic silica concentration tentatively indicate that there is minerogenic
particle influence in the Santa Barbara Channel that tends to covary with the phytoplankton blooms. Deviations from the assumed power-law parameterization of the PSD are analyzed. Performance of existing ocean color remote-sensing algorithms is discussed. (Abstract ID 10410)

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SCIENCE COMMUNICATION IN TIMES OF CRISIS: OUTREACH LESSONS FROM THE GULF OF MEXICO AND THE PACIFIC COAST OF JAPAN

The Deepwater Horizon oil spill and accidental release of radiation from the Fukushima Daiichi nuclear power plant represent two recent events related to the ocean that captured public attention for months. The public desire for information in part motivated scientists and communications staff at the Woods Hole Oceanographic Institution to organize expeditions-based outreach activities to communicate efforts to study the effects of both events on the marine environment. The urgent and potentially controversial nature of both highlighted the need for a well thought-out communications plan that includes a mix of traditional, social, and multi-media. Real-time outreach from the Gulf of Mexico centered around a 6-day cruise in December 2010 with DSV Alvin and ALV Sentry using the educational website Dive & Discover and that presented information through a broad mix of media channels. After the March 2011 earthquake, tsunami and nuclear accident in Japan, efforts focused on a more traditional, text- and photo-based cruise blog. Both of these efforts offer insights into planning and implementing effective science outreach in times of crisis, as well as under less urgent circumstances. (Abstract ID 10012)

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THE FATE OF DEEPWATER HORIZON OIL IN FLORIDA SANDY BEACHES: CAN OIL-EATING MICROBES HELP TO CLEAN UP THE MESS?

Crude oil from the Deepwater Horizon spill was washed onto sandy shores of the Northern Gulf of Mexico, and this study investigates the fate of this oil and its impact on microbial communities in oiled beach sands. Tar balls and pancake oil were deposited on the beach surface, and due to the subsequent deposition of sand layers, congealed oil and tar were embedded as deep as 75 cm in Pensacola beach sands. Dissolved, low-viscosity and dispersed oil fractions could penetrate the sand through the pore space, staining the beach surface layers. Adsorbed oil increased the cohesiveness of the sand and reduced sand permeability. Oiled sand layers contained elevated rates of potential oxygen consumption and dissolved inorganic carbon production, indicative of ongoing degradation of the sedimentary oil deposits. Twenty-four bacterial strains from 14 genera were isolated from oiled beach sands and confirmed as oil-degrading microorganisms by phenotypic characterization and phylogenetic analysis of small subunit (SSU) ribosomal RNA (rRNA) gene sequences. SSU rRNA gene copy numbers of total bacteria were approximately 10 times higher in oiled vs. clean sand. Oil contamination from the Deepwater Horizon spill had a profound impact on the abundance and community composition of indigenous bacteria in Gulf beach sands, and our evidence points to members of the Gammaproteobacteria (Alcanivorax, Marinobacter) and Alphaproteobacteria (Rhodobacteraceae) as key players in beach oil degradation. (Abstract ID 12282)

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ON THE ROLE OF LOOP CURRENT EDDIES IN ALTERING THE OIL PATHWAYS DURING THE DEEPWATER HORIZON OIL SPILL

During the 2010 Deepwater Horizon oil spill, regional models in the Gulf of Mexico were found essential in the prediction of circulation details that would greatly determine the pathways of oil substances. The Loop Current (LC) was initially in an extended position, potentially mixing the oil spill patches within the LC. At the time, the Loop Current was expected to take place and amplify the ecological implications by carrying oil substances toward South Florida and beyond, feeding into the Gulf Stream system. We employ the regional Gulf of Mexico (GoM) HYCOM model to show the role of cyclonic eddies in the detachment of the LC Eddy Franklin (anticyclonic ring), including instances of partial detachment and re-attachment. A possible mechanism for this intensification is presented. The full separation of Eddy Franklin from the main LC front was instrumental in disrupting the connectivity between the Northern GoM and the Florida Straits. In addition, coastal and shelf processes, as well as the persistent southerly winds played a strong role in oil pathways. (Abstract ID 10062)

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COMPOSITION OF THE DISSOLVED ORGANIC MATTER ALONG THE ATLANTIC MERIDIONAL TRANSECT WITH USE OF FLUORESCENCE SPECTROSCOPY AND PARALLEL FACTOR ANALYSIS

The CDOM absorption spectra, DOM fluorescence excitation emission matrix spectra and DOC concentration were measured in water samples collected in eight different biogeographical provinces of the Atlantic Ocean from October-2010 to November-2010. The highest CDOM absorption was recorded at the continental margins of the English Channel, and Patagonian Shelf waters. The CDOM absorption in the mixed layer of both North and South Atlantic subtropical oligotrophic gyres was significantly depleted. There was noticeable increase of CDOM absorption in the deep chlorophyll a maximum layers along the transect and in the deep oceanic waters in the Equatorial Upwelling. The CDOM composition was assessed by the CDOM absorption spectrum slope coefficient ratio according to Helms et al. 2008 and with use of the PARAFAC model applied to EEMs data set. The highest values CDOM absorption spectrum slope coefficient ratio were observed in the northern Atlantic subtropical gyre, which suggests a strong of CDOM photodegradation. The slope coefficient ratio values in southern Atlantic gyre were much higher compared those recorded in the northern hemisphere, indicating biological production of DOM by austral spring phytoplankton bloom. The lowest the slope coefficient ratio were recorded at the continental margins. The results of the PARAFAC model indicated much higher contribution of humic components in the CDOM fluorescence in the northern Atlantic than in the southern sector of the transect. (Abstract ID 9596)

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PALMYRA ATOLL'S ANOXIC LAGOONS: UNDERSTANDING THE HYDROGRAPHY AND ASSESSING RISK FOR THE CORAL REEFS

Palmyra Atoll (5°33′N, 162°02′W) is a relatively pristine coral atoll with three semi-isolated lagoons. Portions of Palmyra’s lagoons are anoxic (Gardner et al., 2011), largely due to modifications made during WWII. Understanding the physical and chemical properties of the lagoon is critical to assessing the risk that the lagoon poses to the reef through its transfer of low pH, anoxic bottom water. We compare CTD data sets collected in May and September 2011 to better understand lagoon circulation and residence time. Profiles distributed throughout the Central and Western Lagoons in September 2011 indicate strong chemical gradients with depth in the deepest, anoxic parts of the Central Lagoon, including changes in total DIC (TDIC) of 600 µmol/kg and in total alkalinity (TA) of 500 µmol/kg. In the Western Lagoon, closer to exchange with the open ocean, TDIC and TA gradients were smaller (~130 µmol/kg and 100 µmol/kg, respectively). The contrast in chemical gradients between the two sites emphasizes the importance of considering bottom water flushing mechanisms and residence time when evaluating the risk posed by anoxic bottom water to adjacent corals. (Abstract ID 12825)

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RELATIONSHIPS BETWEEN ERODIBILITY AND FINE-GRAINED SEABED PROPERTIES ON TIDAL TO SEASONAL TIME-SCALES, YORK RIVER Estuary, VIRGINIA

The complex bio-geo-physical nature of muddy particles in coastal and estuarine environments has limited our understanding of fine-grained sediment dynamics. An ongoing sedimentological study within the York River Estuary is investigating controls on cohesive bed erodibility by assessing changes in seabed properties over varying timescales. During the spring and summer of 2010 and 2011, multiple GOMEX box cores were collected and subsampled for grain size, fossil pellet content, Gust chamber erodibility, and water content. Initial findings suggest that erodibility of the seabed increased during periods following seasonal deposition

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RELATIONSHIPS BETWEEN ERODIBILITY AND FINE-GRAINED SEABED PROPERTIES ON TIDAL TO SEASONAL TIME-SCALES, YORK RIVER Estuary, VIRGINIA
Habitat Associations of Spotted Ratfish (Hydrolagus colliei) in the Monterey Bay National Marine Sanctuary

Improved knowledge of fish-habitat interactions is critical for understanding how species are distributed in the undersea landscape. The spotted ratfish (Hydrolagus colliei) is a deep water species of the Chimaeridae family occurring along the west coast of the United States. Despite its apparent abundance, the habitat associations and latitudinal distribution of spotted ratfish are not well understood. Videographic imagery collected via remotely operated vehicle (ROV) and berthing tow camera sled within the Monterey Bay National Marine Sanctuary (MBNMS) between 2006 and 2011 provided an opportunity to quantify the relationship between spotted ratfish and the habitat attributes (e.g., substrate type and relief) over which they were observed. Results to date indicate that spotted ratfish (n = 152) were found across the full extent of the MBNMS, distributed latitudinally and over all substrate types sampled. These results provide an important incremental step in the development of future management plans for species such as the spotted ratfish which are subject to frequent capture and discard by recreational and commercial fishermen but are yet unmanaged. (Abstract ID 9499)

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Autonomous Gliders: Vertical Velocities in the Tropical Atlantic Observed with Nearshore Tidal Energy at New Jersey Coastlines

In recent years, increasing attention has been shifted towards clean and renewable energy, and various plans and pilot projects have been developed to move away from using fossil fuels as the primary source of energy generation. Tidal energy is a clean, renewable, widely available class 1 renewable energy source. In order to achieve the most cost-efficient environmentally friendly power generation, it is crucial to identify the best power generation sites and to better understand how tidal power generation at these sites will impact their environments. This research makes a survey about tidal energy in estuaries and rivers of New Jersey using computer modeling approaches. Since actual coastal flows are multiscale and multi-physical, it is necessary to capture these characteristics, especially the frequency phenomena at the scales of the tidal power generation equipments. For this purpose, an ultra-fine mesh is generated along the entire region, and FVCOM is set up and calibrated. High-resolution modeling is computationally expensive and therefore carried out on high-performance computing facilities at NERSC (Hopper) or CUNY (Salk). Analysis will be made on solution accuracy and convergence as well as applicability of the models for such small-scale flows. Successful simulations will reveal detailed physics and behavior of tides near the coastlines, which can be used to support tidal power development in the region. (Abstract ID 12581)

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High-Resolution Prediction of Nearshore Tidal Energy at New Jersey Coastlines

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Sargassum Weeds: Examining Trophic Dynamics Within Floating Sargassum Communities of the Northern Gulf of Mexico Using Predator-Prey Mesocosm Experiments

Floating Sargassum seaweed and their associated faunal assemblages are among the most threatened marine communities in the northern Gulf of Mexico during the Deepwater Horizon oil spill. To assess the importance of these habitats within marine food webs and as a refuge for small invertebrates, we conducted mesocosm experiments to investigate trophic relationships within the Sargassum communities. The refuge function of Sargassum was examined by varying the areal coverage (one quarter vs. one half of the surface area of the mesocosm tanks) available to two shrimp species (brown grass shrimp, slender Sargassum shrimp) exposed to three different predators commonly associated with Sargassum (almaco jack, grey triggerfish, and tripletail). All shrimp were consumed in the control tanks (no Sargassum). There was no significant difference in the number of shrimp consumed by almaco jack and tripletail between the two treatments, however, significantly fewer shrimp were consumed by grey triggerfish when the areal coverage was greater. These results suggest that species-specific interactions need to be considered when assessing the loss of Sargassum habitat function due to the oil spill. (Abstract ID 10750)

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Species Effects on the Production and Accumulation of Biogenic Silica in Summer Diatom Blooms in the North Pacific Subtropical Gyre

Summer diatom blooms regularly occur in the North Pacific subtropical gyre (NPSP) and account for a significant fraction of annual organic carbon export. Biogenic silica (bSi) production, silicic acid uptake kinetics, and diatom community structure were examined within summer blooms in 2008 and 2009. Blooms were numerically dominated by Hemiaulus hauckii (2008) or Mastogloia woodwardii (2009). Substrate limitation of Si uptake occurred within both blooms and in the surrounding waters, but the bloom-station diatoms were more efficient at using Si(OH)4, than diatoms from non-bloom waters. bSi production rates were higher in the Mastogloia bloom compared to the Hemiaulus bloom despite lower bSi standing stock and [Si(OH)4] in the Mastogloia bloom. The Mastogloia bloom also had the most efficient Si uptake kinetics observed anywhere to date. High kinetic efficiency for Si uptake by the Mastogloia-bloom assemblage would foster increases in biomass under oligotrophic conditions by allowing further Si(OH)4 consumption within low [Si(OH)4] waters while avoiding growth limitation by Si. These results support the idea that diatom community structure and physiology play important roles in biogeochemical cycling within NPSP blooms. (Abstract ID 9406)

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The Potiguar Eddy

A subsurface-intensified, 150 km-wide, elliptically-shaped eddy is identified off the Brazilian northeast coast through ADCP velocity data obtained during two oceanographic cruises carried out by the Brazilian Navy in 2002 and 2004. The eddy, hereafter referred to as the Potiguar Eddy (PE), can be recognized as an anticyclonic frontal meander of the North Brazil Undercurrent (NBUC) and presents velocity core placed at approximately 100-200 m of depth. It has maximum velocities of about 0.6 m/s in its southern portion, and of 1 m/s in its northern portion. Analysis of the global model outputs from the FVCOM Consortium for the PE region over a three-year period (2003-2006) suggests that the PE is a recurrent feature with quasi-steady behavior. To the best of the authors' knowledge, it is the first time that a mesoscale feature related to the NBUC is described. (Abstract ID 11328)

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Will the Temporal Changes in the Vertical Distribution of Nutrients in the Levantine Basin (Eastern Mediterranean) Affect the Upper Layer's Biology?

The depth distribution of salinity, temperature, oxygen and nutrients changed in the Eastern Mediterranean (EM) following the EM Transient event in the 1990s. Analysis of historical and new data collected in the Levantine basin showed a cyclical increase and decrease of salinity of the upper mixed layer since 1960 and an uplift of the maximum nutrient layer from 1250 to
14C-technique is cumbersome, expensive, and not really suited for monitoring purposes. As to understand (changes in) aquatic ecosystems knowledge of primary production is essential. The PROTOOL project: A tool for automated primary production measurements of phytoplankton

To understand (changes in) aquatic ecosystems knowledge of primary production is essential. Normally this is done by measuring the rate of incorporation of radioactive labeled CO2. This 14C-technique is cumbersome, expensive, and not really suited for monitoring purposes. As a result there is very limited number of long term time series describing changes in primary production. In the FP7-EU program PROTOOL we are developing a new methodology for automated measurements of primary production, based on the combination of a number of optical techniques: 1) the RRPF approach to measure photosynthetic quantum efficiencies, 2) the optical cavity technique to measure algal absorption (PISCAM), and 3) spectral reflectance to measure water quality parameters like chlorophyll concentrations and light attenuation coefficients. Ideally our PROTOOL products should be combined with feryaxes. During this presentation I will show data on primary production estimated based on FRRPF data and will demonstrate daily patterns in photosynthetic parameters with unparalleled temporal resolution. I will also discuss the factors needed to convert rates of electron transport into rates of C-fixture.
The barrier islands of the mid-Atlantic coast are important because they serve as "sponges" in absorbing the constant pounding of waves and tides and reduce erosion of the mainland coast. The barrier islands provide protection for sensitive coastal habitats that support large population of migratory and resident bird species as well as shallow-water benthic environments that act as nurseries to numerous species including oysters, clams, blue crabs, and flounder. We show results from our study of the barrier islands using LIDAR measurements and a decade long CTD observations of the Chincoteague Inlet and offshore shelf water masses. Our goal is to elucidate the effect of sea level rise and global change on the Wallops barrier island ecosystem. (Abstract ID 11716)

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CROSS-SHORE AND ALONGSHORE VARIATION OF WIND AND WAVE-DRIVEN FLOWS IN THE INNER-SHELF AND SURF ZONE AT THE TIP OF CAPE HATTERAS, NC

In-situ measurements of waves and currents were carried out at Diamond Shoals near Cape Hatteras, North Carolina, USA, for the month of February, 2010. Acoustic current profilers were deployed at 14 sites for measuring flows. Sensors were deployed on both sides of Cape Point to measure contrasting currents on either side of Diamond Shoals with different orientations (north-south vs. southwest-northeast). The flow data reveals that wind-driven circulation dominates the flows within the inner-shelf region. Winds blowing from the east and north generate significant flows and waves at the north side of Cape Hatteras, while the south side is sheltered. On the contrary, when wind forcing is from the southeast, strong wind-driven flows and waves are present on both sides of the Cape Hatteras tip. Well defined Ekman layer is observed when winds are from the northwest. A depth-averaged, alongshore momentum balance suggests that the pressure gradient, wind and bottom stress are dominant in the inner shelf region, while vortex forces, bottom friction and breaking induced flows become significant within the transition region from inner shelf to surf zone. (Abstract ID 10361)

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FINESCALE TOWYOS IN THE SARGASSO SEA

During the June 2011 Lateral Mixing experiment, the fine- and microstructure platform Hammerhead was towed on nine occasions lasting 5-9 h each to characterize submesoscale water-mass variability, internal-wave finestructure and turbulent microstructure in the vicinity of recently reseeded fluorescent and rhodamine dye patches. These measurements span lengthscales of 1 cm - 10 km horizontally and 1 cm - 10 m vertically. They included measurements at both a quiet site of almost no mesoscale activity and a moderately active site near a confluence stagnation point. Preliminary results on submesoscale water-mass (spic), rhodamine and fluorescent variability will be presented as they pertain to stirring along isopycnals, as well as the weak internal-wave and turbulence environment. Water-mass variability appears to be coherent over the vertical aperture of the sampling. Hammerhead measurements at the quiet site appear to resolve cutoff horizontal wavelengths of 0.1-1 km for both water-mass and dye variability, indicating that it captured the scale at which mixing terminates the downscale isopycnal cascade of anomalies. (Abstract ID 10342)

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ENVIRONMENTAL SENSITIVITY OF LATITUDINAL SHIFTS IN MARINE FISHES DEPENDS ON LATITUDE AND FISHING EFFECTS

Over-fishing can interact with climate changes to affect fish communities. Although a great amount of effort has been invested in investigating synergistic effects of fishing and climate, quantitative understandings of this issue remain elusive. The difficulty arises because fishes have different life history traits and live in different environments and therefore they might respond to human impacts and climate changes in different ways. In this study, we carried out a meta-analysis using data from the east and west coast of US, North sea, and Bearing sea to investigate to what extent the distributional shift of marine fishes was determined by environmental changes and whether fishing plays a role, after accounting for life history variation. We tested the hypotheses: 1) Species in the high latitude are more sensitive to climate than those in low latitude. 2) The exploited species are more sensitive to climate than unexploited species, but the effects (contribution) of fishing decreases with increasing latitude. Our preliminary result shows that the fishes’ sensitivity to climate change is significantly increasing with latitude while the effect of fishing is complex. (Abstract ID 9896)
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Intuitively, ocean complexity should play an inhibiting role in both approaches. However, as from acoustical oceanography has been our increased understanding of the forward problem. Appearing as opposites, the inverse problem requires extremely detailed knowledge of the opposed to acoustical oceanography’s goal of “finding” oceanographic parameters. While further, a traditional goal of ocean acoustics is finding an acoustic source or scatterer as the inverse problem is concerned with determining the ocean environment from acoustics.

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Comparative Analysis of Marine Bacterial Composition Between the Sea Surface Microlayer and Subsurface Water in the Straits of Florida

A number of studies have suggested that there is a unique ecosystem for marine bacteria in the sea surface microlayer, but little information exists on the microbial community composition of this ecosystem in the open ocean due to sampling complexities. The sea surface microlayer is defined as the uppermost 1 mm of the ocean. An improved sea surface microlayer sampling method has been developed that eliminates the contamination from the vessel and subsurface water. Bacterial samples were collected from inside and outside slacks, and from subsurface water at the same sites. The microlayer sampling was planned to coincide with synthetic aperture radar satellite overpasses (RadarSAT-2, COSMO-SkyMed). A particular emphasis was on detection and quantification of surfactant-producing and transforming bacteria. Surfactants are capable of suppressing short gravity-capillary surface waves, which affect radar back-scatter. Preliminary characterization of the bacterial composition was performed using DNA cloning and analyses of 16S rRNA genes. We are further investigating the use of multiplex 454 sequencing to obtain statistically robust data sets as well as real-time PCR to achieve better detection and quantification of the target bacteria. (Abstract ID 10617)
While pollution in itself is forbidden in Norway since 1981, it is permitted by exemption on a case-by-case basis. STPs are wastes from mine-ore processing placed into the sea, and we have identified in at least 23 different sites in Norwegian fjords, from small to up to more than 50 million cubic meters in size. This study includes: 1) the fate and toxicity of some of the STPs, 2) how organic enrichment of inert tailings may stimulate faunal recolonization and ecosystem recovery, 3) seafloor baffling-structures to limit tailing suspension into the water column while acting as artificial reefs, supplying organic materials to the substrate, and 4) testing which areas may be essential to protect and maintain marine ecosystems and to maximize organic recovery in the tailings following the deposition of the STPs. The project is funded partly by the Norwegian Research Council. The project's industry-partners, Sydvaranger Grove AS, Nordic Mining ASA, Rana Gruber AS and Titania AS are contributing and learning from the project, in order to lead the way in terms of more environmentally friendly and cost-efficient management for STPs. (Abstract ID 11074)

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IMPTAIL – IMPROVED SUBMARINE TAILING PLACEMENTS (STPS) IN NORWEGIAN FJORDS

Scientists mentoring graduate students on research and teaching through COSEE concept mapping collaborative workshops

Four COSEE Centers—Ocean Systems, West, Networked Ocean World, and California—held concept mapping collaborative workshops to help scientists mentor graduate students to improve their teaching and research. Each of the four collaborative workshops paired about five ocean scientists with 25 graduate students in groups of five. Formative and summative evaluation results indicate that the workshops promoted more peer to peer interactions between faculty and graduate students and more familiarity with Ocean Literacy and Climate Literacy principles. An additional surprising benefit of the concept mapping collaborative workshops for graduate students were the ways in which concept mapping was able to help graduate students with their research—in presenting their research ideas to their faculty advisor, planning collaborative work in their laboratory, organizing research ideas for a proposal to a funding agency, developing the early stages of experimental design or thinking on a new research topic, or determining how their research fits in the bigger picture of their scientific discipline. (Abstract ID 10031)

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Mass balance, control volume model of the Marinetics oyster farm in Cambridge, Maryland, USA has been constructed to predict the fluxes of biodeposits out of the farm and the biodeposition rate within the farm. A sequence of calculations at quasi-steady state approximate the entire tidal cycle. Equations expressing fluxes into and out of the control volume as well as intracellular sources and sinks are parameterized using field measurements. Measurement techniques include settling experiments, erosion experiments, current meter and sediment trap deployments. Results indicate that the area is ebb dominated; ebb currents are stronger and the ebb lasts longer than during the flood. During the ebb tide a significant fraction of the biodeposits are predicted to leave the farm before hitting bottom. Accounting for resuspension more than doubles this export. During flood tide, less material is directly exported and much less is resuspended. Averaged over the tidal cycle, most of the biodeposits remain beneath the farm, but may be flushed out during episodic wind and wave events. (Abstract ID 10332)

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Seasonal Cycle of the Eighteen Degree Water and its Lagrangian Pathways

The seasonal cycle of Eighteen Degree Water (EDW) is examined from more than 22,000 temperature and 15,000 salinity observations from profiling floats in the subtropical North Atlantic from 1998 to 2008. EDW volume is maximized in the winter (4.0±0.3 x 10^13 m^3) and minimized in the autumn: the volume difference between these two seasons (2.03±0.23 x 10^13 m^3) is interpreted as either the mean annual production or destruction of EDW. However, only 67% of this value corresponds to the estimated annual subduction rate (~4.3 Sv). Thus, a significant portion of outcropped EDW is recycled within the seasonal thermocline and mixed layer. Variance of the EDW salinity and temperature is largest in the winter and smallest in the late fall, which implies a homogenization of the properties once the water mass is separated from the mixed layer. In order to study further the circulation of EDW and its eventual fate, eddy-resolving ocean model output is used to calculate Lagrangian pathways of EDW by seeding e-particles when the EDW is outcropped in winter and tracking them for five years. (Abstract ID 10723)

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Effects of Tide and Wind on the Eastern Boundary Current of the Yellow Sea in Summer

In order to examine the dynamics of coastal boundary current which flows northward along the eastern boundary of the Yellow Sea in summer, three-dimensional numerical simulations were performed. The modeling domain includes the Yellow Sea and the East China Sea. The nominal horizontal grid size is about 8 km and the model has 30 vertical layers. The model
OCEANIC CYCLE OF Fe IN THE WESTERN EQUATORIAL PACIFIC: INSIGHTS FROM ITS ISOTOPIC COMPOSITION IN THE DISSOLVED AND PARTICULATE FRACTIONS.

The eastern Equatorial Pacific is fed with Fe transported within the Equatorial Undercurrent (EUC). In order to better constrain the Fe sources and cycling, concentrations and isotopic composition of dissolved and particulate Fe (DFe and PFe) have been measured in seawater offshore Papua New Guinea (PNG) and in the western and central Equatorial Pacific during the EUC cruise. Within the EUC, DFe isotopes remain constant (∆56Fe = +0.45±0.10‰) over more than 4000 km, illustrating the usefulness of this new tracer to track Fe provenance within the ocean. This positive value suggests a non-reductive release of DFe, likely from the remineralization of organic matter and significant Fe removal. A simple box model, combining nutrient data, DFe and PFe concentrations and isotopes suggest that Fe removal is not associated to a significant Fe isotopic fractionation (∆56Fe = 0.10 ± 0.32‰). (Abstract ID 10247)

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INTERACTION OF INTERNAL LEE WAVES WITH BOTTOM-TRAPPED INERTIAL OSCILLATIONS IN THE SOUTHERN OCEAN

The Southern Ocean (SO) is home to some of the strongest of the world's ocean currents. Recent observations and numerical experiments suggest that a fraction of the energy of SO currents is converted into internal lee waves (ILW) close to bottom topography. ILW breaking induces large scale motions through momentum deposition, which are bottom-trapped inertial oscillations (IO). These IOs trigger in turn ILW breaking thereby reinforcing the ILW generation. We shall investigate the vertical structure of the IO field, which controls the intensity of ILW breaking. Using unsteady ray tracing simulations, we shall show indeed that the IO profile found in numerical experiments has a much more efficient feedback on wave breaking than another simpler profile. Using two-dimensional numerical experiments, we shall also address the response of ILW breaking in terms of dissipation rate of energy, focusing on the magnitude and spatial variability of this dissipation rate in comparison with field campaigns. (Abstract ID 12383)

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SUSPENDED SEDIMENT TRANSPORT FROM SHALLOWS TO CHANNEL IN AN ESTUARY

In estuaries, shallows are regions of sediment retention and high suspended-sediment concentrations (SSC), whereas channels are regions of greater sediment transport and export. Exchange of sediment between these two environments is critical to an estuary's sediment budget, yet it remains poorly understood. We evaluated suspended-sediment flux (SSF) at six sites spanning the transition from the 16-m deep channel to the 2-m deep shallows of South San Francisco Bay during the spring and fall of 2009. Disaggregated bed sediments were predominately (>85%) mud. Elevated SSC produced by strong wind events dominated the SSF. Spatially, maximum SSF occurred at the slope between shallows and channel. During wind events, transverse SSF was directed towards the channel, driven by channel-ward transverse currents over the shallows at low water, during the interval between initiation of flood-tide currents in the shallows and in the channel. The along-channel component of SSF was directed up-estuary at all stations during wind events, except in the middle of the channel. In mid-channel SSF was directed down-estuary, providing a pathway out of the estuary for sediment exported from the shallows. (Abstract ID 11545)

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COMBINING HIGH-RESOLUTION HICO AND GOCI IMAGERY WITH OCEAN CIRCULATION MODELS: TOWARDS A FULLY-3D ADVECTION-DIFFUSION-REACTION FORECAST CAPABILITY

We present an ocean forecast model "BioCast" to forecast surface bio-optical properties derived from satellite via a coupling to numerical ocean model velocity fields. Surface bio-optical products derived from remote sensing ocean color platforms are used for defining water quality conditions on different spatial scales. For this study, we demonstrate this surface optical property forecast capability at 100m and 500m scales using Hyper-spectral Imagery for the Coastal Ocean (HICO) and Geostationary Ocean Color Imager (GOCI). The BioCast system initially treats surface optical properties derived from satellite as passive tracers for a simplified advection-diffusion scheme. At very high spatial/temporal resolution, we employ hindcast mode to better constrain particle source/sink terms of optically active constituents, particularly suspended sediments, in coastal environments. Hourly sequential GOCI products enable difference fields between BioCast forecast simulations and imagery to suggest potential timescales of sediment processes as well as potential areas where the flow fields might require adjustment. These observations will direct research toward the development of a self-correcting advection-diffusion-reaction forecasting system. (Abstract ID 11890)

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AQUARIUS SATELLITE SALINITY MEASUREMENTS: PRELIMINARY RESULTS OF THE FIRST SIX MONTHS

The US-Argentine Aquarius/SAC-D satellite was launched June 10, 2011 with a suite of sensors for Earth observation and a primary mission to monitor global variations in ocean surface salinity to study the links between ocean circulation, water cycle and climate. Measurements include salinity, wind, rain, surface temperature, sea ice, soil moisture, night images, atmospheric soundings and space environment, coupled with an active educational program. At the time of this writing, the Aquarius sensor has collected ocean salinity data since late August 2011, and initial unvalidated data have been released for evaluation. Aquarius samples the global ocean surface salinity field every seven days and is designed to achieve 0.2 psu accuracy over monthly averages on 150 km spatial scale. The data already show very robust signatures of the basin scale salinity patterns and many details on sub-basin scales. This presentation will provide an early review of the first six months of salinity data, including the status of calibration and validation, ancillary wind and other corrections, a description of the resolvable salinity variations and other notable findings in the initial measurements. (Abstract ID 10148)

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A high-resolution global-Japan coastal coupled FVCOM tsunami model system has been used to assess the tsunami dynamics and coastal inundation associated with the 2011 Japan M9.0 earthquake. This model includes complete oceanic processes such as tides, river discharges, surface wind stress and heat flux as well as the earthquake-derived sea floor changes. The model was validated by comparing with sea level measurements at more than 40 tidal gauges and the observed coastal inundation area. This process-oriented study was carried out to examine the dynamical (hydrostatic and nonhydrostatic) processes required to simulate the propagation and dispersion of earthquake-induced solitary waves toward the coast and wave breaking during the inundation. The experiments showed that the 2011 earthquake-generated tsunami waves were dominated by the long gravity waves and the major features of these waves could be captured well by the hydrostatic ocean model. Nonhydrostatic processes have a major impact on the wave transformation and breaking in the near-shore area before the coastal inundation occurred. Detailed comparisons for these different dynamics are presented with comparisons to field measurements. (Abstract ID 11353)

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SHEAR INSTABILITIES IN INTERNAL SOLITARY WAVES

There are several recent observations of shear instabilities in internal solitary waves. This work presents the results of numerical simulations conducted with a three-dimensional pseudospectral method. Using idealized hyperbolic tangent stratifications, a large number of two-dimensional simulations have been conducted to explore the region in parameter space in which waves are unstable. Three-dimensional simulations suggest that the generated billows three-dimensionalize in the tail of the internal waves and hence two-dimensional simulations can accurately predict the rate energy is transferred from the solitary wave to the Kelvin-Helmholtz billows. (Abstract ID 11351)

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A COMPARISON OF LARVAL BLUEFIN TUNA HABITAT IN THE NORTHERN GULF OF MEXICO AND WESTERN CARIBBEAN

Atlantic bluefin tuna (Thunnus thynnus) have previously been thought to spawn only in the Mediterranean and the Gulf of Mexico. Recent cruises in 2009 and 2010 along the Yucatan coast of Mexico found small bluefin larvae (2.5–4 mm) south of the Yucatan Channel, outside documented BFT spawning grounds. In 2011, a more extensive survey was conducted throughout the region between the Yucatan Peninsula and the Windward Passage to help determine the extent of this larval spawning habitat. Bluefin larvae were found primarily in the western side of the basin, along the coasts of Mexico and Belize. Much of the central and western region of this basin had poor spawning habitat with physical features similar to the Loop current in the Gulf of Mexico, deep thermoclines and temperatures of 20°C at 200 meters. The Honduras Gyre was also unsuitable habitat with high chlorophyll levels and a mixture of shelf and Caribbean current waters. In this presentation we will describe the oceanographic features associated with these results and compare with historical conditions in the northern Gulf of Mexico. (Abstract ID 9948)

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OCEANIC THERMAL FRONTS AND NET PRIMARY PRODUCTION ASSOCIATED WITH LONGLINE CATCHES OF ALCACORE TUNA (THUNNUS ALALUNGA) IN THE SOUTHERN INDIAN OCEAN

In this fishery oceanographic study, we investigated the catches and distributions of albacore tuna (ALB) in relation to sea surface temperature (SST), SST fronts, and net primary production (NPP) in the Indian Ocean. A combination of SST, SST fronts (SST gradient magnitude (GM)), NPP and set longline fishery data were proven to be key for detecting regions with high potential for ALB. The main fishing grounds are mainly concentrated in the southern Indian Ocean, and the fishing season is from June to September. High catch per unit effort (CPUEs) (>8 fish/103 hooks) were concentrated in the area with SSTs of 16–20°C, which are close to the northern zonal band of the Subtropical Front. Histograms of high CPUEs plotted against SST, SST GM, and NPP indicated that high CPUEs were in an SST range of 16.5–19°C and in an NPP range of 300–500 mg C/m2/24h. Although most of the high CPUEs occurred in areas with SST GMs of 0.1–0.3°C/10 km, there were still many high catches located in areas with higher SST GM values. The small distances between latitudinal mean positions of the optimal SST and NPP range contour lines were also considered to be a good indicator for predicting areas of higher ALB abundances. (Abstract ID 9512)

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NASA OCEAN COLOR DATA IN THE GULF OF MEXICO: QUANTITATIVE SELECTION OF ALGORITHMS AND EXPLORATION OF CARBON-TO-CHLOROPHYLL PHYTOPLANKTON PHYSIOLOGY

NASA satellite data products will be supplied to the U.S. Environmental Protection Agency (EPA) to be used in their computational models that characterize hypoxia in the Gulf of Mexico. NASA Ocean Color 2010v6.2 reprocessing of SeaWIFS and MODIS Aqua data were matched to EPA Gulf Ecology Division field observations covering 3 seasons throughout the years 2002–2007. Satellite data within an 8th or 3h time window from a 3x3 pixel (km) box surrounding the field station were quality-controlled and averaged. Validation statistics and total skill scores were employed to quantitatively determine the most appropriate algorithms for providing satellite data products to the EPA. Results for chlorophyll, particulate carbon and total suspended solids show that globally-derived algorithms generally perform better than previously published, coastal-specific algorithms when applied to the recent 2010v6.2 reprocessed satellite data. The relationship between carbon and chlorophyll and the usefulness of satellite data in contributing to the understanding of phytoplankton physiology in the Gulf of Mexico will be discussed. (Abstract ID 12015)

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A NOVEL TRACER TECHNIQUE TO QUANTIFY THE ATMOSPHERIC FLUX OF TRACE ELEMENTS TO THE OCEANS

The atmospheric flux of trace elements and isotopes (TEIs) to the oceans can be a significant component of the budgets for many elements and is therefore extremely important to marine biochemical cycles. This is especially true for the bioactive trace elements. Unfortunately, there are large uncertainties associated with converting rainfall and aerosol TEI concentrations into flux estimates. Following production by cosmic-ray spallation in the troposphere, Be (half-life 53.3d) becomes attached to aerosols and is deposited to the oceans by wet and dry deposition. Due to its radioactive decay, the inventory of 7Be in the upper ocean is balanced by its deposition flux from the atmosphere. By measuring TEI/Be ratios in rainfall and aerosol samples, the atmospheric flux of TEIs can be calculated: Flux(TEI) = Flux(Be) * (TEI/Be), where the Flux(7Be) is derived from measurement of the 7Be inventory in the upper ocean. We will discuss results from field campaigns in the Sargasso Sea and the Arctic Ocean that are designed to test this approach. (Abstract ID 10605)

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THE TP CONVEYOR

Given the elevated energetic costs of biological N₂ fixation, we examined the concentrations of the typical nitrogen fixed trace element 7Be, which is the only element that can accurately predict the rate energy is transferred from the solitary wave to the Kelvin-Helmholtz billows. (Abstract ID 11353)
xation, marine diazotrophs may out-compete non-fi
xing phytoplankton only in N poor regions. This paradigm is apparently in contrast with the observation of high $N_j$. 
fixation rates in the subtropical North Atlantic where vertical nutrient fluxes to the euphotic zone are high in nitrate relative to phosphate, exceeding the needs of non-fi
xing phytoplankton. A mechanism potentially resolving this apparent paradox is the transport of accumulated excess inorganic (PO₄) and organic (DOP) phosphorus, TP*, from distant regions of its formation to the North Atlantic subtropical gyre. In this contribution we explore the sensitivity of TP* accumulation to environmental factors and the potential TP* transport pathways using a state-of-the-art global coupled biogeochemical ocean model. Understanding the controls on marine N₂ fixation...
A technique is presented for assimilating hydrodynamic drifter observations and extracting river bathymetry through an ensemble-based depth-inversion process. We selected to test our technique on Kootenai River, Idaho, USA where numerous drifter velocity observations have been collected. For our research we use the Regional Ocean Modeling System (ROMS) to calculate a prior ensemble of hydrodynamic states. Based on simple statistical assumptions about bathymetry we then assimilate drifter velocity observations to produce a posterior bathymetry estimate. We will also experiment with iterating the process in order to improve our estimate. Note that our technique is not limited to specific environment, drifter observations nor the ROMS numerical model. Theoretically, our method can be extrapolated to any water velocity observation and circulation model that captures the dominant physics of the flow well. (Abstract ID 12485)

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NUMERICAL MODELING OF THE FATE OF OCEANIC RADIONUCLIDES

There is much interest in learning about the fate of radionuclides deposited into the ocean by river discharges and atmospheric deposition, particularly because of the Fukushima Daiichi nuclear power plant damage resulting from the tsunami on March 11, 2011. Here, the results and scientific lessons learned from a numerical modeling study of the fate of radionuclides in the ocean are elaborated. The numerical model employed was Rutgers University’s Regional Ocean Modeling System (ROMS). The ROMS model was one-way coupled to a 1-km resolution US Navy Operational Global Ocean Model (NCOM) which provided the initialization and the model forcing fields. The dispersion of radionuclides was simulated using passive tracer fields and ensembles of Lagrangian particles. Three ways of introducing radionuclides into the ocean were examined: (i) direct injection (from the nuclear reactor’s water tanks), (ii) atmospheric deposition, and (iii) river runoff. Comparisons of model predictions with observed data will also be discussed in the presentation. These model generated tracer and particle fields will be ingested as initialization fields within a larger numerical ocean model covering the Pacific Ocean. (Abstract ID 10480)

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A new dynamical modeling framework for interpreting phytoplankton natural fluorescence

A new analytical framework will be introduced for describing and interpreting the dynamical changes seen in phytoplankton natural fluorescence within a diurnal period. The framework is based on the basic photochemical and nonphotochemical processes known to affect the fluorescence emission of phytoplankton, and it replicates the dynamics of fluorescence-irradiance trajectories seen in laboratory cultures (i.e., natural fluorescence) and in field observations (i.e., sun-stimulated fluorescence) over diurnal periods. When implemented as a model for curve-fitting purposes, the model parameters retrieved illustrate how day-to-day changes in estimated model parameters can be used to track physiological changes in photosynthesis over multi-day timescales in actual experimental and field data. Current challenges with this analytical framework include the ability to account for short-term perturbations to the fluorescence-irradiance trajectories caused for example by intermittent clouds or rapid vertical mixing in the water column, both a focus of ongoing study. (Abstract ID 12412)

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IN SITU PREY INGESTION AND EGG PRODUCTION BY THE CTENOPHORE MNEIMOPSIS LEDINI IN NARRAGANSETT BAY, RI, USA

The ctenophore Mnemiopsis ledini inhabits coastal environments of highly variable prey composition. For example, within Narragansett Bay, prey fields within embayments are often dominated by meroplankton while open bay stations are dominated by copepods. Mnemiopsis occupies both regions and may be advected between different the differing prey regimes. How do different prey regimes influence population growth? We combine temperature-dependent metabolic rates with estimates of carbon intake based on situ gut contents to estimate overall carbon balance on a weekly basis for Mnemiopsis from three sites in Narragansett Bay over two years. The calculated carbon balance is then compared to egg production rates for corresponding periods. Our intent is to use this data to evaluate three questions: first, how does the carbon balance of Mnemiopsis vary through time and space, second, does the carbon balance coincide with egg production, and third, does the type of prey (meroplankton vs copepod) correspond with field egg production rates? (Abstract ID 10340)

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WATER MASS TRANSFORMATION AND THE NORTH ATLANTIC CURRENT IN THREE MULTI-CENTURY CLIMATE MODEL SIMULATIONS

Subtropical Water carried by the North Atlantic Current undergoes substantial transformation on its way to higher latitudes. The geographical distribution of the surface-forced transformation is assessed in three different multi-century climate simulations and compared with observation-based estimates, with a particular focus on the eastern subpolar North Atlantic Ocean. The diagnosis estimates the transformation in water mass outcrop areas from heat and freshwater fluxes. The integrated heat flux in the eastern subpolar region has a larger contribution than the freshwater flux to the transformation in all three models. While the pattern of the Atlantic Meridional Overturning Circulation is similar in all models, the geographical distribution of the fluxes is very different. The different pathways of the North Atlantic Current, and upper ocean low salinity water, as well as sea ice cover have strong influence on water mass transformation. The water mass transformation in the eastern subpolar region shows pronounced variability on decadal time scale in all models, and is found to reflect the variability in the overturning circulation in two of the models with a time lag of 7-8 years. (Abstract ID 9771)

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COMPARING AUTOMATIC VERSUS HUMAN-CREATED QC FLAGS OF OCEANOGRAPHIC MOORING DATA AND APPLICABILITY TO THE OOI

A suite of computationally simple algorithms for data quality control (QC) is presented that generates pass/fail flags for oceanographic data from moorings. The output of these algorithms is compared against existing, human-created QC flags from past mooring deployments in the OceanSITES project (www.oceansites.org). An attempt is made to assess not only physical data such as temperature and salinity, but also data from biogeochemical sensors. Development and tuning of these algorithms is part of the Ocean Observatories Initiative (OOI) neurooceanobservatories), an NSF-funded project that will deploy such instruments in the ocean. Performance of the algorithms will be presented along with a quantitative description of what error margins they can and cannot capture. (Abstract ID 11559)

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HOW DO DYNAMIC LIMITING FACTORS INFLUENCE SUCCESS OF STREAM ECOSYSTEM RESTORATION?

Synthesis studies have revealed little effect of stream restoration on ecosystem functions like metabolism and denitrification yet yield little understanding of why restoration has not improved ecosystem services. To develop a process-based understanding of effects of stream restoration on ecosystem function, we measured interactions between physical and biological processes in restored and unrestored streams in unprecedented detail. Spatially intensive sampling of stream hydraulic, sediment physicochemical characteristics, water chemistry; and biological process indicators were paired with temporally intensive monitoring of hydraulic, suspended sediments, and metabolism. Multivariate statistical analysis revealed that stream restoration that increases channel complexity positively influences metabolism. However, process limitation by other factors (here, labile carbon supply and fine sediment availability) may result in little difference in ecosystem function between restored and unrestored streams. Moreover, limiting factors for stream ecosystem function are dynamic, shifting as the system evolves in response to storm events or other perturbations. Our study argues for establishment of a comprehensive conceptual model of the physical and biological interactions potentially controlling ecosystem function before determining how to best evaluate effects of restoration.
or management treatments. (Abstract ID 11721)

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AMINO ACID D13C PATTERN AS BIOMARKERS OF BIOSYNTHETIC ORIGIN IN MARINE ECOSYSTEMS

Recent research has demonstrated that fungi, bacteria and plants impart characteristic δ13C patterns among amino acids making it possible to track their biosynthetic origin without the use of isotope additions. In this study we explore whether δ13Cpatterns can be used to differentiate between marine photautotrophs, terrestrial plants and bacteria. We found that marine macroalgae (green, brown, red), terrestrial C3 plants, and laboratory cultured bacteria had distinctly different δ13Cpatterns. The δ13Cpatterns of microalgae (cyanobacteria, diatoms and chlorophytes) were also unique and resembled a mixture between terrestrial plants and macroalgae. The most informative amino acids were the ones with long and complex pathways such as phenylalanine, leucine and isoleucine. Since these amino acids are essential for consumers our results indicate that δ13Cpatterns are particularly well suited for investigating trophic and symbiotic relationships in marine environments. The clear differences in δ13Cpatterns between bacteria and photautotrophs make them a promising tool for investigating bacterial diagenesis of primary production. (Abstract ID 11082)

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ASSESSING THE FATE AND IMPACT OF BP OIL ON DEEP-SEA SEDIMENTARY ENVIRONMENTS AND BENTHIC COMMUNITIES: NE GULF OF MEXICO.

Sediment cores were collected in the NE Gulf of Mexico along the Florida slope between 100m and 2000m water depths in order to determine potential impacts of the BP blowout on sedimentation patterns and benthic communities. Sediment cores are utilized to provide a baseline record of pre-blowout (down-core) conditions to identify recent changes (surficial layers) in sedimentation/benthic community that may be attributed to the BP blowout event. A surficial layer, 1-6cm thick, is present in almost all cores. It generally thickens with water depth and becomes more pronounced with increasing depth, particularly between 1,000 and 1,200 m water depth. This correlates with the depth of observed deep-water plumes during and immediately following the blowout event. This surface layer is distinctly different from underlying sediments in terms of sediment texture, and composition, the hydrocarbon signature (which is very similar to that of the subsurface plume) and potentially benthic communities. Short-lived radioisotope (210Pb, 137Cs, 262137Th) geochronologies indicate a 1-2 order-of-magnitude increase in sediment accumulation rates in this surface layer, compared with underlying rates for the past ~100 years. (Abstract ID 11748)

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MULTI-CENTENNIAL SOUTHERN OCEAN VARIABILITY AND GLOBAL IMPACTS IN THE KIEL CLIMATE MODEL

The internal variability in the Southern Ocean simulated in a multi-millennial control integration of the Kiel Climate Model (KCM) displays enhanced variability relative to the red background at decadal and centennial timescales. While multi-decadal variability originates in the North Atlantic, multi-centennial variability is driven in the Southern Ocean. The quasi-periodic occurrence of the deep convection causes strong and regional variability that is period of 300 to 500 years. For instance, global quantities such as surface temperature, sea-ice coverage or sea surface height co-vary on this timescale. The centennial oscillation is driven by the competing roles of heat accumulation in the ocean at mid depth and a suddenly occurring freshwater cap at the surface on buoyancy changes. The build-up of heat during periods without convection and the subsequent heat release to the atmosphere when convection restarts can be viewed as a non-linear recharge oscillator. We show by sensitivity experiments that sea ice has an important moderating effect on the frequency of occurrence and the intensity of the deep convection. Furthermore, we find similarities to the Weddell Sea polynya of the 1970s. Interestingly, surface observations yield some evidence of centennial-scale variability in the Southern Ocean. (Abstract ID 9564)

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ENSO TELECONNECTIONS IN THE CARIBBEAN: INCORPORATING AND DIFFERENTIATING THE INFLUENCE OF CENTRAL PACIFIC ENSO EVENTS UPON SEA SURFACE TEMPERATURES

The recently identified Central Pacific El Niño-Southern Oscillation (CP ENSO) mode has been shown to have different spatial and temporal teleconnections with the Caribbean than the classic Eastern Pacific El Niño-Southern Oscillation (EP ENSO) phases of El Niño and La Niña. Analysis was conducted upon NOAA’s Optimum Interpolation Sea Surface Temperature version 2.0 data 1-degree dataset during the satellite era (1981-2010). For reasons of dynamic validity and orthogonality, an adaptation of both Li et al’s ‘Improved El Niño Modoki Index’ (IEMI) and the NINO3 index were chosen to identify the different CP and EP ENSO events, respectively. The Caribbean has classically been identified as a region where sea surface temperature (SST) is affected by ENSO, but with new knowledge about ENSO, the relationship needed to be revisited. Statistical analysis upon the different populations of ENSO events identified by the IEMI and NINO3 indices identify that depending on event type, SST teleconnections in the Caribbean are associated with different time scales and/or spatial distribution. These results have potential implications for scientists concerned with coral reefs, as well hurricane development due to the distribution of the teleconnections. (Abstract ID 10726)

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THE ROLE OF THE SOUTHERN OCEAN IN THE GLOBAL CARBON CYCLE AND ATMOSPHERIC CARBON DIOXIDE CHANGE

Uncertainty about the causes of glacial-interglacial carbon dioxide variations demonstrates our incomplete grasp of fundamental processes that govern our climate. Using a coarse resolution ocean general circulation model (MITgcm) and coupled biogeochemistry code, an ensemble of idealized perturbations to external forcing and internal physics of the Antarctic Circumpolar Current, including Southern Hemisphere westerly winds, buoyancy forcing and mesoscale eddy processes are examined. We find that intermediate waters are important in determining O(10-20) µatm anomalies in atmospheric CO2 levels in these simulations, which is currently neglected in paleoceanographic discussions of glacial-interglacial climate change. The partitioning of CO2 between the atmosphere and oceanic pools of saturated, soft-tissue, carbonate and disequilibrium DIC are identified in order to elucidate the processes that link circulation, nutrient distributions and biological productivity. These results are robust to significant alterations to surface heat and freshwater boundary conditions, mesoscale eddy activity and rates of air-sea gas exchange and represent a large proportion of the change in glacial-interglacial CO2 that can be currently generated by altered circulation in a variety of models. (Abstract ID 10389)

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SEPARATING INTERNAL WAVES AND VORTICAL MOTIONS IN THE OPEN OCEAN

Energy in the internal wave frequency band is often a combination of internal waves and vortical motions, which have distinct kinematic and dynamic properties. Internal waves carry no perturbation potential vorticity and propagate, whereas vortical motions carry perturbation potential vorticity and do not propagate (but advect with surrounding flow). Understanding how these two different classes of waves compare for separating these two energetic sources properly. In order to accomplish this, measurements on a variety of spatial and temporal scales are needed. Using 18-20 γ−EM−APEX floats, profiling simultaneously between surface and 150 m depth, we measured horizontal velocity (U and V), temperature, salinity, and microstructure (χ) on horizontal scales between 100 m and 10 km. The swarm of floats provides multiple 3-D time-series of temperature, salinity, density, velocity, vertical and horizontal shear, buoyancy frequency, Richardson number, thermal diffusion rate, and thermal diffusivity. The near-simultaneous multi-scale measurements allow us to compute area averaged horizontal
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Simulating Phosphorus Limitation in the Northern Gulf of Mexico

The continental shelf of the northern Gulf of Mexico receives high dissolved inorganic nitrogen (DIN) and phosphorus (DIP) loads from the Mississippi and Atchafalaya rivers during spring. The nutrient load results in eutrophic conditions, supports high primary production and contributes to the development of hypoxic conditions on the Texas-Louisiana shelf in summer. While phytoplankton growth is considered to be typically nitrogen limited, phosphorus limitation has been observed in this region during the period of peak discharge from the Mississippi River in spring and early summer. Here we investigate the presence and spatial distribution of phosphorus limitation in this region using a circulation model of the northern Gulf of Mexico (ROMS) coupled to a multi-nutrient planktonic ecosystem model. Results are compared with available observations and the effect of phosphorus limitation on phytoplankton biomass and nutrient concentrations over the Texas-Louisiana Shelf is analyzed. Several discharge scenarios with altered DIN and DIP loads are evaluated to anticipate the consequences of nitrogen and phosphorus control in the Atchafalaya and Mississippi rivers. (Abstract ID 10879)

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Evaluation of the Modal Composition of the Ocean’s Geostrophic Interior

This study evaluates the importance of individual dynamical modes in the composition of the ocean’s geostrophic flow and of its anomalies from the long-term average. Here, synthetic temperature profiles are estimated using satellite data and EOF modes of the vertical temperature anomaly. The synthetic temperature is combined with climatological salinity to generate a four-dimensional density field, which is used to calculate geostrophic velocities. Rosby radii of deformation and dynamical modes. The significance of each mode is estimated through their projection over velocity profiles, using Rosby radii values to provide a dynamic context for the observed features. As results, it was found (a) that mode 1 accounts for 30% of the geostrophic field on average, value that decreases approximately by a factor of 3 in higher modes, (b) global patterns suggesting the existence of baroclinic Rosby waves of modes above 1, (c) evidences of nonlinear interactions between waves and the vertical mass structure anomalies induced by their own passage, (d) evidences of energy transfer between different modes, and (e) the possibility that satellite altimeters may be insensitive to modes above 1. (Abstract ID 11296)

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Evolution of the Modal Composition of the Ocean’s Geostrophic Interior

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Towards a Merged Satellite and in situ Fluorescence Chlorophyll Product

Fluorescence profiles represent an important dataset of in situ observations, which is presently strongly under-used. Chlorophyll-a climatologies, as well as blended in situ/satellite products, do not integrate fluorescence profiles. Calibrations and cross-calibrations, variability of the Chlorophyll-a to fluorescence relationship and consistency with other data sources are the main issues which have prevented a wider use of fluorescence profiles. We present here a method to standardize fluorometer calibration using the satellite data as a unique global scale reference. The method consists of adjusting the Chlorophyll-a integrated content, measured on the fluorescence profile, with the coincident satellite observation. It was developed and tested using data from three open ocean stations (BATS, HOT and DYNAMED). The comparison with concomitant HPLC Chlorophyll-a estimations reveals an error of about 33%, close to the estimated error of satellite products. The resulting calibrated dataset represents a first fluorescence/satellite merged product, which could be integrated in Chlorophyll-a climatologies to improve their statistical relevance and the vertical resolution of the Chlorophyll-a field. Moreover, the method could be applied to calibrated fluorescence data obtained from autonomous platforms (gliders, profiling floats). (Abstract ID 10270)

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Trace Elemental Composition and the Effect of CO2 on Juvenile Purple Sea Urchin Calcite (Strongylocentrotus Purpuratus)

Ocean acidification will likely have negative impacts on invertebrates with calcifying planktonic larvae, whose delicate skeletons are commonly composed of calcium carbonate polymorphs. We reared larvae spawned from adult purple sea urchins (Strongylocentrotus purpuratus) collected from Oregon, Northern California, Monterey Bay, and Santa Barbara, cultivating them from fertilization through metamorphosis under ambient (380ppm; pH=8.02±0.03) and elevated (1000ppm; pH=7.72±0.03) CO2 levels. Preliminary data suggest that juveniles from the elevated CO2 treatment partitioned ~3% more Mg into their skeletons than those reared under ambient CO2. (*100) D = Mg/Ca. *100/Mg/Ca. Moreover, the skeleton of juvenile sea urchins contained ~1.3 and ~2.3x more strontium and magnesium relative to adult spines, respectively, suggesting that skeleton precipitated during larval and juvenile stages is composed of more soluble forms of calcite. The measured difference between
adult and juvenile trace element composition may explain why elevated CO₂ appears to have greater impacts on urchin skeletal Mg incorporation during early life history stages versus during adulthood (e.g. Ries 2011). (Abstract ID 11694)

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VARIABILITY OF LOCALLY-PRODUCED WATER MASSES WITHIN THE TERRA NOVA BAY POLYNYA

The western Ross Sea is a major source of Antarctic Bottom Water (ABW); High Salinity Shelf Water (HSSW), the densest water mass in the region and a key component of ABW, is formed via brine rejection within the Terra Nova Bay polynya. We use a combination of hydrographic and mooring data to examine inter-annual variability of HSSW and Shelf Water within Terra Nova Bay. High quality hydrographic data exist since the 1980s, while one mooring was deployed in 1984 and the remainder since 1995 as part of the CLIMA program. The hydrographic data suggest that Shelf Water has freshened approximately 0.1 PSU since the 1980s. HSSW became saltier in the late 1990s and subsequently freshened nearly 0.15 PSU. We utilize meteorological observations from Automatic Weather Stations Enide and Rita in conjunction with a satellite-derived history of the opening of the polynya within Terra Nova Bay to delineate higher-frequency variability of these water masses and its relationship with atmospheric forcing. (Abstract ID 12356)

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INTENSIFICATION OF THE LOOP CURRENT FRONTAL EDDIES IN THE NORTHERN GULF OF MEXICO: ROLE OF THE TOPOGRAPHY

We use a free-running numerical simulation of the Gulf of Mexico (GoM) to study the cyclonic Loop Current Frontal Eddies (LCFEs), which are thought to play an important role in the detachment of large anticyclonic rings from the Loop Current (LC). We aim at characterizing these LCFEs and studying their intensification process. Modeled LCFEs have a coherent vertical structure, which extends to the deep layers of the GoM. They may split in two separate upper and lower layer eddies. Deep and surface remnants from different frontal eddies are able to align to form new, coherent structures. LCFEs intensify when the LC is extended into the GoM, as they flow over the deep slope of the northern GoM shelf before reaching deep parts of the GoM again. We employ a vorticity analysis to quantify the effect of topography on the cyclone, which is first intensified in its lower part. This deep intensification also affects the upper part vorticity. The impact of LCFEs on LC variability has implications on coastal to offshore interactions and connectivity of remote shelf regions in the GoM. (Abstract ID 12348)

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IMPORTANT ROLE OF PLANKTON DIVERSITY FOR GLOBAL OCEAN BIOGEOCHEMISTRY

There is ample evidence from observations that different plankton groups have unique impact on marine biogeochemistry. Yet the specific role of plankton groups and ecosystem dynamics for global biogeochemical cycles has never been quantified because plankton diversity is barely represented in ocean biogeochemistry models. Here we present growth characteristics of ten plankton Functional Types (PFTs), and quantify their role using the plankTOM10 Dynamic Green Ocean Model. The model parameters are based on our synthesis of more than 7500 growth rates and constrained by a range of other relevant observations. Growth rate is slowed for the smallest phytoplankton PFTs, but fastest for the smallest heterotrophic PFTs. The PFT

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distributions reproduced by the model are all unique, and generally map onto currently known distribution. Representation of the trophic structure with ten PFTs corrects important bias found in simpler models, and the model now reproduces the lower chlorophyll found in both the Southern compared to the Northern Ocean, and in the Southern Pacific compared to the Southern Atlantic. Representation of macrozooplankton (krill) is key to correcting these biases in the model, which shows the importance of trophic structure and ecosystem diversity for ocean biogeochemistry. (Abstract ID 11066)

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ON THE ROLE OF EDDIES IN THE SOUTHERN OCEAN TEMPERATURE RESPONSE TO THE SOUTHERN ANNUAL MODE.

Recent works suggest that the response of eddy heat flux across the Antarctic Circumpolar Current (ACC) to increased winds associated with the positive trend of the Southern Annular mode (SAM) could be a significant contributor to the observed warming of the Southern Ocean. Here, simulations of a realistic, 1/8-resolution, primitive-equation, regional, ocean-sea-ice model forced by atmospheric reanalyses are used to investigate the mechanisms driving the interannual variability of sea surface temperature in the Southern Ocean and its response to the SAM. As in previous studies, model sea-surface temperature (SST) south of the Polar Front is found to be significantly correlated to the SAM index at lag 2-3 years over 1982-2005. But, our model results show that the interannual variability of eddy heat fluxes across the PF does not contribute significantly to the interannual variability of SST south of the polar front. Rather, model SST south of the Polar Front appears to be governed by a combination of anomalous air-sea fluxes and anomalous horizontal advection along the ACC. These findings advocate that reducing the uncertainty in air-sea fluxes estimates and air-sea flux representation in ocean models is essential for understanding the observed trends in the Southern Ocean. (Abstract ID 11322)

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THE NEW CCCAR “EDDY” OCEAN DATA SERVER.

The Colorado Center for Astrodynamics Research (CCCAR) historical and near-real-time (NRT) mesoscale sea surface height anomaly (SSHA) dataset and data viewers have been available on line since 1996. Over the past 15 years the web based data viewers have undergone a variety of upgrades; however, the SSHA data processing has undergone little modification other than to update mean reference surfaces and include data from new radar altimeter satellites. This past summer a complete overhaul of the system has been completed. The current system uses RADS to generate historical data products and JPL PO.DAAC NRT SSHA for near real-time data products. Both the historical and NRT data sets include along-track SSHA and daily global gridded 1/4 degree resolution products. The historical data product is based on the multiplatform Cressman analysis of all of the available satellites on a given date that was implemented in the original system. The reanalysis was completed using a new suite of SSHA processing tools developed entirely in MATLAB, which simplifies incorporation of new data streams and development of new interpolation methods. Work in the coming year will focus on improving the mesoscale interpolation procedure. Examples of data products and operational applications based on the CCCAR mesoscale sea surface height data system will be highlighted. (Abstract ID 11416)

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INORGANICS IN ORGANICS: QUANTIFICATION OF ORGANIC PHOSPHORUS AND SULFUR AND TRACE ELEMENT SPECIATION IN NATURAL ORGANIC MATTER USING HPLC-ICP-MS

A method is presented for the chemical characterization of natural organic matter (NOM). We combined reversed-phase chromatographic separation of NOM with high resolution inductively coupled plasma mass spectrometry. A desolation technique was used to remove organic solvent derived from the preceding chromatographic separation. We applied our method to solid-phase extracted marine dissolved organic matter samples from South Atlantic Surface Water and Antarctic Surface Water. The method provided a direct and quantitative determination of dissolved organic phosphorus and sulfur and fractions of differing polarity and also allowed simultaneous speciation studies of trace elements. Dissolved organic carbon:phosphorus and carbon:sulfur ratios for the different chromatographic fractions of our two samples ranged between 341 – 3025 for C:P and 11 – 1225 for C:S. Differences in elemental distribution between the fractions were attributed to different biochemical environments of the samples. Sulfur was exclusively found in one hydrophilic fraction, while uranium showed a strong affinity to the hydrophobic fractions. Our method was designed to be easily adapted to other separation techniques. The elemental information will deliver valuable information for ultra-high resolution molecular analyses. (Abstract ID 11867)

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REFLEXION OF A PLANE WAVE ONTO A SLOPE AND WAVE-INDUCED MEAN FLOW

Most studies of internal gravity wave breaking in the ocean focus on the impact of mixing on the background potential energy, as estimated by a diapycnal diffusivity. By contrast, the kinematic part of mixing, associated with momentum deposition when the wave field dissipates, has drawn very little attention in the ocean. In the atmosphere, the fundamental role of wave-induced mean flows on atmospheric circulation has been realized for fifty years. This topic is addressed here for a simple academic configuration of oceanic relevance, of a plane wave interacting with a simple slope. While previous works on this subject were conducted in a (quasi) two-dimensional vertical plane, laboratory experiments on the Coriolis platform and three-dimensional numerical simulations using the non hydrostatic Symphony-NH code have been carried out in the present case. As we shall show, a strong horizontal mean flow develops in the interaction region between the incident and reflected wave, which is inherently three-dimensional. The dynamics and features of this flow for both normal and oblique incident wave planes will be discussed, as well as implications for the oceanic context. (Abstract ID 12339)

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STRATEGIES FOR AUTONOMOUS SENSORS

The growing application of autonomous platforms to the study of biogeochemical processes demands new approaches for calibration and interpretation. Direct calibration and cross-calibration against known reference sensors are required to determine uncertainties and to support quantitative analysis across arrays of sensors. For many biogeochemical sensors, pre- and post-deployment laboratory calibration is insufficient, and should be augmented with other approaches, including direct in situ calibration, cross calibration against well-characterized references and the use of redundant and/or related sensors. Laboratory characterization and in situ calibration are also required to develop the biogeochemical proxies for optical and acoustic measurements. The 2008 North Atlantic Bloom (NAB08) experiment characterized patch-scale evolution of the spring phytoplankton bloom using four gliders, a Lagrangian float and intensive ship-based sampling, underpinned by an aggressive calibration effort. Proxy sensors were used for carbon cycle components, with ship-based efforts providing direct calibration and data for constructing proxy relationships. Direct calibrations were propagated to other autonomous sensors through deliberate intercalibration profiles. NAB08 illustrates an effective approach for implementing process-scale calibration of autonomous sensors and provides guidance for the design of larger-scale efforts. (Abstract ID 11507)

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NO EFFECT OF CO2 ON ELEMENTAL STOICHIOMETRY AND TEP PRODUCTION OF EMILIANIA HUXLEYI IN NUTRIENT-LIMITED CHEMOSTATS
Aggregation processes in the ocean cascade from the nano to micro-scale, primarily by gel particle formation from high-molecular-weight organic polymers, and subsequent entanglement of mineral particles, phytoplankton and fecal pellets. We tested the hypothesis that gel particle production increases with ocean acidification, thus increasing aggregation. Chemostat experiments with Emiliania huxleyi were conducted at 180, 380, and 750 ppm CO$_2$ and natural low phytoplankton abundances. Flow rate was set at a low growth rate simulating non-bloom conditions, and pH, DIC and total alkalinity were determined. Cell numbers and Chl were similar in each of the chemostats since phytoplankton abundance is determined by nutrient levels, which were identical. However, TEP should be higher in experiments with higher CO$_2$ based on past studies. It was not. POC should increase in experiments with higher CO$_2$ as more gels are formed, and PIC should decrease as calcification slowed down. It did not. Because of higher phytoplankton exudation, DOC should be higher in experiments with higher CO$_2$, but decrease once gel formation begins. It was not. We will discuss possible reasons for these differences. (Abstract ID 11361)

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**DISTRIBUTION AND PERTURBATION OF DISSOLVED SILVER IN WESTERN PACIFIC MARGINAL SEAS: FROM HEADWATERS TO THE OPEN OCEAN**

Due to its photochemical reactivity, Ag is considered one of the more toxic elements and an ideal urban pollution indicator. A series of waters from headwaters, tributaries, estuaries and coastal waters subjected to varying levels of anthropogenic pressures, as well as waters of Taiwan Strait, East China Sea, South China Sea, and West Philippine Sea were collected and analyzed. The concentrations of Ag showed wide range (0.1–350 ppb) from the headwaters to the estuaries, strong correlations were found between the Ag concentration and the watershed population, and the estimated average flux from island Formosa to the ocean was about 118 tons/yr, implying the anthropogenic input is now an important source to the ocean. In surface waters from the East China Sea to the South China Sea, dissolved Ag distributions were characterized by decreasing long-shore southward and increasing near-shore with concentration gradients (0.1–75 ppb) with the highest level near river inputs, correlated with population. Vertical profiles of dissolved Ag concentrations in East China Sea, South China Sea, and West Philippine Sea reconfirmed its nutrient-type distributions which significantly correlated with silicate concentrations. Although there were conspicuous indications of anthropogenic sources in the nearshore surface waters, it seemed to be local and only affect the surface waters rather than the deep layers, the large-scale contaminations of Ag in the open ocean waters were not observed. (Abstract ID 10136)

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**LONG-TERM STORAGE AND ANALYSIS OF NITRITE OXYGEN ISOTOPES IN SEAWATER**

Nitrite is an important intermediate in major biological transformations of the nitrogen cycle. Decoupling of its production and consumption processes, can cause nitrite to accumulate such as in the primary nitrite maximum at the base of the euphotic zone and the secondary nitrite maximum in oxygen minimum zones. Isotopic analysis of this pool is critical for the full interpretation of microbial processes occurring in these regions of the water column. Analysis of δ$^{18}$O–NO$_2$ is still in its infancy due to the lack of widely available references materials and problems with storage and analysis associated with the tendency of oxygen atoms to exchange between nitrite and water. Studies to date mainly conducted in freshwater have recommended long-term storage and analysis with appropriate techniques to exchange and water and standards. To date many methods in freshwater have recommended storage at pH 12, with a suggested analysis method that requires near neutral conditions to be restored prior to analysis. We present here data from an 8 month storage test in seawater and a viable method for subsequent analysis, without any need to restore near neutral conditions prior to analysis. (Abstract ID 11177)

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**ESTIMATION OF SUSPENDED SEDIMENT MASS FLUX DURING SUMMER MONSOON USING ADCP IN THE DAMMED NAKDONG ESTUARY, KOREA**

The Nakdong estuary has witnessed the acceleration in siltation of waterways and the growth of deltoid barrier islands since the construction of estuary dam in 1987. The observation contradicted the initial expectation that the estuarine dam would stabilize sediment supply, but field assessment has been difficult due mainly to the lack of field data. This study aims to obtain field data during the summer monsoon to assess the temporal variation of suspended sediment mass flux in the Nakdong estuary. ADCP backscatter intensities, which were simultaneously observed at downstream of the dam and the inlet of barrier islands, were calibrated with an improved inversion algorithm against measured suspended sediment concentrations. Acoustic estimates of suspended sediments in Nakdong Estuary showed in great agreements with optically-derived and water sampled SSCs. The temporal variation of SSC profiles clearly exhibited the influence of estuary dam through intermittent freshwater discharge in the Nakdong Estuary. (Abstract ID 12100)

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**ALTERED ESTUARIES OVERVIEW**

Estuaries provide habitats for living organisms and support high productivity. However, many estuaries over the world have been degraded due to alteration caused by various human activities. Efforts have been made in recent decades to understand the nature of altered estuaries and the natural response to these modifications, with the intention of restoration and/or best management practices of estuaries. This paper overviews various types of alteration, that many estuaries have undergone, and their consequences in physical and biogeochemical processes. Further, the direction for their restoration and adaptive management will be presented. (Abstract ID 10970)

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**A SEA ICE-OCEAN COUPLED MODELING OF THE OCEANIC CIRCULATION IN THE ARCTIC OCEAN**

An ice-coupled Ocean General Circulation Model (OGCM) has been used to simulate the oceanic circulation in the Arctic Ocean. The OGCM used in this study is the Regional Ocean Model System (ROMS) version 3.6, which is a three-dimensional, sigma-coordinate, primitive equation ocean model with a free surface. The model area covers the region 55°–90°N, 180°–180°E with orthogonal curvilinear coordinates of 27−43km grid resolution. A total of 70 s-coordinate levels are adopted in the vertical direction with enhanced resolution near the surface. Daily ECMWF (European Center of Medium range Weather Forecasting) reanalysis data with 1.5° resolution during the period 1990-2009 are used to calculate heat and salt fluxes as well as wind stress at the sea surface. We used SODA-Simple Ocean Data Assimilation) Global 1/2° data for temperature and salinity along inflow open boundaries. To assess model performance, model results are compared with those of IPCC AR4. (Abstract ID 10811)

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**EFFECT OF SUBMERGENCE AND SALINITY ON THE DISTRIBUTION OF PHRAGMITES AUSTRALIS IN TIDAL MARSHES OF THE REPUBLIC OF KOREA**

We compared distribution of Phragmites australis in small estuaries with (Gosung) and without (Guman) a barrage. Through the comparison of two sites, we expected to see the controlling factor for the P. australis distribution. Distributions of P. australis and habitat characteristics such as flooding patterns and salinity exposure were measured for the study. P. australis seems to prefer low submergence time (average hydroperiod: 40.3%) in the relatively high places (over 150cm above mean sea level) in Guman estuaries. However, P. australis didn’t appear in the marsh without freshwater influence even in high areas above 150cm. The diurnal salinity variation observed in the water column (2 highs and 2 lows in a day) was not observed in the porewater near P. australis roots. In the long term mooring measurements, however, overall ranges of the salinity variation in two sites were similar. We suggest that the porewater salinity that will directly influence P. australis is determined by the combinations of various hydrological factors such as tidal strength, drainage of sediment and freshwater input in the P. australis habitat. (Abstract ID 10950)

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**A HYDROGRAPHIC SURVEY IN THE CENTRAL AMUNDSEN SEA SHELF IN 2010-2011**

In December 2010 and January 2011, Korea Polar Research Institute conducted a hydrographic
survey in the central Amundsen Sea shelf near Gets and Dotson Ice Shelves using the new Korean IBRV Araon. The CTD data reveal that the near bottom intrusion of the Circumpolar Deep Water (CDW) into the shelf area is relatively weaker than the previous observations reported in various literatures. Vertical distributions of water properties on the cross (channel) section appear to incline slightly to the eastern flank of the channel suggesting that a physical process governs its synoptic circulation in the region. Possible physical processes for the CTD intrusion and synoptic circulation in the central Amundsen Sea shelf will be presented. (Abstract ID 9692)

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SEASON AND DEPTH OF ALKENONE PRODUCTION IN THE EAST SEA/JAPAN SEA AND EAST CHINA SEA
Long chain (C37) alkenones can be used as a proxy of past sea surface temperature. To test the applicability of alkenones, this study investigated the season and depth of alkenone production in the NW Pacific marginal seas. Surface and subsurface seawater samples were collected from the southwestern part of the East Sea/Japan Sea and East China Sea during the cruise of National Fisheries Research and Development Institute of Korea in 2008-2010. Samples were filtered for suspended material at two-month interval from the East Sea and three-month interval from the East China Sea. Subsurface samples were collected at the water depths of 20, 50, 70, 100 m by CTD bottle casting. The results of alkenone analysis show that the concentration of total C37 alkenones is generally high in the surface mixed layer, and decreases with depth, indicating that alkenones seem to be produced at or close to the surface mixed layer. Seasonal variation in alkenone concentration shows that the concentration appears to be higher in summer compared to other season, but it is still present in any other season. (Abstract ID 12210)

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USING WORLDVIEW-2 IMAGERY ACQUIRED AT MULTIPLE ANGLES TO DETERMINE OCEAN DEPTH NEAR OAHU, HAWAII
Multispectral imaging (MSI) data acquired at different view angles provide an analyst with a unique view into shallow water. Observations from DigitalGlobe's WorldView-2 (WV-2) sensor, acquired in 39 images in one orbital pass on 30 July 2011, will be analyzed for bathymetry data taken from along the windward side of the Oahu coastline. Satellite azimuth and elevation range from 18.8 to 185.8 degrees and 249 to 77.8 degrees (respectively). WV-2's eight multispectral bands provide depth information (especially using the Blue, Green, and Yellow bands), bottom type, and surface glint (using the Red and NIR bands). Bathymetric analysis from the optical data are compared to LiDAR-derived bathymetry. This work should show the impact of varying view angle on inferred bathymetry. (Abstract ID 12345)

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THE SUMMER ASSEMBLAGE OF LARVAL FISHES IN THE WATERS OF EAST CHINA SEA SHELF AND TAIWAN IN 2007
This study investigates the assemblage of larval fish and its relationship with hydrographic features in the East China Sea and waters surrounding Taiwan in the summer 2007. The survey were conducted on 1-11 July 2007 by LORECS with 30 stations in the southern East China Sea and on 4-16 July 2007 by TaiCOFI (Taiwan Cooperative Oceanic and Fisheries Investigation) with 32 stations in the seas around Taiwan. A total of 12,670 larval fishes belonging to 94 families and 108 taxa were identified. Engraulidae, Gobiidae and Sillaginidae were the three most abundant families and accounted, respectively, for 56.92%, 23.94% and 6.67% of the total specimens numerically. Among these taxa, Engraulis japonica and Sillago japonica were the two most dominant species and accounted for 56.15% and 66.9% of the total specimens in number, respectively. According to the dendrogram derived from cluster analysis of fish larvae and hydrographic features, the larval assemblages of 51 sampling stations were divided into three groups: A (Kurushima assemblage), B (coastal assemblage, further divided into two subgroups B1 and B2), and C (Taiwan water current assemblage). The dominant species were Diaphus sp, Bregmaceros sp, and latissid species for group A, Engraulis japonicus, Sillago japonica, and Cynoglossus sp for group B1, Gobid Type 2 species, Engraulis japonicus, and Bregmaceros sp for group B2, and Ausis spp, sciaenid species, and gobid Type 1 species for group C. (Abstract ID 9808)

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OIL DROPLETS IN Fecal PELLETS OF DOLIOLIDS AFTER UPTAKE OF DISPERSED OIL
After an oil spill off Nova Scotia, Conover (1971) found copepods with particulate oil and calculated that as much as 10% of the oil particulates were associated with copepods and their feces. In the present work we used light field and fluorescence microscopy to determine if oil droplets were in doliolids (Doliolleta gegenbauri) and their fecal pellets after exposure to dispersed oil droplets. The dispersed oil droplets, formed by mixing dispersant with crude oil, varied in size from 2 to 30 µm with exposure concentrations ranging from between 2000 to 35,000 droplets/ml. After exposure for 4 hours the stomach of the doliolids showed the presence of many oil droplets followed by discharge of fecal pellets with an abundance of oil droplets. Uptake of oil droplets only took place if food (mixture of diatoms and small flagellates) was available to the doliolids. Oil concentrations in the dolioloids and their fecal pellets (based on droplet volumes, droplet counts and oil density) ranged from 0.08 to 0.20 µg/doliolid and 0.1 to 0.15 µg/fecal pellet. (Abstract ID 9931)

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FINDING APPROPRIATE ABIOTIC PARAMETERS TO EVALUATE BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN TEMPERATE CONTINENTAL SHELF WATERS
Continental shelf waters of the northeastern Pacific host an array of benthic macroinvertebrates that are heterogeneously distributed across a diversity of habitats. Habitats of continental shelf waters can be described based on depth, relief, and grain size. Our objective was to characterize macroinvertebrate assemblages and their habitat associations in these shelf waters that have not been surveyed for benthic invertebrate communities. Video observations were made on the continental shelf margin using a submersible at three sites in the mid 1990s and an ROV at two sites in 2011. We performed Correspondence Analysis (CA) to map associations between 59 invertebrate species and 15 habitats along ordination planes with weighted scores. We also used Nonmetric Multidimensional Scaling (nMDS) to compare similarity among sampled sites and different habitats based on macroinvertebrate density patterns across different habitat substrata. Our CA and nMDS results showed that primary grain size was a stronger indicator of different macroinvertebrate assemblages than the amount of relief. Using Canonical Correspondence Analysis, we will evaluate correlations between changing invertebrate densities and other abiotic parameters after taking different geographic latitudes into consideration. (Abstract ID 9730)

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EXTREME OCEANIC AND ATMOSPHERIC ANOMALIES IN THE SOUTH PACIFIC AND WESTERN ANTARCTICA ASSOCIATED WITH THE 2009-10 EL NINO
Satellite, in-situ measurements, and reanalysis products are used to document the evolution of extreme oceanic and atmospheric anomalies in the South Pacific and western Antarctica during late 2009 to early 2010. During this period, a record warming occurred in the mid-latitude South Pacific and western Antarctica. The South-Pacific warming, confined to the mixed layer, occupied an area the size of Australia with the sea surface temperature (SST) anomaly exceeding five times the standard deviation of SST variability in that area. It was also substantially larger than the tropical SST anomaly associated with the concurrent El Nino. A record increase in ocean bottom pressure (OBP) and sea level was also observed in the southeast Pacific. These anomalies were associated with an extremely strong and persistent anticyclone over the southeast Pacific and western Antarctica. A mixed-layer heat budget analysis and barotropic vorticity analysis were performed to explain the physical processes that cause the SST and OBP anomalies. Our analysis suggests that the extreme atmospheric and oceanic conditions in the South Pacific may have been amplified by the 2009-10 central-Pacific El Nino. (Abstract ID 10489)

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DETERMINE OCEAN DEPTH NEAR OAHU, HAWAII USING WORLDVIEW-2 IMAGERY ACQUIRED AT MULTIPLE ANGLES TO

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THE SUMMER ASSEMBLAGE OF LARVAL FISHES IN THE WATERS OF EAST CHINA SEA SHELF AND TAIWAN IN 2007

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Spatial and temporal resolutions, the remote-sensing results demonstrate the importance of sensing, with an objective to validate and improve remote sensing methods. Satellite data include measurements from HICO, MERIS, and GOCCI. Because these sensors have different spatial and temporal resolutions, the remote-sensing results demonstrate the importance and improvement of high-spatial and high-temporal resolutions in the monitoring of water qualities, as well as characterizing dynamics of community phytoplankton. These would provide needed information for the design and preparation of the GEO-CAPE.

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AN INTERACTIVE APPROACH TO DEVELOP ENVIRONMENTAL MANAGEMENT STRATEGY FOR THE ESTUARIES WITH RIVER-MOUTH BARRAGES IN THE REPUBLIC OF KOREA

Korean estuaries were severely altered. Total 228 estuaries among 463 estuaries were lost their free connection with open sea by river-mouth barrages. Most wetlands of the barraged estuaries were converted to land, which is estimated about 427km2 during the last two decades. In order to improve deteriorated water quality and ecosystem health particularly in the barraged estuaries, recently Korean Government launched an integrated research program which aims to support development of national-estuarine policy and management strategy. The integration was made in multi-level: it covers geographically estuarine management area as well as upstream watershed, deals with socio-economic problems as well as scientific interests, consists of required functional project components such as monitoring, modeling and GIS-based database, and provides a platform to secure stakeholders involvements. This paper presents the interim progress and performance assessment of program in the integrated perspective. (Abstract ID 10805)

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SPRING-NEAP VARIATIONS OF RESIDUAL CURRENT AND SALINITY AT YEOMHA CHANNEL, SOUTHERN KOREA

Measurements of velocity and salinity profiles were made to describe the along-channel structure of flow and salinity in Yeomha channel, South Korea, where typical tidal velocities are ~2 m/s. The Observation of surveys on August, 5(Neap tide) and 12(Spring tide),2010. Observation data were obtained with a 60kHz ADCP and CTD over 13 repititions of a along-channel transect during one semidiurnal ~13 hours/tidal cycle. For the data uniform grids have a horizontal and vertical sigma coordinate. The residual current was calculated through least-squares fit of semi-diurnal(M2)and quarter-diurnal(M4). As a result of the analysis, during spring tide residual flow pattern was all area out flow and also out flow stronger than neap tide. During neap tide was inflow near bed and outflow near surface layer. The spring tide mean salinity was vertically mixed and neap tide was stronger stratification. Those observation result spring tide have a strong barotropic forcing more than neap tide. Yeomha channel have a different sea-level slope between upstream and downstream. Upstream have a high-sea-level slope than downstream during spring tide but neap tide almost same(Song and Woo,2011). (Abstract ID 11037)

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DESIGN OF ENVIRONMENTAL INFORMATION SYSTEM FOR THE ANALYSIS OF ECOLOGICAL CHANGES OF THE ESTUARY

The necessity to handle the weakening of circulation and variety which the estuary has is increasing because of the coastal erosion and significant decrease of tideland. The data collected from the estuary are important to understand the environmental change. However, there is no integrated EIS(Environmental Information System) to cover such a great amount of data. Thus, the purpose of this study is to design an integrated EIS of the estuary based on GIS which includes the integrated DB of ecology and environmental change continuously. Firstly, the user needs analysis was conducted by reflecting utilization and plan of the integrated EIS from experts of the environment who will be the actual users of the system. For environment of the system development, ArcObjects component was used in order to realize the GIS module based on VB.NET. The stage of the system design determines the suitability prior to establishing the actual system and supports the rapid system development. The suitability of the design can be verified by developing the actual system, and a study for utilization of the integrated EIS will also be required. (Abstract ID 10191)

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IN-SITU MEASUREMENTS OF PHYTOPLANKTON FLUORESCENCE USING LOW COST ELECTRONICS

Chlorophyll a fluorometry has long been used as a method to study phytoplankton in the ocean. In-situ fluorescence provides the best resolution for spatial distribution of phytoplankton. However, the high price of commercially available in-situ fluorometers can make them unaffordable to individuals or institutions. Presented here is an investigation into building an in-situ fluorometer using low cost electronics. The goal was to construct an easily reproducible in-situ fluorometer from simple and widely available electronics. The simplicity and modest cost of the sensor makes it valuable to students and professionals alike. Open source sharing of architecture and software will allow students to reconstruct and customize the sensor on a small budget. Research applications that require numerous in-situ fluorometers or expendable fluorometers can also benefit from this study. The sensor uses blue LEDs to excite chlorophyll a and measures fluorescence using an amplified red LED as a photodiode. The sensor is controlled by an Arduino microcontroller that also serves as a data logger. (Abstract ID 11216)

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NITROGEN SOURCE AND PCO2 SYNERGISTICALLY AFFECT CARBON ALLOCATION, GROWTH AND MORPHOLOGY OF THE COCCOLITHOPHORE EMILIANIA HUXLEYI

Emiliania huxleyi is the most abundant coccolithophore in the worlds ocean, and plays a major role in the global carbon cycle by regulating the exchange of CO2 across the ocean-atmosphere interface through photosynthesis and calcium carbonate precipitation. In future climate, ammonium concentration in seawater is expected to rise due to ocean acidification. To examine the synergetic effect of elevated PCO2 and increased ammonium/nitrate ratio on E. huxleyi, we maintained continuous cultures for at least 200 generations under different conditions of PCO2 and nitrogen source. Assimilation of nitrogen as ammonium depresses growth rates, cell size and the ratio of inorganic to organic carbon. At present, increased ammonium availability may extend to more open waters and could reduce bio-mineralisation by calcifying organisms, while increasing primary production in these species, thus exerting feedback on climate. (Abstract ID 11756)

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DECREASING DOWNSCAL CARBON CONCENTRATIONS COUPLED
TO INCREASING INORGANIC NUTRIENTS OVER SHALLOW CORAL REEF COMMUNITIES, MOOREA, FRENCH POLynesIA

Dissolved organic material (DOM) can be both produced and consumed by a variety of coral reef organisms from bacteria to corals. However, the extent to which hydrodynamics and reef communities mediate DOM fluxes are generally unknown. In Moorea, French Polynesia, a series of fixed station surveys revealed persistently low concentrations of dissolved organic carbon (DOC) inside of the shallow reef crest relative to offshore concentrations. Water velocities measured using fixed profilers and drifters were predominantly unidirectional onshore, driven by wave breaking and modulated by tidal changes in water depth. Flow across shallow reef flat habitats was associated with significant net declines in DOC especially within the first 100 m inshore of the reef crest. Although the mechanism of DOC removal is presently unknown, concurrent increases in water column dissolved inorganic nitrogen and phosphorus concentrations suggest rapid consumption of DOM coupled with release of remineralized inorganic nutrients. Among-shore comparisons reveal marked differences in wave forcing and cross-reef water flow that likely alter net material fluxes through the reef communities around Moorea. (Abstract ID 12705)

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OCEANOGRAPHY IN 2030: CHANGING OCEAN SCIENCE WITH SOCIAL MEDIA

The history of oceanography is rich in examples of how social interactions shaped our scientific discoveries. Since the iconic expeditions of the 19th century, like the Challenger Expedition, teams of scientists have collaborated in exploration at sea. This group culture of activity has led oceanographers to be ‘early adopters’ of social communication technologies (e.g., email) to enhance their research capability. The next two decades will bring equally powerful new social media, especially social interaction technologies, that will change the way we operate at sea, collaborate with each other, analyze data, establish reputation, and publish results. Some of these collaboration mechanisms will impact all education and science fields more or less equally. A measure of the innovation capability and plasticity of our own field will be the degree to which we are able to not only capitalize on social media innovations but to co-innovate to enable unique uses for ocean science or to shape social media as a result of our specific needs. (Abstract ID 9623)

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HIGH VARIABILITY OF OCEAN ACIDIFICATION PARAMETERS IN SANTA MONICA BAY, CA

We investigate the temporal variability of pH and of the aragonite saturation state, $\Omega_{arag}$, in Santa Monica Bay (SMB), California on the basis of $\sim$250 weekly measurements of dissolved inorganic carbon and alkalinity spanning 6 years (2003 until 2008). Mean values of pH and $\Omega_{arag}$ in the upper 30 m (801 and 2.61) are comparable to observations from the subtropical gyre of the North Pacific, but the temporal variability is an order of magnitude larger ($\sigma_{pH}=0.0024$ and $\sigma_{\Omega_{arag}}=0.085$). This variability is primarily controlled by upwelling and relaxation events, mesoscale variability, and the interaction of photosynthesis and respiration. pH and $\Omega_{arag}$ decreases rapidly with depth, such that the aragonite saturation horizon is reached already at 130 m, on average. The depth of this horizon varies strongly, showing several times reaching depths as low as 30 m. The deeper layers (125 – 300 m) exhibit statistically significant negative trends, as expected from the progression of ocean acidification. No significant trends can be seen in the near-surface ocean, mainly because of the high temporal variability. (Abstract ID 11352)

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LINKAGES BETWEEN LARGE-SCALE CLIMATE SIGNALS AND THE REPRODUCTIVE SUCCESS AND SURVIVAL OF LARVAL STAGES OF COASTAL MARINE FISH

We examined 40-year time series of the juvenile abundance of 56 species of demersal fish off the coast of Southern California versus major climate signals, such as PDO, NIPOG, and El Niño, to look for patterns in what might be controlling the reproductive success and early stage survival of these species. We found significant relationships (often very highly significant with high correlation coefficients) between juvenile abundance and one or more of the climate signals for 31 of the 56 species examined. For nearly all of the correlations, there was often a lag of several years between the climate signal and the juvenile abundance, in some cases up to ten years. For roughly 1/3 of the species, the lag was within the range of estimated time to maturity for that species, suggesting bottom-up environmental control on reproductive output. For a few species, the lag between climate signal and abundance was similar to the maximum age for that species. Mechanisms for why these climate signals are linked to juvenile abundance will be further discussed. The results of this study have direct impacts on fisheries management, as many of the species found to be highly correlated with climate signals are important managed fisheries species. (Abstract ID 11824)

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EXPLORATION OF ASTORIA CANYON HABITAT ASSOCIATIONS IN DEEP-WATER DEMERSAL FISHES

Submarine canyons are largely unexplored along the Cascadia margin of the Pacific Northwest. Canyons are complex oceanographic features that modify sediment transport and currents, and may play important roles in the life histories of fishes. This study is part of a larger project aimed to explore Astoria Canyon both geologically and biologically, and is focused on examining fish-habitat associations down to 1,350 m. Video imagery from seven dives using the ROPOS ROV was analyzed for fish associations with bottom type, steepness, and association with structure-forming invertebrates with the ultimate goal of better understanding critical fish-habitat associations and providing baseline information for some commercially important species in a previously unexplored area. The shoreward end of the canyon was dominated by sedimentary lithologies and two species of commercially important sandeels. Fishes were not uniformly distributed over the range of observed substrates, and multivariate analysis showed that species grouped together on a gradient of depth and habitat complexity. Finally, although diversity generally decreased with increasing depth, diversity increased below 900 m, and this pattern was perhaps due to a complex geologic feature at this transect. (Abstract ID 12746)

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VERTICAL AND HORIZONTAL PATTERNS OF BACTERIAL AND ARCHAEAL COMMUNITIES ALONG THE ROMANCHE FRACTURE ZONE IN THE TROPICAL ATLANTIC

The composition of prokaryotic communities was determined in the meso- and bathypelagic waters fanned out from the Romanche Fracture Zone (RFZ, 27°5′31′′′′79°W to 06°N 14°35’3W) in the tropical Atlantic. The prokaryotic communities clustered according to different water masses as revealed by TRFLP (terminal restriction fragment length polymorphism) analyses. The composition of bacterial and archaeal communities determined by cloning and sequencing also revealed stratification with depth and the presence of water-mass-specific communities. The abundance of Crenarchaeota, assessed by catalyzed reporter deposition-fluorescence in situ hybridization (CARD-FISH), was significantly higher in deeper layers contributing up to 30% to the total prokaryotic community. SAR11 was more abundant in the top 500 m (on average 15% of Bacteria). In contrast, SAR202 exhibited a higher contribution in deeper water masses (30% of Bacteria). SAR326 was found mainly at the bottom of the euphotic zone and the North Atlantic Deep Water (NADW). SAR406 contributed up to 20-30% to the bacterial abundance in NADW while Alteromonas and Planctomycetes did not vary significantly with depth. (Abstract ID 9905)

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OVERVIEW AND RECENT IMPROVEMENTS OF THE GLOBAL AND REGIONAL MERCATOR OCEAN OPERATIONAL SYSTEMS

Since December 2010, Mercator Ocean operates in real time new versions of the global system at V and the Atlantic and Mediterranean system at 1/12 nested in the global one. Both new analysis and forecasting systems deliver weekly and daily services in the framework of the MyOcean project. Many improvements concern the ocean/sea-ice model (NEMO code) and the assimilation scheme (reduced order Kalman filter). Moreover, a method of bias correction based on a variational approach is used. We will present here recent validation results. It demonstrates the high level of performance and the stability of the new systems for all variables.
and their superiority to the previous ones in most aspects. In addition, since July 2010, two new systems are operated in real-time. The first one is a global 1°12′ forecasting system which delivers weekly services. This system does not benefit from all the recent improvements but offers a new perspective on the global ocean mesoscale predicting. The second one is a high resolution system at 1/36′, nested in the Atlantic and Mediterranean one. This system covers the Iberian-Bocas-Cay region, includes high frequencies processes and is able to reproduce small structures like tidal fronts or upwelling filaments. (Abstract ID 11412)

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IRON AND COPPER LIMITATIONS DRIVE METABOLIC STRATEGIES OF THE MARINE DIATOM PSEUDO-NITZSCHIA DELICATISSIMA

Iron (Fe) limits phytoplankton growth in ~50% of the ocean. Fe-enrichment in these regions triggers diatom growth, and notably that of Pseudo-nitzschia. Copper (Cu) may also be an important micronutrient in low-Fe oceanic regions because of its suggested role in Fe acquisition. To better investigate the effects of Fe and Cu limitations on the growth and physiology of diatoms, we conducted batch cultures of P. delicatissima under Fe limitations, Cu starvation and Fe/Cu co-limitations. Physiological measurements were performed by flow cytometry during exponential growth. Fe limitations induced a decrease of chlorophyll content and quantum yield (QY). Severe Fe-limitations induced a decrease of both esterase activity and no storage of lipids while Fe-mild limitation induced an increase of both esterase activity and lipid content. Cu starvation induced an increase of chlorophyll content, with a QY identical to control cultures, an increase of both lipid content and esterase activity. Cu-co-limitations induced modifications close, but significantly different, to Fe limitation. These results indicate that in P. delicatissima the Cu demand for Fe acquisition may be low relative to other cellular Cu pools. (Abstract ID 12901)

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THE EFFECTS OF THE 2010 BP OIL SPILL/DEEPWATER HORIZON INCIDENT ON DEEP-SEA MACROFAUNA COMMUNITIES

Following the destruction of the BP-owned Deepwater Horizon oil platform on 20 April, 2010, approximately 206 million gallons of crude oil entered the deep Gulf of Mexico (GoM). After the wellhead was capped and crude oil ceased flowing into the GoM on 15 July, 2010, three sites were sampled on 26 of September, 2010. The sites were N, NE, and SW in relation to the destroyed Macondo wellhead, between six and ten kilometers away. Nine GOMEX box cores were taken to evaluate the possible damage caused to deep-sea macrofauna communities in the Deep-Gulf of Mexico. The numbers of animals of each taxon identified were recorded and compared to the 2000-2002 Deep Gulf of Mexico Benthos (DGoMB) study. Several classes of animals, crustaceans in particular, showed significant decreases (p<0.05) in abundance; while aplacophorans increased (p=0.001) in both categories. PAF (Polycyclic Aromatic Hydrocarbon) analysis confirms the presence of crude oil within the top 15 cm of sediments, chemically similar to Louisiana Crude oil, and tar balls found on the coast of Florida following the spill. (Abstract ID 10121)

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GLIDER AND OTHER OBSERVATIONS OF ANOMALOUS UPWELLING ON THE WEST FLORIDA SHELF IN SPRING/SUMMER 2010

Coincident with the Deepwater Horizon oil spill in spring through summer 2010, the West Florida Continental Shelf (WFS) experienced a state of anomalous upwelling due in part to anomalous interactions between the Gulf of Mexico Loop Current and its eddies with the continental slope. These conditions, while having nothing to do with the oil spill itself, influenced the movement of oil once oil was present within the northern Gulf of Mexico coastal ocean. Such anomalous conditions were identified using coastal ocean observing system resources deployed on the WFS, including gliders, moorings and HF-radar. Glider data in particular show the ventilation of the shelf by water of deep ocean origin and implied impacts on biota. In combination, these observations helped to remove some of the mystery of why oil moved as it did, and these observations will continue to be useful for interpreting anomalous behaviors in coastal ocean ecology as may have existed during that time. (Abstract ID 12215)

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VERTICAL MIGRATION OF ZOOPLANKTON AND ITS IMPACT ON WATER QUALITY WITHIN RESERVOIRS

Reservoirs, which are a constructed inland water system, are primarily used for drinking water supplies, and consequently it is critical that their water quality be maintained at a high level. This requirement often involves intervention to manipulate the physical-ecological interactions in order to maximise water quality. Processes that are often employed include artificial stratification and selective withdrawal process. However, to maximise their efficiency a detailed understanding of the physical-ecological processes are required, but is currently lacking. This presentation will examine the importance of the diurnal vertical migration of zoo plankton on the mixing dynamics within sub-tropical reservoirs and it will consider the important timescales that influence their behaviour. Field studies have indicated that the natural timescales are dominated by the diurnal diurnal migration (O(hours)) and the limited turbulent mixing this induces (O(secs)). It will also consider that by artificially manipulating the water column (O(weeks)) that ecological behaviour can be altered. (Abstract ID 11242)

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HIGH-RESOLUTION AIRBORNE WAVEFORM LIDAR FOR OCEANOGRAPHIC RESEARCH

It is now accepted that to better understand the coupling between the atmosphere and the ocean, surface-wave processes must be taken into account. Traditional airborne LIDAR systems and in-situ instrumentation have limited directional and frequency responses and do not have the resolution required to fully test modern theories of directional wave spectra. Directional observations at lower and higher wavenumbers, the latter being close to the end of the gravity-wave range, are especially limited, but are important as they need to be resolved in current wind-wave models. Over the past two years, we have integrated a novel, portable, high-resolution airborne topographic LIDAR, with video and hyperspectral imaging systems. It includes a new scanning waveform LIDAR coupled to a highly accurate GPS/ inertial measurement unit permitting airborne measurements of the sea surface elevation and whitecap coverage with swath widths of up to 800 m under the aircraft track over water, and horizontal spatial resolution as low as 0.2 m. We describe system performance, and present preliminary results from recent measurements, where we obtained wave directional spectra down to wave lengths of 0.8 m. (Abstract ID 12728)

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GENERATION OF NEAR-INERTIAL SHRE SPIKES CONDUCIVE TO MIXING AT THE BASE OF THE SOUTHERN OCEAN MIXED LAYER

Shear-driven diapycnal exchange at the base of the Southern Ocean mixed layer (SML) is critical to climatically important processes such as Antarctic Intermediate Water formation, primary production and the deep export of CO2. Shear at the base of the SML is dominated by near-inertial wind-driven currents and is expected to vary in amplitude with the winds. However, shipboard observations of winds and upper ocean currents reveal intermittent peaks in the shear uncorrelated with wind-stress fluctuations. We adapt a simple shear-spike generation model developed for stratified continental-shelf seas to the open ocean. Detailed analysis of two Drake Passage hydrographic transects from February 2009 show that the model is proficient at predicting shear-squared spiking when the wind forcing is dominant. Richardson number analysis confirms that much of the shear spiking is adequate to drive diapycnal mixing across the base of the SML. Rotary spectral and statistical analysis of an additional 136 Drake Passage transects from 1999 to 2006 reveals the prevalence shear-spike mixing throughout the year, with the highest associated diapycnal mixing potential occurring in northern Drake Passage during winter. (Abstract ID 11107)

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MOMENTUM TRANSFER TO MEAN FLOWS BY SHOALING, NONLINEAR INTERNAL WAVES

We analyze moored time series of vertical profiles of currents and density obtained from western Massachusetts Bay, a region where variability is dominated by large amplitude, shoaling
internal tides and nonlinear internal waves. Tidally-averaged, Eulander cross-shore currents have a three-layer structure, with offshore flow at the surface and bottom and onshore flow at the depth of the pycnocline. The strength of this three-layer flow is correlated with the observed amplitude of onshore propagating internal waves, suggesting that the shedding internal waves are driving this three-layer internal undertow. Idealized numerical modeling studies of shedding internal waves also reveal a similar three-layer Eulander mean cross-shore flow driven by the waves. We hypothesize the observed tidally-averaged cross-shore flow balances the cross-shore momentum and mass fluxes by the shoaling nonlinear internal waves. (Abstract ID 12415)

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SEASONAL AND INTERANNUAL VARIABILITY IN EUPHAUSIUS DIETS AND FEEDING RATES IN THE EASTERN BERING SEA

As part of the Bering Ecosystem Study (BEST), we investigated how changing sea-ice conditions affect the ecology of euphausiids. We hypothesized that interannual variation in the timing and extent of sea-ice and associated food resources would lead to differences in diet and ultimately production and availability of euphausiids for higher trophic levels. To test this, we measured feeding rates of euphausiids, with emphasis on the two dominant species (Thysanoessa raschii and Thysanoessa inermis). Feeding rates on chlorophyll, phytodetritus and microzooplankton were measured in incubation experiments in spring and summer, 2008-2010. T. raschii feeding rates on phytodetritus followed a functional response with a maximum ingestion rate of 2.6 mg C d⁻¹. However, T. raschii fed on ice algae at much higher rates. The high abundance of krill in cold years may in part be due to the nutritional boost they get from ice resources. Microzooplankton was ingested by both species and comprised more than half of ingested carbon in summer. All three years were cold with similar oceanic conditions and little interannual variability in feeding and diets was seen. (Abstract ID 12606)

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DIFFERENTIAL CYCLING OF DOC AND DON ACROSS THE EASTERN TROPICAL SOUTH PACIFIC

Seawater incubations were performed in the ETSP to investigate the dynamics of dissolved organic carbon and nitrogen (DOC, DON) consumption across ocean productivity gradients. Incubations of surface DOM (0.2 µm-filterate), inoculated with microbes (whole water) from surface or subsurface depths (100 or 200 m), were carried out at oligotrophic and mesotrophic stations and monitored over ~2 weeks. Incubations at the oligotrophic station showed 2.4 µM surface DOC removal when mixed with subsurface microbes (and no change in inorganic N), similar to previously reported observations from the BATS site. At the mesotrophic station, both surface and subsurface microbes remineralized 8.9 µM DON; however, consumption patterns differed between the two conditions. Subsurface microbes consumed all available nitrate, resulting in an initial increase of total organic nitrogen (biological biomass + DON) followed by slow remineralization of some of this material. We find both a larger bio-reactive component of DOC-than DON and gradients in the quantities of bio-reactive and non-reactive DOM across mesotrophic to oligotrophic ocean systems. (Abstract ID 12218)

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THE CARBONATE NATION: LIVING ROCKS ASSOCIATED WITH GAS HYDRATES

Methane dissociated from gas hydrates often fuels anaerobic methane oxidation by a consortium of bacteria and archaea, with carbonate precipitation being a by-product. Sub and ROV collections of carbonates from Hydrate Ridge North (590 m) and South (770 m) on the Cascadia margin reveal distinct microbial, protist and faunal hard-substrate assemblages that vary as a function of environmental seepage activity. Macrofaunal communities at active sites exhibited higher diversity and density than at inactive sites, and were dominated by gastropods on the surface and polychaetes living both inside and on carbonate surfaces. Inactive rocks supported much lower densities, with polychaetes and crustaceans dominant. Carbonate-associated microbial diversity also varied between active and inactive sites, with active carbonates dominated by methanotrophic archaea and sulfate-reducing bacteria. C and N stable isotopic analyses reveal a much broader range (70 per mil for C, 20 per mil for N) and lighter signatures of carbonates and fauna at active than inactive sites reflecting highly diverse trophic pathways. Comparisons with Hydrate Ridge sediments and Costa Rica carbonates provide insight into the unique functioning of the seep carbonate ecosystem. (Abstract ID 9787)

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A CALL FOR DEEP-OCEAN STEWARDSHIP

The deep sea is the largest biome on earth, and houses a significant fraction of the planet’s biodiversity. Once considered monotonous and of limited environmental value, we now recognize that the deep sea is heterogeneous and that the habitats and organisms provide key ecological functions and ecosystem services. These habitats and organisms are now subject to intensified human activities. There is greater demand for biological, mineral and energy resources in the deep sea and continued use of the deep sea as a repository for waste. Climate change impacts also loom. This talk will provide a biogeographic overview of these pressures on continental margins and in the high seas, and highlight the imperative for sustainable management in the face of multi-sectoral pressures. We call for stewardship of the deep ocean via integration of biodiversity and conservation science, technology, informatics, economics, policy, law and communication, effected through engagement of stakeholders. Now is the time to implement sustainable management of deep-ocean ecosystems. This will require greater involvement of deep-sea researchers, creation of political will, and significant capacity building in many countries. (Abstract ID 9789)

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HORIZONTAL AND VERTICAL DIFFUSIVITY ESTIMATED FROM A DYE STREAK

A series of fluorescein dye streaks were injected at about 35 m depth in the seasonal thermocline of the Sargasso Sea in June 2011 during the OINR-sponsored Lateral Mixing experiment. The dye was pumped from the R/V Cape Hatteras as it traveled on a straight course creating a streak of order 500 meters long. Within a few hours after injection, transects of the dye streak were made using a Moving Vessel Profiler, which is an automated system that winches the sensor “fish” up and down while the ship is underway. Estimates of both the horizontal and vertical diffusivity are made by comparing the observed spreading of the streak with the solution of the classic diffusion equation for an initial streak. This simple approach may be plausible because the streak is measured over a relatively short time period of 5 to 10 hours after injection, such that the estimated spreading and straining by the mean field appears to be small. (Abstract ID 10724)

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The Hyperspectral Imager for Coastal Oceans (HICO) is a hyperspectral sensor currently installed on the International Space Station (ISS). HICO has 128 spectral bands, an effective spectral range from 400 to 900 nanometers, and 100 meter spatial resolution. The Hyperspectral Optimization Exemplar (HOPE) is an iterative optimization algorithm that estimates phytoplankton and detritus absorption coefficients, particle backscattering coefficient, bottom albedo and water depth (bathymetry). For the presented work, HICO imagery covering Freshwater Beach, Australia, were used as input to the HOPE algorithm to create bathymetry estimations for several images. The Automated Processing System (APS) imagery covering Freshwater Beach, Australia, were used as input to the HOPE algorithm to estimate phytoplankton and detritus absorption coefficients, particle backscattering coefficient, bottom albedo and water depth (bathymetry). For the presented work, HICO imagery covering Freshwater Beach, Australia, were used as input to the HOPE algorithm to create bathymetry estimations for several images. The Automated Processing System (APS) imagery covering Freshwater Beach, Australia, were used as input to the HOPE algorithm to estimate phytoplankton and detritus absorption coefficients, particle backscattering coefficient, bottom albedo and water depth (bathymetry).
The NOAA Coral Reef Watch (CRW) Decision Support System (DSS) has historically used a high-quality climatology based on satellite SST data set (v5.2). The high-quality climatology required quality levels and algorithms to fill gaps in the data. The new products provide improved, high-resolution tools and more accurate information to researchers and resource managers for better understanding of the complex processes that cause stress on coral reef ecosystems and better manage for a changing climate. (Abstract ID 11343)

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DIAPYCNAL MIXING IN THE SUBPOLAR NORTH ATLANTIC INFERRRED FROM CTD/LADCP SURVEYS

Mixing induced transformation of water masses maintains the ocean stratification and supports the meridional overturning circulation. During the years 2003-2011, nine large-scale hydrographic surveys with a total of 801 stations were carried out with combined CTD/LADCP measurements in the subpolar North Atlantic. Observational data are analyzed to get an overview of the extent of diapycnal mixing. In the upper ocean and at mid-depth, the average diffusivity $K_v$ is $O\left(10^{-3}\right) \text{m}^2 \text{s}^{-1}$. Intensified mixing of $O\left(10^{-1}\right) \text{m}^2 \text{s}^{-1}$ is found over rough topography (Mid Atlantic Ridge), in the region of Western Boundary Current (WBC), and the high-quality climatology required quality levels and algorithms to fill gaps in the data. The new products provide improved, high-resolution tools and more accurate information to researchers and resource managers for better understanding of the complex processes that cause stress on coral reef ecosystems and better manage for a changing climate. (Abstract ID 11343)

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LATERNAL CIRCULATION IN JAMES RIVER ESTUARY AND ITS EFFECT ON ESTUARINE EXCHANGE FLOWS: A NUMERICAL MODELING STUDY

Field experiments were conducted during the spring of 2010 to observe flood-ebb and spring-neap variability of lateral flows, stratification and along-channel flows in the James River estuary. Hindcast simulations using ROMS have been conducted to investigate the dynamics of the lateral circulation and examine its role in estuarine exchange flows. Differential advection and Ekman tidal rectification have been suggested as two key mechanisms to drive lateral circulations in tidally driven estuarine channels. We have conducted model diagnostics to assess the relative importance of these two mechanisms in driving the lateral flows in the James River. Previous studies of lateral circulation dynamics have focused on the analysis of subtidal momentum balance in the along- and cross-channel directions. We have developed a novel way to examine the dynamics of lateral circulations by diagnosing the equation for the streamwise vorticity. We have also analyzed the subtidal momentum balance in the along-channel direction and examined the role of the lateral flows in driving the estuarine exchange flows. The modeling analysis is closely aligned with the related analysis of the observational data. (Abstract ID 9603)

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INTERACTIVE VISUALIZATION AND ANALYSIS OF NEAR REAL-TIME OCEAN OBSERVATIONS AND OCEAN FORECAST MODELS

The JPL OurOcean Team has built several Coastal Ocean Prediction Systems combining satellite and in-situ ocean observation data and a Regional Ocean Modeling System (ROMS) with a multi-scale 3D variational data assimilation scheme. In addition, the JPL Team has also developed several real-time experimental data products including a global 1-KM Sea Surface Temperature (GISSST). A blended Sea Surface Salinity (SSS) data product is also been developed that merges data from the recently launched Aquarius satellite and SSS measurements. The biggest challenges for these systems are the management of the huge volume of data products and the effective presentation and delivery of these data sets to the users to facilitate science discovery and decision making. In this poster, we present three Science Portals - GISSST Data Portal, the SSS Educational Toolkit, and the Gulf of Mexico Observation and Forecast System. We will demonstrate the use of the Google Earth plug-in and a number of custom interactive analysis tools to help scientists, educators and the general public understand and investigate a diverse set of oceanic phenomena contained in the ocean observations. (Abstract ID 10931)
regions. Using nonlinear grazing models and our correction factor, the grazing rates can be accurately estimated. We also found that the nonlinearity of dilution experiments is related to the ratio of initial phytoplankton biomass and half saturation parameter in a Holling II grazing model. Our findings may have large impacts on current understanding of rate processes of the plankton community and associated biogeochemical fluxes in marine ecosystems. (Abstract ID 11389)

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DYNAMICS OF WIND-INDUCED LATERAL CIRCULATION AND ITS EFFECTS ON ESTUARINE EXCHANGE FLOW AND STRATIFICATION

Lateral circulation is fundamental in estuarine dynamics because it transports momentum and alters stratification. Recent studies of lateral processes have been focused on tidal time scale, despite observational evidence of strong wind-induced lateral motion. Using a 3D hydrodynamic model implemented in a rotating, stratified estuary, complemented by the analyses of streamwise vorticity (SV) budget, we have quantitatively examined the lateral dynamics under various wind conditions. The lateral flow is mainly driven by Ekman dynamics, but thermal wind responses across surface Ekman layer construct/destroy lateral baroclinicity dynamics under various wind conditions. The lateral flow is mainly driven by Ekman dynamics, but thermal wind responses across surface Ekman layer construct/destroy lateral baroclinicity to create asymmetry between down- and up-estuary winds. The flow structure has important implications: Firstly, the lateral straining offsets along-channel straining; secondly, Coriolis acceleration associated with lateral flow works against the net driving force, putting a "brake" on the along-channel exchange flow. Although the bathymetry is specific to Chesapeake Bay, we change Coriolis parameter f as a preliminary way to explore estuaries at different longitudes. The wind-driven lateral circulation and its effects are appreciable when f is large. To clarify the net wind effects, we construct regime diagram using Wedderburn (W) and Kelvin (Ke) numbers. (Abstract ID 10691)

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INTERANNUAL VARIABILITY OF COASTAL HYDROGRAPHY IN THE GULF OF MAINE 2002-2010

In-situ observations including long-term moored meteorological and oceanographic measurements and multi-year gulf-wide ship survey data are used to quantify interannual variability of hydrographic conditions in the Gulf of Maine during summers 2002-2010. The cumulative upwelling index (CUI) shows that the upwelling (downwelling)-favorable wind conditions was most persistent in 2010 (2005) over the 9-year study period. River discharge was highest in 2005. Peak runoff started in early April in 2010 as opposed to late April to middle May in other years. Moorded time series show that coastal water temperature was 0.5-2°C warmer than average in summer 2010, and about 2°C colder than average in 2004. Coastal salinity in April 2010 was the lowest in the nine-year study period. Both moored ADECP current measurements and dynamic height/geostrophic velocity calculations based on gulf-wide ship survey data show large variability in coastal circulation. May (June) 2010 had the weakest alongshore transport in the eastern (western) Gulf of Maine during the study period. Such hydrographic variability may have significant impacts on interannual variations in the timing and magnitude of harmful algal (Alexandrium fundyense) blooms. (Abstract ID 10585)

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THE COMPARISON OF TWO DIFFERENT VERTEX DUFFUSION SCHEMES CONSIDERING THE WAVES INFLUENCE IN THREE-DIMENSION OIL-SPILL TRANSPORTATION MODEL

In the paper, in order to considering the wave's influence to the oil particles' vertical diffusion, we used two schemes to get the vertical turbulence diffusion, and established the Lagrangian stochastic oil particles transportation model. The first scheme is derived from a vertical eddy viscosity semi-empirically. The second scheme is that we use the vertical turbulence diffusion Kh in the POM2k as Kh in the oil spill model. We did six contrast experiments with the two schemes. The results show: a) the vertical turbulence diffusion also influences the horizontal transportation of the oil particles if we think the empirical results is true, and our oil spill 3-d transportation model describe correctly the particles movement, then maybe we can get the conclusion that in POM2k, the turbulence diffusion profile with depth is more rational than it in the first scheme, but the sea surface turbulence diffusion in POM2k maybe is too large especially on the condition that the wind speed is small. (Abstract ID 10144)

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PLENUM NUMERICAL SIMULATION OF STRUCTURES AND VARIABILITIES OF THE EASTERN COAST UPWELLING OFF THE HAINAN ISLAND USING QUIKSCAT WINDS

The spatial structures and variabilities of the upwelling east/northeast off the Hainan Island are investigated using a nested high-resolution Princeton Ocean Model (POM) forced by QUIKSCAT winds during 2000-2007. The results show that the model successfully simulates the summer upwelling off the Hainan Island and its inter-seasonal/inter-annual variability. Strong upwelling occurred from mid-July to mid-August with maximum intensity occurring east off the Hainan Island associated with southwestern monsoons of the South China Sea (SCS). A set of sensitivity experiments further indicate that, while the local wind stress is the primary factor responsible for the variability of the upwelling east/northeast off the Hainan Island, the general circulation significantly enhances the upwelling northeast off the Hainan Island through transporting the cold water northeastward. The joint effects of the local wind stress and the general circulation result in stronger upwelling northeast off the Hainan Island. (Abstract ID 9819)

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SPREADING, CONVERSION, AND SPICINESS VARIATION OF THE NORTH PACIFIC TROPICAL WATER IN THE PHILIPPINE SEA

Newly formed North Pacific Tropical Water (NPTW), as a subsurface salinity maximum, is advected to the Philippine Sea by the North Equatorial Current (NEC). In this study we use hydrographic observations to investigate its spreading, conversion and spiciness variation in this region. Estimated for water saltier than 34.9 psu, the mean southward (northward) transport of the NPTW is 5.5 (4.6) Sv by the MC (Kuroshio) at 8N (18N). Fields of geostrophic current, sea level variation, and potential vorticity suggest that the southward spreading is basically dependent on the MC, whereas its northward spreading can be achieved by both the Kuroshio advection along the Luzon coast and mesoscale eddy stirring in the open ocean. The NPTW undergoes a prominent freshening in the Philippine Sea. Lying below fresh surface water, freshening is more significant for the upper part of the NPTW due to diapycnal mixing, and salinity maximum tends to occur on denser isopycnal surfaces in the MC and Kuroshio. Prominent isopycnal spiciness variation of the NPTW in interannual time scale is also detected, which is mainly caused by the anomalous anti-cyclonic (cyclonic) circulation in the Philippine Sea during the warm (cold) ENSO events. Because of strong isopycnal and diapycnal mixing in the vicinity of the Mindanao Eddy, property anomalies in the MC are dissipates quickly, and the spiciness anomalies appeared in the Philippine Sea have little influence on the equatorial Pacific SST. (Abstract ID 9582)

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A MULTI-SCALE THREE-DIMENSIONAL VARIATIONAL DATA ASSIMILATION SCHEME AND ITS APPLICATION TO COASTAL OCEANS

A multi-scale three-dimensional variational data assimilation (MS-3DVAR) scheme for high resolution coastal ocean models that represent a wide range of spatial scales is presented. An equivalence between the standard 3DVAR cost function and a set of cost functions for spatially distinct scales is derived. This equivalence provides a pathway for developing the MS-3DVAR scheme using partitioned cost functions and thus background error covariances of multi-scale length scales. MS-3DVAR improves the effectiveness of the assimilation of both very sparse and high resolution observations via the multi-decorrelation length scales and reduced inherent observational representativeness errors. In the implementation presented, the cost function set consists of two components for large and small scales, and 3DVAR is implemented sequentially from large to small scales. In coastal ocean applications, MS-3DVAR is effective in assimilating two of the most common types of ocean observations - sparse vertical profiles and high-resolution surface measurements (High-Frequency radar velocities and satellite surface temperatures) - simultaneously. A set of identical twin experiments is used to illustrate the advantages of MS-3DVAR over a conventional 3DVAR scheme. Its effectiveness and robustness are demonstrated using results obtained from real-time applications in support of field experiments and coastal observing systems. (Abstract ID 10676)

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We will discuss solutions from a series of simulations forced by different combinations of gravity waves, gas bubbles dissolve, change size, rise due to buoyancy, and are subducted by LAYER TURBULENCE AND AIR-SEA GAS TRANSFER. These features are also observed in the ocean. The mean bubble number density decays exponentially with depth. Different from previous studies which find that wind is the only parameter determining the bubble e-folding depth, we find that wave age is an additional governing parameter. The buoyancy of bubbles weakens both Langmuir circulations and near-surface dissipation. Gas fluxes generated by bubbles are dependent on both winds and waves.

(Simplified) Abstract ID 9460

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EDDY-MODULATED INTERNAL WAVES AND MIXING ON A MID-OCEAN RIDGE

Mesoscale eddies are ubiquitous in the ocean and dominate the energy content on subinertial time scales. Recent theoretical and numerical studies (e.g. Nikurashin and Ferrari, 2010) suggest a connection between mesoscale eddies and diapycnal mixing in the deep ocean, especially near rough topography in regions of strong geostrophic flow. However, unambiguous observational evidence for such a connection has not yet been found and it is still unclear what physical processes are responsible. Here, we present observations that demonstrate energy transfer near the crest of the East Pacific Rise from low-frequency flows, including mesoscale eddies, to near-inertial oscillations, finescale variability and mixing. In particular, our measurements imply a significant increase in diapycnal diffusivity near the seafloor during episodes of increased subinertial flow. Our findings are expected to be useful for validating and improving numerical-model parameterizations of mixing in the ocean. Since the frequency and intensity of mesoscale eddies depend on the state of the climate, the observed eddy-modulated mixing connect climate change and climate variability to physical and biogeochemical dynamics in the deep ocean and implies an unexplored feedback mechanism potentially affecting the global climate system. (Abstract ID 11688)

(Simplified) Abstract ID 9460

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UNCERTAINTY GENERATION IN OCEANIC AND ATMOSPHERIC MODELS

How uncertainties are generated in deterministic geophysical fluid flows is an important but mostly overlooked subject in the atmospheric and oceanic research. In this study, it is shown that the generating mechanisms include local entropy generation (LEG) and cumulant information transfer, both of which are explicitly expressed with the aid of a theorem established herein. To a system the former is intrinsic, representing the evolutionary trend of a marginal entropy and bringing connections between the two physical notions namely uncertainty and instability. The latter results from the interaction between different locations through dynamic event synchronization, and appears only in the course of state evolution. Although in practice it is notoriously difficult to estimate entropy for ocean systems, which are in general of large dimensionality, estimation of the LEG can be accurately fulfilled withsembles of limited size. If, furthermore, the processes of a system under consideration are quasi-ergodic and quasi-stationary, its LEG actually can be fairly satisfactorily estimated even without appealing to ensemble predictions. These assertions are illustrated and validated in an application with two simulated quasi-geostrophic jet streams with compact chaotic attractors. The LEG study provides an objective way of rapid assessment for predictions, which is important in practical fields such as adaptive sampling and adaptive modeling. (Abstract ID 12778)

(Simplified) Abstract ID 9460

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VARIABLE DIFFUSION BOUNDARY LAYER AND DIFFUSION FLUX AT SEDIMENT-WATER INTERFACE IN RESPONSE TO DYNAMIC FORCING IN A TIDAL FLAT

Taking advantage of acoustic Doppler current meter and Mini Profiler with oxygen probe, we performed in situ measurement of the dynamics of bottom boundary layer (BBL) combined with the diffusion boundary layer (DBL) and the oxygen diffusion fluxes in a tidal flat. The thickness of DBL can be estimated accurately by using of the methods of linear distributed zone in oxygen profile, the slope discontinuity of profile and variance of concentration. The numerical model of PROFILE was utilized to simulate the in situ dissolved oxygen profile and then the consumption rates of the layered dissolved oxygen were calculated in the sediment. In tidal flat the BBL thickness (SBDL) was controlled by the current velocity (U) in the BBL: 

SBDL = 16681.6D/U + 0.1 (where D is molecular diffusion coefficient). The diffusion flux was positive correlation with the turbulent dissipation rate, friction velocity and turbulent energy. Under the influence of periodical tidal current and turbulence, the DBL thickness and the flux would vary markedly. The DBL thickness and the diffusion flux varied 3.5 times in a tidal period. (Abstract ID 11195)

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ESTIMATION OF WAVE PROPERTIES FOR THE PERSIAN GULF USING VIDEO IMAGERY

Wave properties for the Persian Gulf are studied in this research using video imagery. We set up an offshore tower in Doha, Qatar and both wind velocities and time-series images of waves in the Persian Gulf are taken from a single charge-coupled device (CCD) camera attached on the tower at 4.8m height. Wave-resolving time series imagery is measured, and can be regarded as an array of wave gauges in which each pixel intensity variation is a proxy for the oscillation of the free surface. Accordingly, based on video imagery techniques, many wave properties for the Persian Gulf can be estimated. Using a frequency domain (complex) empirical orthogonal function (COEF), incident frequency and wavenumber can be estimated from a cross-spectral matrix, from which phase speed and other kinematic wave properties can be further determined. Some advanced properties are also evaluated, such as mean direction-frequency and wavenumber-frequency relationships, and will further be correlated with wind velocities from the tower. The results are prepared for the further studies such as energy density spectrum evaluations and the numerical simulation of wind-wave generation using spectrums kept in fidelity out of the video-based measurements. (Abstract ID 11323)

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CONSTRUCTING A FRAMEWORK TO CLASSIFY OCEAN DATA ACTIVITIES: A TOOL FOR CONTENT DEVELOPERS, DATA TRANSLATORS AND EDUCATORS

The world we live in is increasingly characterized by data. The Ocean Observatories Initiative (OOI) is spurring advances in sensor technologies and cyber infrastructure that are changing the way oceanographers conduct research and share their results with the world. As we look to train the next generation of scientists, it is imperative that students have the opportunity to develop the skills necessary to collect, analyze and understand data. To meet this challenge, COSEE Networked Ocean World (NOW) has collaborated with scientists and educators to develop a framework to categorize and describe classroom activities that utilize ocean datasets and visualizations. The framework is designed to make data activities more accessible to both formal and informal educators by facilitating the discovery of ocean data and data products appropriate for their audience of learners. It is also designed to assist content developers by providing them a means to guide their development efforts towards suitable presentation formats for various inquiry styles. The model framework is currently being reviewed with classroom educators and lesson developers in the COSEE NOW online community. (Abstract ID 11835)

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A NUMERICAL STUDY ON THE STRATIFICATION AND MIXING PROCESSES IN THE TOKYO BAY, JAPAN

Tokyo Bay is a semi-closed bay which is surrounded by several metropolises including Tokyo City as well as a number of industrial areas. Since it has a close relationship with many human activities, a lot of observations and modeling efforts have been made. Nevertheless a further understanding of stratification and mixing processes is still necessary. In our study, a hydrostatic, incompressive, z-level model — MSSG model is used to simulate the spatial and temporal variations of stratification and mixing processes in the Tokyo Bay. The numerical results reveal that the stratification and mixing processes in the Tokyo Bay exhibit distinct seasonal variations as indicated by the observers. In summer, an anticyclonic circulation is formed in the head of Tokyo Bay and the water column shows a strong stratification structure;
while in winter the circulation in the bay is clockwise and the water column is vertically homogeneous. (Abstract ID 12640)

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TRANSMITTANCE OF SOLAR RADIATION THROUGH PONDED ARCTIC SEA ICE

The Arctic sea ice cover is becoming predominantly thinner and younger, undergoing physical changes that appear to be driving increased transmittance of solar radiation. Quantifying light transmittance through the ice cover is essential for modeling primary productivity within and beneath the ice, as well as large-scale surface heat and mass balance terms. In a melting ice cover, light transmittance is governed by ice thickness and surface melt pond coverage. Measurements during the 2010 and 2011 ICESCAPE campaigns documented the spatial distribution of the light field beneath ponds of varying horizontal extent. Peak values of pond transmittance were found to be 3 to 10 times larger than transmittance through bare ice. This study uses these observations, along with results from a two-dimensional radiative transfer model to help constrain the character of the transmitted light field beneath melt ponds.

Observed areal melt pond fractions as high as 40% suggest that light transmitted through ponds is a significant, if not dominant, component of the total under-ice light field. (Abstract ID 12831)

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FORCED BUOYANT CONVECTION IN A CLOSED STRATIFIED VOLUME

We have performed an experiment with forced buoyant convection by pumping 2 m^3 s^-1 of surface water into the deeper part of the rather small and strongly stratified By Fjord, surface area ca 6 km^2 and maximal depth 50 m. The pumps inject horizontal jets through 8 nozzles at a depth of 35 m. The initial jets transform to rising buoyant plumes interleaving below the pycnocline usually located just below the sill depth of the fjord mouth (13 m). The volume flow induced by the pumping grows to 50 m^3 s^-1 between nozzle depth to below the pycnocline. The entrainment by the initial jets and the buoyant plumes is estimated from changes in the hydrography measured by moored instruments and CTD profiles. We present the entrainment into the jets and the plunging and the resulting basin-wide circulation induced by the pumping. The pumping acts as a vertical line source/sink and the circulation may have similarities to circulation induced by boundary mixing in stratified basins. (Abstract ID 11946)

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GLOBAL PATTERNS OF EPIPELAGIC GELATINOUS ZOOPLANKTON BIOMASS: CURRENTLY ACCESSIBLE DATA FORMS A FRAGMENTED PICTURE

Concern over the potential proliferation of jellyfish has caught public attention, but it remains unclear whether this is a new phenomenon. Large numbers of gelatinous zooplankton are reported periodcally, however, their ecological and economic impact is hard to define without baseline biomass estimates. In lieu of regular long-term time-series, we undertook a meta-reported periodically; however, their ecological and economic impact is hard to define without unclear whether this is a new phenomenon. Large numbers of gelatinous zooplankton are

GLOBAL PATTERNS OF EPIPELAGIC GELATINOUS ZOOPLANKTON BIOMASS: CURRENTLY ACCESSIBLE DATA FORMS A FRAGMENTED PICTURE

Global patterns of epipelagic gelatinous zooplankton biomass: Currently accessible data forms a fragmented picture

Part II: Dependence on Translation Speed, Mon. Wea. Rev., 137(11), 3744-3757. (Abstract ID 9315)

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GLOBAL ANALYSIS OF WAVES AND EDDIES IN SURFACE DRIFTER TRAJECTORIES

The characterization of currents due to different physical mechanisms— inertial oscillations, coherent eddies, and large-scale waves—is an important and challenging data analysis problem. We present theory, test applications, and preliminary results from an analysis of the entire Global Drifter Program data set. Two different methods are pursued. The first permits oscillatory motions, such as those associated with coherent eddies, to be automatically extracted from Lagrangian trajectories. Application to numerical model output confirms that vortex currents are indeed extracted very well, and demonstrates that eddies and waves can be clearly distinguished. The application to surface drifters reveals spatial patterns that show a remarkable resemblance to the completely independent tracking of altimetric eddies carried out by other authors. Inertial oscillations, being stochastic in nature, must be analyzed in a different manner. We create a frequency-domain statistical method to estimate the time-varying frequency shift (due to background vorticity) as well as the damping parameter. The method is tested against numerical simulations of wind-forced eddy fields, with encouraging results. Examples of strong inertial shifts by coherent eddies are found in the drifter data. (Abstract ID 12636)

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THE SUCCESSION AND STABLE ISOTOPES IN MODERN PLANKTONIC FORAMINIFERA: RECORDS FROM SEDIMENT TRAPS AND PLANKTON TOWS

This study reports on the stable isotope composition of modern planktonic foraminifera tests collected from plankton tows and sediment trap moorings in the northern South China Sea. Results show that foraminiferal δ18O is primarily influenced by seawater temperature, while δ13C is affected by surface water nutrients, which in this region can be discerned from wind stress data. A pattern of enriched 18O values, associated with marked 13C depletion, is common to three species collected between late October and late December 2004. This distinct isotopic signal corresponds to a decrease in SST and increase in wind stress, indicating the onset of prevailing northeast winds during the winter season. In addition, succession of planktonic foraminifera was observed based on the sediment trap moorings with 3-day collecting duration at the continental slope. In general, variation of shell abundance (#; number of specimens per gram of original bulk sample) shows a pattern that seems to be related to the lunar cycle: shell abundance increases from low values at new moon and reaches its maximum before full moon. (Abstract ID 10105)

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OCEANS IMPACT ON THE INTENSITY OF THREE RECENT TYPHOONS (FANAPI, MALAKAS, AND MEJI) – RESULTS FROM THE ITOP FIELD EXPERIMENT

During the 20 August to 20 October 2010 ITOP field experiment, three typhoon cases, Fanapi (category-3), Malakas (category-2), and Meji (category-5) were studied. Using airborne C130 dropwindsonde data, C130 AXBT (Airborne Expendable Bathythermograph) data, in situ upper ocean thermal structure data from the Argo floats, satellite sea surface temperature and altimetry data together with an ocean mixed layer model, the impact of ocean’s thermal structure to the intensity of these 3 typhoons is investigated. It is found that all three typhoons passed over regions of similarly warm sea surface temperature (SST) of ~ 29.5˚C. However, much distinction is found in the subsurface. It is found that this distinction in the subsurface thermal structure played critical role in the intensification of the three typhoon cases. Reference: Lin et al. 2008: Upper Ocean Thermal Structure and the Western North Pacific Category-5 Typhoons, Part I: Ocean Features and Category-5 Typhoon’s Intensification, Mon. Wea. Rev., 136, 3288-3306. Lin et al. 2009a: Warm ocean anomaly, air-sea fluxes, and the rapid intensification of tropical cyclone Nargis (2008), Geophys. Res. Lett., 36, L03817. Lin et al. 2009b: Upper Ocean Thermal Structure and the Western North Pacific Category-5 Typhoons Part II: Dependence on Translation Speed, Mon. Wea. Rev., 137(11), 3744-3757. (Abstract ID 9315)

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FLUID PERMEABILITY AND THE STRUCTURE OF ARCTIC SEA ICE

Fluid permeability of sea ice is a critical factor in ice-ocean interactions in the Antarctic. The transport properties of sea ice are important in snow-ice formation, the evolution of salinity profiles, and control algal and bacterial growth. We will present field data on the transport properties of sea ice taken in McMurdo Sound during a 2010 Antarctic expedition. We will analyze permeability measurements supplemented by data on corresponding crystalline structure and electrical measurements, providing insight into sea ice evolution and its role in
the climate system. (Abstract ID 12767)

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COPEPOD COMMUNITY GROWTH RATES IN RELATION TO BODY SIZE, TEMPERATURE, AND FOOD AVAILABILITY IN THE EAST CHINA SEA - A TEST OF METABOLIC THEORY

COPEpod is one of the most dominant meazoan in terms of abundance and biomass in oceans. To investigate the importance of copepods in plankton community growth rate is one of the indispensable factors concerning evaluation. In this study, we conducted shipboard incubation by artificial cohort methods to estimate the size-specific growth rate of copepods in the East China Sea. The spatial-temporal variation of growth rate was linked to environmental factors. We tested the hypothesis that copepod community growth rates follow the metabolic theory. Our results suggest that in general, factors inferred from the metabolic theory (i.e. temperature and body size) are correlated with the estimated growth rates. We note however, the allometric coefficients vary among taxa, suggesting phylogenetic effects. (Abstract ID 9716)

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THE ASYMMETRIC UPWIND FLOW-NEW OBSERVATIONS AND THEORY

The classic theory predicts an upwind flow along the central trough in a lake or semi-closed oceanic basin. However, our new observations, involving three Chinese vessels in the Yellow Sea during 2006-2007, winter and ten long term moorings, show that the upwind flow, in the Yellow Sea-Yellow Sea Warm Current (YWSC) is actually arrested topographic waves in response to local wind stress forcing. The northwesterly monsoonal wind prevails in the Yellow Sea-Yellow Sea Warm Current (YWSC) is actually arrested topographic waves in response to local wind stress forcing. (Abstract ID 9335)

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THREE-DIMENSIONAL OCEANIC EDDY ANALYSIS IN THE SOUTH CHINA SEA FROM A NUMERICAL PRODUCT

With strong monsoon, kuroshio influence, northern shelf, and bottom topography, the South China Sea (SCS) is an area with strong eddy activity. By applying an automated eddy detection scheme to a 9-year (2000-2008) high-resolution numerical model of the oceanic circulation in the SCS, a three-dimensional eddy dataset is developed. It includes information for each eddy's location, polarity, intensity, size, boundary and moving path at fifteen vertical levels. Through a series of statistical analyses applied to the eddy dataset, three-dimensional statistical characteristics of mesoscale eddy variations in the SCS are elucidated; these shed light on how eddies are generated, evolve and terminate. A significant percentage of eddies is found to be generated around Luzon Strait, northern shelf and northwest of Vietnam, which indicates that kuroshio and upwelling in the SCS play a vital role in eddy generation. Three types of eddies, based on shape, are identified from the numerical product: bowl, lens and cone. (Abstract ID 12841)

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ESTIMATING THE GROWTH RATE AND BIOGEOCHEMISTRY OF GENETICALLY DIVERSE PROCHLOROCOCCUS USING RNA/DNA RATIOS

The marine cyanobacteria Prochlorococcus is the most abundant phytoplankton in tropical and subtropical open oceans and accounts for 5-25% of global marine primary production. While much is known about the abundance and genetic diversity of this genus, little is known about the activity of the different clades in their natural environment. Here we show that in several Prochlorococcus cultured strains the rRNA/dDNA ratio is strongly correlated with their specific growth rate over a range of light-regulated growth conditions. Moreover, a field study reveals that the rRNA depth profile of the dominant clade eMT9312 is consistent with the total Prochlorococcus primary production. Using this approach, we measured rRNA content for two major Prochlorococcus clades eMT9312 and eMT9313, in three representative field stations. The growth rate inferred from their rRNA/dDNA ratio is uncorrelated with their abundance in the water column, and is significantly influenced by light and nutrient availability. Further, exploring the biogeochemistry of production will greatly help unravel the ecological and biogeochemical contribution that these genetically distinct, but morphologically similar marine microbes have in a changing ocean environment. (Abstract ID 12557)

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ENHANCED DIAPYCNAL MIXING DURING INTERMEDIATE FLUSHING OF A SINGE SILL FORD

In deep fjords, the flushing of layers above sill level is often dominated by intermediate circulation caused by coastal density field fluctuations, rather than by estuarine circulation and tidal exchanges. Intensive observations of such a flushing event in Gullmar fjord, Sweden, including 20 microstructure profiling transects through the entrance during two 24-hour periods, show that dissipation rates of turbulent kinetic energy were enhanced in the inflowing layers in a wedge extending six kilometers into the fjord from the narrow entrance. The density and dissipation rate fields reveal non-linear, oblique internal wave beams with typical horizontal length scales from 0.3 to 3 km extending from the bottom and from the halocline near the entrance towards the center of the inflowing layer, bounding the enhanced dissipation wedge. Various generation mechanisms for these beams are discussed and related to the total loss of energy and diapycnal mixing in the inflowing layers. (Abstract ID 11241)

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EFFECT OF MESOSCALE EDDIES AND CRYPTOPLANKTON ON LARVAL FISH ASSEMBLAGES IN THE GULF OF MEXICO: IMPLICATIONS FOR ATLANTIC BLUEFIN TUNA (THINNULLUS THINNULUS)

It is widely known that eddies and their attendant fronts play an important role in oceanic biological processes and may constitute a unique pelagic habitat for larvae. Previous studies that we conducted in the Gulf of Mexico (GOM) region showed that the variability in the Loop Current and anticyclonic ring field was reflected on the larval fish distribution of some species, likely associated to the boundaries of the latter features. To date, however, there has been only very limited studies in the region using satellite data to assess the influence of smaller mesoscale features on larval assemblages. Our primary goals in this study are to (1) explore the effect of the divergence and convergence associated to cyclonic and anticyclonic eddies on larval assemblages. Our primary goals in this study are to (1) explore the effect of the divergence and convergence associated to cyclonic and anticyclonic eddies on larval assemblages. Our primary goals in this study are to (1) explore the effect of the divergence and convergence associated to cyclonic and anticyclonic eddies on larval assemblages. Our primary goals in this study are to (1) explore the effect of the divergence and convergence associated to cyclonic and anticyclonic eddies on larval assemblages. Our primary goals in this study are to (1) explore the effect of the divergence and convergence associated to cyclonic and anticyclonic eddies on larval assemblages. Our primary goals in this study are to (1) explore the effect of the divergence and convergence associated to cyclonic and anticyclonic eddies on larval assemblages. (Abstract ID 9578)

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THE IMPACT OF CLIMATE CHANGE ON THE SOUTHERN OCEAN CARBON CYCLE IN CESM1-BGC CMIP5 EXPERIMENTS

The Southern Ocean is a key region for the global carbon cycle. It is a region where anthropogenic uptake and natural outgassing of carbon are large opposing terms in the carbon budget. Climate change, through its effects on winds, stratification, and temperature, has the potential to alter the balance between these terms. We present results of CMIP5 experiments performed with the Earth System Model CESM1-BGC, examining the impact of climate change on the Southern Ocean carbon cycle. (Abstract ID 12584)
change on the natural and anthropogenic carbon budget of the Southern Ocean. (Abstract ID 12855)

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PHYSICAL OCEANOGRAPHY FROM SPACE IN 2030

This presentation will describe remote sensing concepts for physical oceanography research in the coming decades. It is based on community input through the National Research Council Decadal Survey (http://science.nasa.gov/earth-science/decadal-surveys/), a recent special issue of Oceanography on the Future of Oceanography from Space (http://tos.org/oceanography/archive/22-4.html), and a symposium on Oceans in 2025 (http://www.oceans2025.org/). Three themes include science drivers in physical oceanography, developing space technology to address the science requirements (including those defined by the Global Climate Observing System), and speculation on the data products available in 2030 and the science goals that can be enabled by these data products. (Abstract ID 10973)

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GARBAGE PATCHES: SOUND SCIENCE AND MARINE DEBRIS

Headlines continue to feature stories about plastic marine debris aloft in areas of our oceans referred to as garbage patches—oceanic areas of high marine debris concentration. The myriad of information over the years, sometimes contradictory, has left the public confused: Why haven’t I seen a photo of a garbage patch? Are our seas really choked with plastic litter and garbage? This presentation will help demystify and clarify what is actually known about the garbage patches, particularly in the North Pacific Ocean. Up-to-date, accurate, science-based information (i.e., sound science) on the patches will be shared. During this presentation, tips on online resources for information and materials will also be shared, along with an introduction to the National Oceanic and Atmospheric Administration’s Marine Debris Program. (Abstract ID 11120)

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ASSESSING THE ABUNDANCE AND TYPES OF MARINE DEBRIS ON SHORELINES AND SURFACE WATERS IN CHESAPEAKE BAY TRIBUTARIES STRATIFIED BY LAND USE

Scientific monitoring of anthropogenic marine debris (solid, persistent, man-made material) is necessary in order to understand the source, distribution, abundance, movement, and impact of debris on local, regional, and global scales. Establishing baseline information on the abundance and types of marine debris is necessary for evaluating the effectiveness of measures to prevent marine debris and its impacts. The NOAA Marine Debris Program conducted surveys on shorelines and surface waters of Chesapeake Bay tributaries as part of an effort to develop standardized, statistically sound, marine debris monitoring protocols. Shoreline and pelagic macro-debris (> 5 mm) samples were assessed based on material category (i.e. plastic, metal, glass, etc.) in order to evaluate the spatial distribution and temporal variability of marine debris in these systems. Survey results indicated a greater abundance of debris in urban regions compared to mixed or agricultural watersheds. This presentation will examine the drivers of spatial and temporal variation in marine debris densities, including land use, tidal amplitude, and weather-related events. (Abstract ID 11116)

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OBSERVATIONS OF CURRENTS IN A TIDALLY MODULATED INLET

Observations of currents were obtained over a 4-week period at the tidally modulated inlet leading to Hampton/Seabrook Harbor in southeastern New Hampshire in the Fall of 2011. The temporal variation and vertical structure of the currents were observed with 600 kHz and 1200 kHz RDI Acoustic Doppler Current Profilers (ADCP) deployed on low-profile bottom tripods in 6 and 12 m water depths near the entrance to the inlet, and with a Nortek Aquadopp ADCP mounted on a jetted pipe in 3 m depth on the flank of the inlet channel. Across-inlet current profiles were obtained at various tidal stages with a 1200 kHz RDI vessel-mounted ADCP onboard the personal watercraft (the Coastal Bathymetry Survey System) that transited the inlet multiple times at various spatial locations. Flows within the inlet were dominated by semidiurnal tides 2.5 - 4 m in elevation, with velocities exceeding 3 m/s. Horizontal and vertical variations in the flow structure will be discussed and compared to the spatial and temporal variation in water depth and bedform features, observed every 2-3 days with a high-resolution multibeam sonar. (Abstract ID 12491)

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ON THE SEASONAL CYCLE OF THE ATLANTIC WATER TEMPERATURE WITHIN THE ARCTIC BASIN

Recent mooring observations in the Arctic Basin suggest the existence of a seasonality of Atlantic Water (AW) temperature. Here the DRAKKAR global ocean/sea-ice model is used to examine the seasonal cycle amplitude of AW temperature within the Arctic Ocean and to investigate the possible mechanisms governing this seasonality. The simulation as well as available mooring data reveals that the amplitude of the AW temperature seasonal cycle is significant only in the Nansen Basin along the continental slope, where AW is primarily advected. In the model, the seasonal cycle of the AW temperature is advected from Fram Strait up to St. Anna Trough and then re-energized by the Barents Sea Branch. This suggests that the seasonal AW temperature signal survives over a finite distance (~1000 km) as it is weakened by mixing and diffusion processes. The seasonal bias in in-situ observations taken during spring and summer does not induce a significant error when considering the interannual-to-decadal variations of AW temperature, because the seasonal cycle accounts for a small or negligible part of AW temperature variability, even near the inflow region. (Abstract ID 10403)

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THE INFLUENCE OF NICKEL ON NITROGEN AND CARBON FIXATION RATES IN THE EASTERN TROPICAL SOUTH PACIFIC

Nickel is a relatively understudied trace element in marine systems, despite its known role as a metallic cofactor for biogeochemically relevant enzymes. Recent evidence suggests that nickel may play a role in marine nitrogen and carbon fixation, which could have important implications for global nutrient cycling in the modern and future global oceans. Culture-based studies show that nickel can limit the growth of some marine cyanobacteria, including diazotrophs. Genetic evidence suggests potential physiological roles may include nickel-superoxide dismutase and nickel/iron-uptake hydrogenase. We tested the ecological relevance of these findings by directly examining the effect of nickel additions on nitrogen and carbon fixation rates in oligotrophic surface waters in the Eastern Tropical South Pacific. Carbon fixation, as measured by HCO3 uptake, was significantly stimulated (+10% to 20%) as a result of nickel additions (1.616 ± 0.044 mg C/m^2/d) relative to the control (1.179 ± 0.082 mg C/m^2/d). Results from parallel experiments using stable isotope methods to measure HCO3 and %14CO3 fixation rates simultaneously will provide additional insight. This work provides our need to better understand the role of nickel in marine biogeochemistry. (Abstract ID 11213)

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APPLICATION OF A NUMERICAL PREDICTION MODEL TO CORAL REEF ECOSYSTEMS: A SEASONAL CORAL BLEACHING THERMAL STRESS OUTLOOK SYSTEM

NOAA Coral Reef Watch (CRW) has made major advances in its ability to predict thermal stress that can cause mass coral bleaching in tropical shallow waters, including a newly-developed global seasonal outlook system based on NOAA's operational Climate Forecast System (CFS), produced in collaboration with NOAA's National Center for Environment Prediction. These outlooks predict the likelihood of thermal anomalies capable of causing large-scale, mass coral bleaching. They are part of CRW's decision support system that combines model predictions, satellite observations, and in-situ measurements to assist coral reef management. To help reef managers make cost-effective, focused management decisions to protect potentially hard-hit reef sites within large reef tracts, CRW's next step will be to develop outlooks with fine-scale predictive coastal ocean models to provide improved water temperature predictions within reef areas. This presentation introduces the new CFS-based global outlook system, describes needs and requirements for predicting reef-scale thermal stress, and seeks collaboration in applying coastal ocean models to CRW's decision support system for coral reef management in a changing climate. (Abstract ID 10100)

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ROLE OF EKMAN TRANSPORT VERSUS EKMAN PUMPING IN DRIVING SUMMER UPWELLING IN THE SOUTH CHINA SEA

Relative roles of Ekman transport and Ekman pumping in driving summer upwelling in the South China Sea (SCS) are examined using QuikSCAT scatterometer wind data. The major upwelling regions in SCS are the coastal regions east and southeast of Vietnam (UESEV), east and southeast of Haiyan Island (UESEH), and along the southeast coast of Guangdong Province (UESG). In UESE, both Ekman pumping and Ekman transport are equally important in generating upwelling there. The Ekman transport increases linearly from 0.49 to 1.23 Sv from May to August while the Ekman pumping increases from 0.36 to 1.22 Sv during the same period. In UESE, the mean estimates of Ekman transport and Ekman pumping are 0.14 and 0.07 Sv, respectively, indicating that 33% of the total wind-driven upwelling is due to Ekman pumping there. In UESE, the mean Ekman transport is 0.041 Sv with the peak in July, while Ekman pumping is much smaller (0.003 on average during summer), indicating that the upwelling in this area is primarily driven by Ekman transport. In the summers of 2003 and 2007 following ENSO events, both Ekman transport and Ekman pumping decreased in UESE due to the abnormally weak southwest monsoon. On the other hand, Ekman transport was slightly enhanced and Ekman pumping was weakened in UESEH and UESE during these two summers. (Abstract ID 11532)
the Ekman current facilitate the anticyclonic eddy shedding from Kuroshio. The cyclonic eddy with diameter about 150 km and thickness about 700-800m was observed at the west side of the Kuroshio in May 2010 and May 2011 respectively. This cyclonic eddy with SCS waters at the west side of the Kuroshio should be induced by the Kuroshio intrusions. Therefore the Kuroshio in the Luzon Strait is an unfixed "western boundary current": it can block westward at the west side of the Kuroshio should be induced by the Kuroshio intrusion. Therefore the

Submarine Groundwater Discharge (SGD) is an important land-ocean material transport pathway. However, its role in the budgeting of carbon in the coastal ocean remains poorly constrained. Here, we used radium isotopes to quantify the SGD rate and examined the impact of the SGD-derived carbonate loads in three study areas: northern South China Sea (NSCS), West Florida Shelf (WFS), and Wauquicot Bay (WB) in Cape Cod. These submarine estuaries (STE) all have SGD, but with quite different dissolved inorganic carbon (DIC) and total alkalinity (TAlk) behavior during the STE mixing. Elevated DIC and TAlk existed in the NSCS STE compared with seawater. In contrast, DIC and TAlk showed positive correlation with seawater in the WB STE, with conservative mixing observed in these areas and seasonal and regional processes in other. Based on a DIC mass balance in the SWFS, 70-80% of DIC sources come from SGD input. Together, these studies indicate SGD must be a carbon source in continental shelf CO2 budgets. (Abstract ID 10297)

CARBONATE SYSTEM BIOGEOCHEMISTRY IN SUBTERRANEAN ESTUARIES AND ITS IMPACT ON THE COASTAL OCEAN INORGANIC CARBON CYCLE

Submarine Groundwater Discharge (SGD) is an important land-ocean material transport pathway. However, its role in the budgeting of carbon in the coastal ocean remains poorly constrained. Here, we used radium isotopes to quantify the SGD rate and examined the impact of the SGD-derived carbonate loads in three study areas: northern South China Sea (NSCS), West Florida Shelf (WFS), and Wauquicot Bay (WB) in Cape Cod. These submarine estuaries (STE) all have SGD, but with quite different dissolved inorganic carbon (DIC) and total alkalinity (TAlk) behavior during the STE mixing. Elevated DIC and TAlk existed in the NSCS STE compared with seawater. In contrast, DIC and TAlk showed positive correlation with seawater in the WB STE, with conservative mixing observed in these areas and seasonal and regional processes in other. Based on a DIC mass balance in the SWFS, 70-80% of DIC sources come from SGD input. Together, these studies indicate SGD must be a carbon source in continental shelf CO2 budgets. (Abstract ID 10297)

A MODELING STUDY OF THE SEASONAL VARIABILITY OF THE CIRCULATION IN THE RHODE ISLAND SOUND AND BLOCK ISLAND SOUND

Recent observations have shown that the Rhode Island Sound (RIS) and Block Island Sound (BIS) exhibit significant and curious seasonal changes in their circulation patterns. Strong cyclonic flow exists during summer, stratified conditions, but disappears during winter, vertically mixed conditions. Several process-oriented, hypotheses-driven experiments with a high-resolution version of the Regional Numerical Modeling System (ROMS) are implemented to understand the mechanisms that determine this behavior. Results show that seasonal fluctuations in wind combine with residual tidal currents to shape the RIS seasonal variability while buoyant discharge from the Connecticut River must be included to understand the seasonal cycle of the BIS. (Abstract ID 11625)

COMPARISON OF PEPTIDE HYDROLYSIS BETWEEN OXIC AND HYPOXIC WATERS IN THE NORTHERN GULF OF MEXICO

Peptides and proteins are key compounds involved in carbon and nitrogen cycles in the ocean. Extracellular enzymatic hydrolysis is often thought to be the limiting step in remineralization of peptides by microbes. As the low-oxygen zone is expanding in the ocean, it is important to understand the difference of peptide hydrolysis between oxic and hypoxic waters. In this study, we compared hydrolysis rates of peptide analogs leucine-methylcoumarylalane, Lucifer Yellow Anhydride-alanine-valine-phenylalanine (LYA-AVF), and several plain peptides between oxic and hypoxic waters in the northern Gulf of Mexico. For all of the compounds tested, hydrolysis rates were 1-5 times faster in the hypoxic water than those in the oxic water, which may be due to higher extracellular enzymatic activities in the hypoxic water. In addition, stoichiometry of amino acids released from AVF hydrolysis was different between hypoxic and oxic waters, suggesting that either those amino acids were taken up by bacteria in different rates or the hydrolysis pathways of AVF were different. Our data shed new lights on hydrolysis rates and pathways of small peptides in low-oxygen waters. (Abstract ID 9560)

SPACEBASED OBSERVATION OF CARBON DIOXIDE PARTIAL PRESSURE AT OCEAN SURFACE

The ocean as the source and sink of carbon dioxide is important to global warming and ecology, but its quantitative contribution to the change of atmospheric carbon storage is insufficiently known. The exchange depends on the difference in fugacity (partial pressure) of carbon dioxide between sea and air and a transfer velocity. Fugacity in sea is measured largely on ships; they are not sufficient to characterize spatial and temporal variability. Attempts have been made in the past to relate the fugacity in sea to parameters that could be measured from space. These relations are found to be valid only in limited regions and in specific seasons. We have developed a statistical model to estimate the fugacity over global oceans for all seasons from NASA space measurements using the state-of-art statistical techniques. The input data are sea surface temperature (AMSR-E), dynamic topography (JASON and OSTM), productivity (MODIS), and salinity (climatology and Aquarius) over global oceans. We have evaluated the accuracy of the fugacity data and its application on carbon cycle and will explore proper remedies of any deficiency. We are examining the role of various drivers in different location and seasons. (Abstract ID 10653)

REFERENCES

In-Situ Spectrophotometric Measurement of Dissolved Inorganic Carbon in a Biofouling-Prone Region

An automated spectrophotometric procedure for in-situ DIC analysis is described. Based on use of a Teflon AF liquid core waveguide (LCW) as both the optical cell and equilibration membrane, an acidified seawater sample outside the LCW is equilibrated with an inner LCW solution that has a known alkalinity. DIC is then calculated from measured pH within the LCW and the known alkalinity within the LCW. The instrument was tested within a high productivity area of Florida Bay, with a once per minute sampling rate. DIC measurement results show that the method is capable of accurate measurements with high temporal resolution sampling. Furthermore, the measurement chemistry, combining acidified external seawater samples with a clean, synthetic internal solution, provides a biofouling-resistant protocol for long-term monitoring of DIC in natural waters. When combined with spectrophotometric pH and pCO2 on the same platform, the DIC measurement procedure allows full characterization of the marine CO2 system with high spatial and temporal resolution. (Abstract ID 9450)

Bio-Optical Discrimination of Phytoplankton Functional Groups in Monterey Bay, CA using Multiple Autonomous Underwater Vehicles

A large collaborative experiment, BIOSPACE/CANON, was conducted in October, 2010 to investigate a significant phytoplankton bloom in Monterey Bay, CA. Multiple autonomous underwater vehicles equipped with hydrographic and bio-optical sensors were deployed through the bloom period. It is hypothesized that the dominant phytoplankton groups associated with this bloom have distinct particle backscattering (bb) characteristics and can be discriminated from each other. The temporal and spatial variability of phytoplankton community structure was observed by analyzing pigment fluorescence and bb at 532 nm. The bloom peaked on October 15th, followed by a marked decrease by the 18th. Two major bloom patches were found contributing to the elevated biomass in the Bay: 1) Procrorcentrum micans, a dinoflagellate, dominated the phytoplankton population close to the coast and was featured by a lower fluorescence/bb532 ratio; 2) offshore in the central bay, a diatom bloom of Pseudo-nitzschia was detected, in contrast, with a higher fluorescence/bb532 ratio. Our results demonstrate the capacity for differentiating functional phytoplankton groups using optical sensors on autonomous underwater vehicles, enabling synoptic mapping of biological ocean dynamics. (Abstract ID 12603)

The ocean as the source and sink of carbon dioxide is important to global warming and ecology, but its quantitative contribution to the change of atmospheric carbon storage is insufficiently known. The exchange depends on the difference in fugacity (partial pressure) of carbon dioxide between sea and air and a transfer velocity. Fugacity in sea is measured largely on ships; they are not sufficient to characterize spatial and temporal variability. Attempts have been made in the past to relate the fugacity in sea to parameters that could be measured from space. These relations are found to be valid only in limited regions and in specific seasons. We have developed a statistical model to estimate the fugacity over global oceans for all seasons from NASA space measurements using the state-of-art statistical techniques. The input data are sea surface temperature (AMSR-E), dynamic topography (JASON and OSTM), productivity (MODIS), and salinity (climatology and Aquarius) over global oceans. We have evaluated the accuracy of the fugacity data and its application on carbon cycle and will explore proper remedies of any deficiency. We are examining the role of various drivers in different location and seasons. (Abstract ID 10653)
impact of natural and forced climate variability on the gulf of mexico

According to a recent study by Liu et al. [2011], the surface temperature (SST) of the GoM may increase more than 1.5°C by the end of the 21st century. The observed SST in the GoM during the 20th century shows long-term SST variability similar to the Atlantic Multidecadal Oscillation. The amplitude of this multi-decadal signal is as large as 0.5°C, which is comparable to the AGW-induced SST increase in the GoM by 2030. This means that the AGW-induced SST increase in the GoM can be doubled or nearly canceled out due to natural variability until the mid-21st century. Therefore, to further explore the impact of natural climate variability on the forced response of the GoM, here we perform dynamic downscaling of the surface-forced global ocean model simulation to the GoM region for the period of 1871-2008. The Regional Ocean Modeling System, with the fully eddy-resolving horizontal resolution of about 10km in the GoM, is used as the downscaling model. The potential implications of natural and forced changes in the GoM on pelagic fish species and their spawning patterns are discussed. (Abstract ID 9947)

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seasonal variation of currents and sea level on the west florida shelf as revealed by long-term moorings

The seasonal variations of the circulation on the West Florida Continental Shelf are examined using data from an array of acoustic Doppler current profilers moored across the inner to outer shelf, with some records exceeding 10 years duration. For the inner shelf, the seasonal variations are pronounced and primarily in response to local wind forcing. An upwelling favorable circulation prevails during summer months (June–September). This seasonal favorable circulation prevails during autumn to spring months (October–April), reversing to a downwelling favorable environment during summer months (June–September). This seasonal variability becomes less pronounced over the mid to outer shelf where the role of buoyancy forcing increases. The seasonal variations of sea level are pronounced across the entire shelf. Steric height is generally lowest in February and highest in September. Coastal sea level derives from a combination of deep ocean and coastal ocean effects. The steric height contribution from the deep Gulf of Mexico comes from the upper 100 m, and this accounts for about half of the seasonality in the coastal sea level, the other half due to local shelf effects. (Abstract ID 10310)

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eddy analysis in the subtropical zonal band of the north pacific ocean

There are two zonal bands of evidently high eddy kinetic energy (EKE) in the North Pacific Ocean. The highest one is located in the Kuroshio Extension and the second one is in the subtropical area. This paper is focused on the latter. The following observational data are used: satellite measured sea surface height anomalies (SSH), sea surface temperature (SST), Argo data and QuikSCAT wind. An eddy detection scheme based on velocity geometry is applied to the SSHA-derived geostrophic currents to identify and track eddies, and generate an eddy dataset in the band, including spatial and temporal information of eddy generation, evolution and termination. Through the analysis of the eddy data set, a series of eddy characteristic parameters are investigated. It is found from 1993 to 2010, there are over ten thousand eddies generated in the band (we count each eddy for its whole life time as a single item). Cyclonic eddy number exceeds anticyclonic eddy number by about 4%. While eddies move westward, both cyclonic and anticyclonic eddies defects northward north of 21oN and southward south of 21oN, respectively. Statistically, during an eddy’s lifetime, the first one-fifth lifetime is its growing period, the three-fifths after that is its stable stage and the last one-fifth is its decaying period. The eddy location and time information is used to track observed Argo vertical profiles falling in eddy areas, which exposes how eddies impact the thermoline and hadoline. (Abstract ID 12831)

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organism matter decomposition in marine waters is tightly related to global carbon and nitrogen cycles. As regions of low-oxygen waters are projected to increase, it is essential to understand the mechanisms of how organic matter decomposes in these waters. We compared the decomposition pathways and products of small peptides between surface oxygenated and bottom hypoxic waters in the northern Gulf of Mexico. In surface oxygenated waters, small peptides were hydrolyzed into individual amino acids by extracellular enzymes, while in bottom hypoxic waters these small peptides were directly taken up by bacteria at a much higher rate than those in surface waters, releasing ammonium as metabolites. In other words, remineralization of peptide appears to be more efficient in hypoxic waters than that in oxic waters. While it is not entirely clear what factors trigger such a difference of peptide hydrolysis, preliminary results indicated that different microbial communities between oxic and hypoxic waters are the leading candidate. This study suggests that the increasing regions of low-level dissolved oxygen in the ocean will profoundly affect marine carbon and nitrogen cycles. (Abstract ID 10922)

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instability and hydraulics of turbulent stratified shear flows

The Taylor-Goldstein (T-G) equation is extended to include the effects of small-scale turbulence represented by non-uniform vertical and horizontal eddy viscosity and diffusion coefficients. The vertical coefficients of viscosity and diffusion are assumed to be equal and are expressed in terms of the buoyancy frequency of the flow and the dissipation rate of turbulent kinetic energy per unit mass, quantities that can be measured in the sea. The horizontal eddy coefficients are taken to be proportional to a dimensionally correct form that found appropriate in the description of horizontal dispersion of a field of passive markers. The extended T-G equation is applied to examine the stability and greatest growth rates in a turbulent shear flow in stratified waters near a sill, that at the entrance to the Clyde Sea in the west of Scotland. Here the main effect of turbulence is a tendency towards stabilizing the flow; the greatest growth rates of small unstable disturbances decrease, and in some cases flows that are unstable in the absence of turbulence are stabilized when its effects are included. The effects of turbulence on the hydraulic state of the flow are assessed by examining the speed and propagation direction of long waves in the Clyde Sea. Results are compared to those obtained using the T-G equation without turbulent viscosity or diffusion. Turbulence may change the state of a flow from subcritical to supercritical. (Abstract ID 9394)

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assessing atmospheric response to surface forcing in the observation: cross-validation using gefa, lim and fdt

Three statistic methods (GEFA, LIM and FDT) are compared for their assessment of the atmospheric response to sea surface temperature variability in the coupled climate system with a sample length comparable with the observation (decades). The comparison is made first in an idealized coupled model and then in the observation. For daily to pentad data, the simple model study demonstrates that all the three methods are able to provide a consistent assessment of the atmospheric response. For monthly data, GEFA is able to produce an assessment comparable with the daily or pentad assessments using the three methods. The consistence of the three methods is further confirmed in the observation for the responses of the atmospheric geopotential height (at 200hPa) to the tropical ENSO mode and the North Pacific mode. It is found that the three methods produce a consistent response with the overall pattern correlation over 0.95 and the amplitude difference within 10-20%. The consistent results in both the simple model and the observation suggest that the three statistical methods can be used as a cross-validation on the robustness of the assessment of the atmospheric response to surface forcing in the observation. (Abstract ID 9668)

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A three-dimensional model has been developed to study the coastal upwelling circulation and dynamics in the East China Sea. Driven by a southeastward wind stress with representative magnitude of summer monsoon, we identify three distinct upwelling centers/zones off a coastal promontory off Zhoushan, at the head of a submerged valley in the central part of the shelf and on the Subei Shoal in the coastal waters north of the Changjiang Estuary, respectively. Zhoushan upwelling center is formed by geostrophically amplified onshore transport, which is induced by a counter-current pressure gradient force as a result of centrifugal acceleration moving cyclonically around the promontory. The upwelling in the submerged valley and adjacent upwelling in Subei Shoal are dynamically linked. Steep slopes around the valley form strong along-isobath currents and advect cold deep waters upslope towards Subei Shoal, as jet-like seaward toward the Shoal. The upward cross-isobath transport around the edge of the valley is mainly intensified by topographically varied along-isobath pressure gradient, and is further strengthened at head of the valley by bottom frictional transport. Although tidal mixing and shoredow residual current enhance the upward motion, the wind-driven upwelling circulation is suppressed by the tidal forcing due to the formation of front between the vertically well mixed waters shoalward of the 30 m isobath and the stratified waters farther offshore. (Abstract ID 11487)

A regional three-dimensional numerical model is developed to study the coastal upwelling circulations in the East China Sea. Driven by a southeastward wind stress with representative magnitude of summer monsoon, we identify three distinct upwelling centers/zones off a coastal promontory off Zhoushan, at the head of a submerged valley in the central part of the shelf and on the Subei Shoal in the coastal waters north of the Changjiang Estuary, respectively. Zhoushan upwelling center is formed by geostrophically amplified onshore transport, which is induced by a counter-current pressure gradient force as a result of centrifugal acceleration moving cyclonically around the promontory. The upwelling in the submerged valley and adjacent upwelling in Subei Shoal are dynamically linked. Steep slopes around the valley form strong along-isobath currents and advect cold deep waters upslope towards Subei Shoal, as jet-like seaward toward the Shoal. The upward cross-isobath transport around the edge of the valley is mainly intensified by topographically varied along-isobath pressure gradient, and is further strengthened at head of the valley by bottom frictional transport. Although tidal mixing and shoredow residual current enhance the upward motion, the wind-driven upwelling circulation is suppressed by the tidal forcing due to the formation of front between the vertically well mixed waters shoalward of the 30 m isobath and the stratified waters farther offshore. (Abstract ID 11487)

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STICKY GROUNDS – HARDBOTTOM MESOPHOTIC HABITAT ON THE WEST FLORIDA OUTER CONTINENTAL SHELF

Carbonate mounds located along the central West Florida Shelf in water depths of 125-130 meters were investigated using swath bathymetry, sidescan sonar, subbottom imaging, rock dredging, and submersible dives. These features extend alongshore and are 5 to 15 m high with base areas of 5-50 m. Possible origins are sea-level lowstand coral or oyster reefs, or perhaps more recent post-lowstand benthic development. These enigmatic structures, known to fisherman as the sticky grounds, were built, at least superficially, by calcified worm tubes and sediment, and contain oysters normally restricted to brackish nearshore areas. Bioerosion is extensive. Submersible dives using the Johnson Sea Link in August 2010 found diverse benthic communities including eighteen different fish species. The extent and significant of associated living resources with these bottom types is particularly important in light of the 2010 Deepwater Horizon oil spill in the northeastern Gulf and the proximity of the Loop Current. Understanding the distribution of these environments for essential fish and benthic communities may have significant implications for ecosystem management and future oil and gas activities in this outer region of the WFS. (Abstract ID 12197)

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MODE WATER IN THE SEA OF JAPAN: A STUDY ON THE REPRODUCIBILITY OF MODE WATER IN THE DATA-ASSIMILATING REGIONAL NAVY COASTAL OCEAN MODEL

Mode water in the Sea of Japan is associated with anticyclonic eddies that form in the meanders of the Tsushima Warm Current. Previous work has shown free-running, ocean models are able to capture the processes that generate mode water; however, data assimilation is seen to have a negative impact. For this study, a 3.5km resolution Regional Navy Coastal Ocean Model is used to assess the ability of a data-assimilating model to reproduce the mode water structure in the region. The model's response to the assimilation of in-situ and synthetic profiles demonstrates the model's difficulty recreating and retaining mode water beyond a single forecast run, which is thought to occur because the climatological data used to derive the synthetic profiles are too coarse to capture the seasonal mode water evolution. Temperature profiles capturing the mode water layer are recreated using seasonal datasets and Empirical Orthogonal Function (EOF) analysis. However, EOFs corresponding to mode water have been correlated only with sub-surface parameters of the vertical profile and lack a surface trigger, which is necessary in order to make the synthetics operational. (Abstract ID 10354)

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CONTINUOUS ESTIMATES OF NET COMMUNITY PRODUCTIVITY AND AIR-SEA CO2 FLUX ACROSS THE NORTH PACIFIC TRANSITION ZONE

A band of high mean annual air-sea CO2 uptake extends across the North Pacific at ~35-45° N, in the transition zone between the subarctic and subtropical gyres. This strong sink (~4-10 mol C/yr) has been attributed to the combined effects of the solubility and biological pumps. To determine the contribution of biological carbon export to this region of high CO2 influx, we continuously measured the ratio of dissolved oxygen to argon (O2/Ar) in the North Pacific mixed layer using a shipboard equilibrator inlet mass spectrometer (EIMS). O2/Ar is a tracer of net community productivity (NCP), equivalent to the rate of organic carbon export. We report regional variability of NCP and CO2 flux from five trans-Pacific cruises in the transition zone on a volunteer observation ship during fall, winter and spring 2008-2010. NCP in the transition zone along the cruise tracks was positive in fall and spring, and negative in the western part of the basin in winter. (Abstract ID 12619)

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CREATING COMPELLING INFORMATION GRAPHICS TO COMMUNICATE OCEAN SCIENCE

Scientific information targeted to a technical audience is frequently presented with the background first, followed by research, then results or impact. Because messages to a broader non-technical audience are frequently structured in reverse order, showing impact first, communications that need to be targeted both audiences (i.e., web), should be designed so the information can be processed easily by both groups. Information graphics can add information
to the overall piece, allowing viewers more flexibility. We have developed graphics that can be processed by the viewer independent of the text and function as stand-alone sources of information. We have increased the sources of photography and technical illustration that we draw from in order to customize the graphic to the scientific content and media for which it is intended (i.e., website feature, blog, display, presentation). We incorporate the unexpected, thus making the message compelling. This poster will show recent examples of graphics describing ocean resources at risk, climate change impacts on the ocean, and restoration processes. (Abstract ID 12411)

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RECOMMENDATION FOR A REVISED CORAL BLEACHING THRESHOLD

Since 2002, NOAA Coral Reef Watch has used an empirical-based bleaching threshold in combination with global SSTs derived from AVHRR satellites to provide real-time bleaching warnings to coral reef conservation managers. Bleaching alerts can prompt temporary closures of reefs to fishing and tourism during times of stress, relieving multiple stressors on corals. Recent findings about the physiology of coral bleaching show that the bleaching threshold currently used by NOAA should be updated. Corals have a variety of mechanisms by which they can respond to changes in their thermal environment that are not included in the current bleaching algorithm. For example, prior experience to elevated temperatures has been shown to increase the thermal tolerance of corals in both field and laboratory studies. Here, NOAA Coral Reef Watch bleaching prediction method is revised to account for the possibility of acclimatization and adaptation. Methods are compared at the 50km and 4km scales and calibrated against well-documented bleaching observational datasets from Reefbase between 1980-2010. An improved bleaching threshold will refine future bleaching predictions and provide better real-time bleaching alerts to coral reef managers. (Abstract ID 12326)

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ASSESSING THE SPATIAL SCALES OF GLACIER RETREAT IN FJORD ENVIRONMENTS

Past glaciation events are a driving force in the geomorphology of the bathymetry in present day inlets on the northwest coast of North America. The sporadic rate of retreat of glaciers approximately 15,000 years ago carved inlets and fjords on Vancouver Island and deposited debris forming bathymetric features like sills at a variety of spatial scales. A single beam bathymetric survey was conducted in Dee Bay, British Columbia in September 2011 using a Knudsen 320M Echo Sound profiler to identify significant sill structures along the fjord length. The presence of sills, on varying scales, is evidence of shifting rates of glacial retreat during the last glaciation. (Abstract ID 12861)

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ORGANIC LIGANDS- A KEY CONTROL ON TRACE METAL BIOGEOCHEMISTRY IN THE OCEAN

Trace metals are essential micronutrients to marine phytoplankton, controlling primary productivity in oceanic regions and hence exert a major influence on the global carbon cycle and play a key role in regulating global climate. However, the availability of these metals to the biota is governed by speciation, whereby trace metals are bound by organic ligands that may reduce or enhance metal bioavailability, depending on the metal and the resulting metal-ligand complex. To date, we know little about the composition, source and provenance of metal-binding ligands, which is hindering further advances in the field of trace metal biogeochemistry. Metal-binding ligands are typically present everywhere in the water column for the bioactive elements, suggesting that they are either highly recalcitrant, and/or a result of passive biological production in-situ. This overview will focus on recent advances investigating the relationship between the source and function of trace metal-binding ligands and will introduce a newly funded SCOR working group (WG 139) on organic ligands. (Abstract ID 11278)

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BLACK CARBON IN THE SURFACE MIXED LAYER ACROSS THE NORTH ATLANTIC OCEAN

Black carbon (BC) and particulate organic carbon (POC) were determined in filter samples taken on EN 415, en route from Narragansett (RI), USA to Nice (France) in 2006. BC concentrations in surface water ranged from 2-11 ng L\(^{-1}\), while POC concentrations varied from 4-60 ng L\(^{-1}\). The fraction of BC was highest close to the U.S. East coast (up to 80% of POC), but decreased to < 20% in the Mediterranean. The BC\(^{14}C\) isotope ratio shifted from heavier close to the U.S. East Coast (-10 to -14%) towards values close to marine carbon near Europe (-20 to -21%). Carbon 13 isotope ratios for POC were always in the range typically observed for marine carbon (-21 to -24%). Measured BC concentrations in the surface water exceeded predictions (derived from a global circulation model) by one to two orders of magnitude. (Abstract ID 12666)

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COUPLED TERRESTRIAL-OCEAN MODELING OF CLIMATE AND LAND USE CHANGE IMPACTS ON BIOGEOCHEMICAL AND ECOSYSTEM PROCESSES IN THE MISSISSIPPI BASIN AND GULF OF MEXICO

Changing climate and land use practices have the potential to dramatically alter coupled hydrologic-biogeochemical processes and associated movement of water, carbon and nutrients through various terrestrial reservoirs into rivers, estuaries, and coastal ocean waters. Consequences of climate– and land use–related changes will be particularly evident in large river basins and their associated coastal outflow regions. The large spatial extent of such systems necessitates a combination of satellite observations and model-based approaches coupled with targeted ground-based site studies to adequately characterize relationships among climate forcing (e.g., wind, precipitation, temperature, solar radiation, humidity, extreme weather), land use practice/land cover change, and transport of materials through watersheds and, ultimately, to coastal regions. We describe a NASA Interdisciplinary Science project that employs an integrated suite of models in conjunction with remotely sensed as well as targeted in-situ observations with the objectives of describing processes controlling fluxes on land and their coupling to riverine, estuarine and ocean ecosystems. (Abstract ID 12224)

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INCORPORATION OF NITROGEN FROM N2-FIXATION INTO AMINO ACIDS OF ZOOPLANKTON

Eurytemora affinis (Copepod) were fed 15N-labeled Rhodomonas salina (Cryptophyta) or 15N-labeled Nitrosopumena marina (Cyanobacteria) in excess under controlled laboratory conditions. Zooplankton collected from the Baltic Sea were fed natural phytoplankton amended with 15N-labeled N. marina in batch cultures. We quantified the direct incorporation of 15N tracer from N2-fixing N. marina (diazotroph nitrogen) and ammonium-utilizing R. salina into the amino acid nitrogen (AA-N) of zooplankton using a multiple gas chromatography-combustion-isotope ratio mass spectrometry (GC-C-IRMS), gas chromatography-mass spectrometry (GC-MS), elemental analysis-isotope ratio mass spectrometry (EA-IRMS) approach. Highest incorporation of 15N was found in field zooplankton relying on N. marina and in E. affinis relying on R. salina. Decreasing specific and mass-specific rates during field experiments possibly were due to food shortage whereas decreasing rates in E. affinis grazing on R. salina more likely were due to satiation. Specific and mass-specific rates were consistently low in E. affinis when exposed to N. marina suggesting that these animals were reluctant to feed on N. marina. Essential isoleucine received most
**THE WIND SCATTEROMETER CLIMATE RECORD PATHFINDER**

Originally designed only for ocean wind measurement, wind scatterometer backscatter measurements have proven useful in land and cryosphere studies. Spanning nearly 35 years, scatterometers offer the longest active microwave measurements of the globe. The multiple frequency, multiple sensor dataset includes Seasat (Ku-band 1978), ERS-1/2 (C-band 1992-2003), NCSAT (Ku-band 1996-1997), QuickSCAT (Ku-band 1999-present), SeaWinds (Ku-band 2003), ASCAT (C-band 2007-presents) and OSCAT (Ku-band 2009-present). Additional scatterometers are planned. The Scatterometer Pathfinder Project (SCP) www.scp.bu.edu has generated a comprehensive Climate Data Record of global and regional backscatter images to facilitate use of this unique dataset. Reconstruction techniques are used to generate backscatter images on consistent and compatible grids for the various sensors. Image grids are available at various resolutions and time-scales, including enhanced resolution and local-time-of-day. The grids facilitate fusion with microwave radiometer (AMSR-E and SSM/I) data sets also processed to the same grid. Several examples of application of SCP images to climate studies are illustrated, including using QuickSCAT to map the declination spatial extent of Arctic multiyear ice from 1999-2009. Such data can be useful in polar ocean modeling. (Abstract ID 9912)

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**METABOLISM OF SUBTROPICAL CORAL REEFS AND SEAGRASS BEDS DETERMINED BY EDDY CORRELATION**

Coral reefs and seagrass beds represent challenging environments for in-situ measurements of metabolism due to their complex three-dimensional structures and variable community compositions. The eddy correlation technique can be deployed non-destructively on these environments to produce whole-system integrated oxygen fluxes at a high temporal resolution. Using oxygen fluxes as a proxy for carbon cycling, metabolism was studied for a subtropical 1.5m deep reef, a 4m deep reef, and a 4m deep seagrass bed, all located within 150m in the Florida Keys, USA. Large differences in metabolic rates were found for these systems and were linked to irradiance, waves, mean current, and community surface area. Seagrass net primary production measured by eddy correlation agreed well with values determined by the standard punch technique, suggesting that other organisms in seagrass beds have a net balance between production and respiration. Waves and currents enhanced respiration through the flushing of sediments and reef structures. Photosynthesis-irradiance curves appear to not reach a maximum for the studied systems presumably due to shading arising from the physical structures of these habitats. (Abstract ID 10360)

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**HIGH PRODUCTIVITY IN THE NORTHEAST PACIFIC DURING THE LAST GLACIAL MAXIMUM INDICATED BY DIATOM TRANSFER FUNCTIONS**

Maximum Likelihood transfer functions applied to modern calibrations from NE Pacific reveal significant relations between diatoms and oceanic annual productivity. The existence of no-analog lead us to test this transfer function not only with independent methods such as Artificial Neural Networks but also by comparing the no-analogs removal. The reconstructions using both approaches and the removal of no-analogs show similar results and have the same trends. Results show that during the Last Glacial Maximum, annual productivity was higher by 1.5 to 2 times than modern days, despite the suppression of coastal upwelling. Comparison of our results with previous data of organic carbon and carbonate mass accumulation rates and percentages, shows that although the ecosystem was productive, it was less efficient in exporting organic carbon. The results presented here are the first approach considering quantitative reconstructions of oceanic productivity in this area. Possible sources for the nutrients needed to support such system can be the recycling of water column, the freshwater inputs, the increase of open ocean upwelling, enhancement of southern currents and/or a mixture of all the previous. (Abstract ID 9897)

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**FILTRATION CAPABILITIES OF FOUR BIVALVE SPECIES IN THE CHESAPEAKE BAY**

As human population around the Chesapeake Bay increases, so does pollution associated with urban sprawl and development. The increased nutrients in the Bay cause massive algal blooms, leading to hypoxia and reduced biodiversity. Filter-feeding bivalves have the ability to provide a "top-down" control on phytoplankton activity. Bivalve species filter particulate matter from the water and excrete the less nutritious particles. This process effectively sequesters seston and provides a “top-down” control on phytoplankton activity. Bivalve species filter particulate matter from the water and excrete the less nutritious particles. This process effectively sequesters seston and provides a “top-down” control on phytoplankton activity. Bivalve species filter particulate matter from the water and excrete the less nutritious particles. This process effectively sequesters seston and provides a “top-down” control on phytoplankton activity. 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Macoma balthica, and Rangia cuneata – lab trials were performed over 6 hour periods to determine chlorophyll-a drawdown of the species. Twelve mesocosms were set up in a raceway, filled with a seawater and algae solution, and five individuals of each species. Hourly water samples were tested for chlorophyll-a concentrations using fluorometry. Crassostrea virginica and Ischadium recurvum were both proficient at removing chlorophyll-a from the water, individually and in combination. Therefore, further studies should be conducted to analyze the feasibility of restoration using these two species as well as to better understand the filtering abilities and life history of both species. (Abstract ID 10368)

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ENHANCING MODELING SKILL OF THE VERTICAL STRUCTURE AND TRAPPING ABILITY OF DENSITY GRADIENTS IN THE LOWER COLUMBIA RIVER ESTUARY

Furthering the physical and biogeochemical understanding of the estuarine turbidity maximum (ETM) is a priority of the Center for Coastal Margin Observation & Prediction. Essential to this endeavor is the ability to predict the physical processes controlling the ETM at high temporal and spatial resolution. The Virtual Columbia River modeling system offers simulations that already capture important density gradients in the estuary, but increased resolution and skill are required to support detailed ETM studies. Here, we describe an effort to improve the vertical density structure in the North Channel of the estuary as represented by the three-dimensional, finite element circulation model SELFE. Refinements to grid resolution, bathymetric representation, oceanic forcings, and turbulence closure model selection have been implemented and skill assessed to measure the ability of the model to represent ETM-forming trapping processes. Evaluations of individual and composite refinements rely on comparisons over a spring-neap cycle, of hindcast simulations to observations from the Saturn observation network. Preliminary results indicate that carefully selected combinations of refinements, but no single change, result in an improved vertical density representation particularly during neap tides. (Abstract ID 11952)

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BLOOD CHEMISTRY VALUES FOR ATLANTIC CROAKER (MICROPOROGONIAS UNDULATUS) UNDER NORMOXIC AND SEVERE HYPOXIC CONDITIONS

Atlantic croaker (Micropogonias undulatus), an abundant and commercially important species found in hypoxic areas of the Chesapeake Bay, was used to assess physiological effects of hypoxia using blood chemistry analysis. Experiments were conducted at 24, 48 and 72 hr with fish under normoxic (5 mg/L of DO) and hypoxic (1.5 mg/L of DO) conditions. Blood samples were analyzed for plasma chemistry and electrolytes. Glucose levels were elevated at all three time periods. Glutamic oxaloacetic transaminase (GOT) levels were higher in hypoxic fish than normoxic in the 24 and 72 hr experiments. Phosphorus levels were elevated in hypoxic fish at 24 and 48 hr compared to normoxic fish. The increase in muscle enzymes is an indicator of tissue damage and may reflect liver dysfunction while the increase in phosphate may reflect cellular demand for ATP necessary for cellular functioning during hypoxia. Severe hypoxia did not cause significant changes in plasma chemistry values. This study shows that Atlantic croaker may adjust their metabolic activities during periods of low DO. (Abstract ID 9786)

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USE OF TRACE ELEMENTS TO REVEAL SEA TURTLE POPULATION CONNECTIVITY BETWEEN OCEANIC AND NERITIC FORAGING AREAS IN THE ATLANTIC

Trace elements have been used to determine population connectivity in a variety of marine organisms by analyzing the elemental composition of inert tissues with continuous growth such as calcium based structures like otoliths as well as keratin based structures like hair. The elemental signature of a tissue reflects that of the environment in which the animal feeds and grows, making it possible to infer different developmental areas by analyzing different growth layers of the tissue. This principle may be useful in cases where marine organisms have cryptic developmental stages like the oceanic stage of green turtles (Chelonia mydas) in the Atlantic. Scute, the keratinized epidermal covering of the bony shell of sea turtles, is inert after deposition and has continuous growth. Thus, scute records a "history" of where the turtle has been. By analyzing the elemental composition of the different layers of scute, it is possible to identify oceanic foraging grounds of green turtles in the Atlantic. We present the results of the trace elements analysis of oceanic scute layers from young green turtles from different regions in the Atlantic. (Abstract ID 12904)

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USING ISOTOPE HYDROLOGY TO UNDERSTAND THE IMPACTS OF CLIMATE CHANGE TO COASTAL WETLANDS IN PUERTO RICO

In Puerto Rico, climate change is expected to create a rise in sea level and an alteration of precipitation patterns. This represents a great danger for coastal wetlands due to the hydrological changes in the island. The Humacao Natural Reserve is composed of different coastal wetland ecosystems that are home to many threatened species, making it an ideal place to apply isotope hydrology to understand how climate change will affect it. We will collect monthly water samples from different water sources reaching the HNR (runoff, lagoons, ocean and rainfall) and analyze them for their isotopic ratios (O18/O16, H21/H20). Our objectives are the following: 1) develop a local database of isotopic data, 2) analyze the temporal and spatial variations of these values, and 3) determine the contribution of rainfall to the wetland ecosystems. Preliminary analysis shows a variation of water isotope values in a small spatial scale (100 m). We expect further variation of isotopic values across scales, especially of rainfall samples. Results from this research will clarify and contribute to important aspects of hydrology and climate change impacts on the HNR. (Abstract ID 9556)

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DRIFTER ON AN ALIEN SEA: EDUCATION AND OUTREACH ON THE TITAN MARE EXPLORER

Earth is not the only world with seas. In the last 5 years, the NASA/ESA Cassini mission has mapped hundreds of lakes and three seas (Kraken, Ligeia and Punga) on Saturn’s giant moon Titan. These seas, hundreds of km across, are composed primarily of liquid ethane. In Titan’s thick atmosphere (~4x denser than Earth’s) and low gravity (1/7 of Earth’s), these seas present an exotic environment in which to explore air sea exchange and other physical oceanographic processes. Titan’s seas are the focus of a mission currently under evaluation by NASA, the Titan Mare Explorer (TIME), which would feature a capsule delivered by parachute to Ligeia Mare, arriving in 2023. This vehicle - much like drifting baos on Earth - would drift over three months (6 Titan days) measuring the liquid composition and using cameras, meteorological instruments and a depth sounder. This mission offers unparalleled opportunities to engage the public, and an exotic hook with which to stimulate physical sciences education. (Abstract ID 10911)

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EXPLORATION OF TITAN’S SEAS

Oceanography is no longer just an Earth Science. The ongoing NASA/ESA Cassini mission has found that three seas of liquid ethane adorn Saturn’s giant, frigid moon Titan: these seas (Kraken Mare – 1000km across, Ligeia Mare, ~500km, and Punga Mare) and hundreds of lakes, present an exotic environment (low gravity, dense atmosphere, hydrocarbon liquid) in which to explore familiar physical processes such as air sea heat and moisture exchange, wind-driven currents and waves, etc. This talk will review the radar and optical observations of Titan’s seas, and model studies showing that thermal stratification may occur in Titan summer, and that (nonresonant) tidal amplitudes of the order of meters with currents of ~cm/s are expected. Titan’s seas are the focus of a mission currently under evaluation by NASA, the Titan Mare Explorer (TIME) proposal, which would feature a capsule delivered by parachute to Ligeia Mare, arriving in 2023. This vehicle would drift over three months (6 Titan days) measuring the liquid composition and turbidity, studying conditions with cameras and meteorological instruments, and exploring the seafloor with a depth sounder. (Abstract ID 10906)

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LITHOCENIC SEDIMENT DISTRIBUTION AND TRANSPORT IN THE CARIACO BASIN, VENEZUELA.

In order to understand carbon sequestration in coastal zones, it's necessary to recognize transport mechanisms of lithogenic material from the land to the ocean. The Cariaco Basin is surrounded by several small mountainous rivers, whose discharge is linked to the position of the Intertropical Convergence Zone. The basin is also located in a tectonically active margin. We examined the lithogenic sediment distribution and transport from the shelf to the deep Cariaco Basin between 2005-2009. Bottom nepheloid layers (BNL) were the principal transport mechanism of particles from the coast. The particulate organic carbon (POC) concentration and isotopic composition (δ13C) within the BNL varied seasonally in response to changes in contribution of terrestrial vs. marine particles. During upwelling, δ13C = −23‰ to −24‰; during the rainy season δ13C was more depleted (−25‰ to −27‰). POC concentration was generally low in the BNL (~50-200 mg Cm⁻³), compared to surface measurements (~150-300 mg Cm⁻³). Episodic events, such as earthquakes and hyperpycnal flows, also play an important role in lithogenic particle transport. These events have the capacity of rapidly sequestering large quantities of sediments and POC to the deep basin. (Abstract ID 11459)

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MELT RATE SENSITIVITIES UNDERNEATH PINE ISLAND ICE SHELF DERIVED FROM AN ADJUNCT GENERAL CIRCULATION MODEL

Increased melt rates under floating ice shelves around Antarctica have been suggested as a dominant cause for observed acceleration of marine ice sheets that feed these ice shelves. The associated melt rates are difficult to observe directly. We present first steps towards estimating the melt rates underneath floating ice shelves from ocean hydrographic data and optimal control methods. We address to which extent ocean hydrographic observations away from the ice-ocean boundary can be used to constrain sub-ice shelf melt rates. We derive sensitivity patterns of sub-ice shelf melt rates to changes in ocean circulation underneath the Pine Island Ice Shelf in the Amundsen Sea Embayment. The sensitivity patterns are computed with an adjoint model of a full-fledged ocean general circulation model that resolves the sub-ice shelf circulation and includes a thermodynamic melt rate parameterization. The adjoint state can be used to identify dominant water mass pathways and time scales that affect melt rates, provide guidance for oceanographic field campaigns. (Abstract ID 11462)

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OCEANSWIDE: USING REMOTE OPERATED VEHICLES (ROVS) FOR INTERACTIVE SCIENCE AND TECHNOLOGY OUTREACH

Remote operated vehicles (ROVS) are exciting, hands-on instruments for communicating concepts in both science and technology to a wide range of audiences. OceansWide is a non-profit organization dedicated to sharing the discoveries and research collected through ROVs with the general public. We provide a platform for scientists and educational partners worldwide to access live audio and video feeds sent directly from the research vessel to their lab or classroom. The technology of ROVS also introduces students to a wide range of future careers that complement science. Our program also offers opportunities for post-college students to be trained as support staff for the vehicles and as educators. Our goal is to transform the ways in which students and educators interpret the world of marine science and open new opportunities for scientists to share their passion for the ocean with the next generation of ocean explorers. (Abstract ID 11509)

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EFFECTS OF INTERANNUAL WAVE CLIMATE VARIATION ON THE SOUTHERN COAST OF BRAZIL

Small variability on wave climate could result in significant changes on the morphology of coastal environments. Based on the fourteen-years (1997–2010) NW/W3 database, the influence of interannual variation of storm wave climate at two areas of the southern Brazilian coast is assessed. These data has been used as boundary condition in the wave propagation model (MIKE21 SW – DHI) prepared for each coastal region of interest. Study sites include a protected beach (Massaguaçu – São Paulo state) and an exposed beach (Imbituba-Laguna – Santa Catarina state). In order to represent energetic conditions at each site, the top 15% of the waves were selected. Based on wave power estimates and statistical analysis, the most energetic month (May) was selected to be represented here. Results show that at the headland protected beach (Massaguaçu), nearshore directional variability is only 11% of the offshore variation, while at the exposed beach the nearshore variability reflects 33% of that offshore. This variation of up to 30° causes magnitudes of the potential longshore drift to vary up to three times in the region. (Abstract ID 11199)

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PROTIST COMMUNITIES THROUGH THE DEEP CHLOROPHYLL MAXIMA LAYER OF THE MACKENZIE CANYON, BEAUFORT SEA, ARCTIC OCEAN

Molecular gene surveys have highlighted the diversity of protists throughout the water column but tend to focus on surface or deep samples. A deep chlorophyll maximum layer (DCM) is common in many pelagic regions and is ubiquitous in the salinity stratified Arctic Ocean accounting for over two thirds of primary production in the Canadian Beaufort Sea. In the Beaufort Sea the maximum peak occurs below the nutrient poor upper mixed layer within Bering Sea Pacific Winter Water; the DCM can be either very sharp or more diffuse. Here we explored the diversity of protists in Arctic DCM using a targeted 18S rDNA gene pyrosequencing approach to determine community structure in the upper, mid and lower reaches of the DCM in the region of the Mackenzie Canyon, where physical processes result in asymmetric peaks in chlorophyll in situ fluorescence on either side of the canyon. (Abstract ID 11421)

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SOUTHERN OCEAN MERIDIONAL OVERTURNING AND AIR-SEA CO2 FLUX VARIABILITY IN THE COMMUNITY EARTH SYSTEM MODEL

The rate of Southern Ocean meridional overturning is an important determinant of air-sea CO2 exchange in the region. Coarse-resolution ocean general circulation models indicate tight coupling between meridional overturning and variations in the position and intensity of surface wind stress; thus, these models suggest that Southern Ocean CO2 flux varies in phase with wind fluctuations. However, studies based on eddy-permitting models question whether coarse-resolution models with parameterized eddies simulate an appropriate circulation response to variable and changing wind intensity. Recent literature indicates that the key to obtaining an appropriate response at coarse resolution is to specify a variable and weakly restricted eddy-induced advection coefficient (k) in the eddy parameterization. Here, we use output from hindcast simulations of the Community Earth System Model (CESM) to document the impact of wind stress variability on meridional overturning and sea-air CO2 flux. As CESM simulates the ocean at coarse resolution with a variable k implementation, this study provides a first evaluation of how carbon fluxes respond to wind changes in a variable k model. (Abstract ID 9751)

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CHANGING WINDS AND DISPERSION OF PACK ICE AFFECT ACCESS TO PREY AND PHYSIOLOGICAL CONDITION OF BOTTOM-FEEDING MARINE BIRDS

Viability of Arctic habitats for some marine birds and mammals depends on the presence of sea ice to dissipate waves and as a platform for resting. However, unusual wind patterns can consolidate pack ice into cover so dense that air-breathing predators are excluded from the better feeding areas. Spectated eiders typically winter among openings in pack ice in areas where densities of bivalve prey are very high. However, in the Bering Sea during winter 2009, a large region of continuous, unbroken ice restricted the eiders to areas with much lower abundance of potential prey. Prey fragments in the intestine and stable isotope and fatty acid biomarkers indicated that in 2009 the eiders did not expand their diet beyond bivalves. Moreover, their body fat was 33–35% lower than on the same date (19 March) in 2001 when they occupied areas with much higher bivalve density. These findings indicate that in the Bering Sea, where annual sea ice extent has not shown long-term change, climatic variations in wind-driven dispersion of ice can still strongly affect habitat availability to benthic-feeding endotherm predators. (Abstract ID 9600)

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LIFE-HISTORY CONSTRAINTS AFFECTING INVASION SUCCESS IN THE ASCIDIAN BOTRYLLUS SCHLOSSERI

The reproductive success of ectotherms in temperate seasonal environments is constrained by temperature limits for growth and sexual reproduction. Botryllus schlosseri (class Ascidiacea) is a temperate ectotherm that disrupts benthic communities and bivalve aquaculture. Its dispersal from temperate to colder subarctic waters raises the question as to how it could adapt to an increasingly short season for growth and reproduction. To answer this question, we followed cohorts of marked colonies (settling throughout the year) in Arnold’s Cove NL. Temporal windows for growth and reproduction were both shorter (~2 months) than in temperate waters, indicating the life cycle was time constrained. Compared with colonies in temperate waters, these time constraints selected for enhanced early reproductive effort (during 1-3 events), thereby shortening generation time at the expense of future growth and reproduction. This strategy is adaptive, as fitness in ectotherms is maximized by producing as many generations as possible within a season. Coupled to high overwintering survival (~90%) in colonies settling late in the year, these results help to explain the establishment success of temperate B. schlosseri in sub-arctic waters. (Abstract ID 10411)

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RECONSTRUCTING LATE HOLOCENE HYDROGRAPHIC VARIABILITY IN THE GULF OF MAINE, USA: IMPLICATIONS FOR THE NORTH ATLANTIC CLIMATE DYNAMICS

Chronologically accurate interpretations of the marine sediment record play a crucial role in the study of ocean and atmospheric climate dynamics. The accuracy of sediment-based age-depth models in marine environments can be vastly improved by constraining past variability in the local marine radionuclide reservoir effect (ΔR). We attempt to resolve the ΔR evolution in the Gulf of Maine, USA via an absolutely dated master shell chronology. Located near the junction of the Gulf Stream and the Labrador Current, the Gulf of Maine is an ideal location to study large-scale ocean circulation dynamics within the North Atlantic. Using an annually resolved master shell growth chronology constructed from the bivalve Arctica islandica, we present a timeseries of annual oxygen isotope values as well as a decadal scale ΔR timeseries during the last two centuries. Preliminary results support the hypothesis that the GoM source waters shifted during the Little Ice Age, a phenomenon likely influenced by variability in the Labrador Current. (Abstract ID 12332)

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A CHARACTERIZATION OF BIOGEOCHEMICAL PROPERTIES IN THE CHURCHI SEA: RESULTS FROM ICESCAPE 2010-2011

The continental shelves of the Chukchi Sea constitute a highly productive ecosystem within the Arctic Ocean that is undergoing rapid change due to sea ice loss. As climatic change continues to alter the biogeochemical and optical properties of this region, fully understanding the resulting ecological impacts is of utmost importance. During ICESCAPE 2010-2011, we conducted a thorough biogeochemical and optical study of several regions in the Chukchi Sea, including Kotzebue Sound, Central Channel, Hanna Shoal, and Barrow Canyon. Here, we relate biological measurements (such as chlorophyll a and particulate organic carbon and nitrogen) to physical properties (such as sea ice cover, ocean currents, temperature, and salinity) to better characterize the ecosystem in terms of its current environment and ongoing response to climate change. Considering the role of the Chukchi Sea as an important habitat and feeding ground for an array of upper trophic level organisms, this characterization is both relevant and timely. (Abstract ID 11696)

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IMPACTS OF VERTICAL MOMENTUM MIXING IN AN ARCTIC OCEAN MODEL

We examine the consequences of adopting coefficients of vertical mixing of horizontal momentum that are orders of magnitudes larger than commonly used values. The ocean and sea-ice model covers the whole Arctic Ocean and the subpolar North Atlantic with a horizontal grid spacing of about 18 km. The viscosity coefficient is determined by a prescribed background value, a closure based on the solution of a turbulent kinetic energy equation, and an enhanced value in case of convective instability. A set of simulations are carried using a climatology of surface atmospheric forcing and the background viscosity coefficients varying from 0.0001 to 0.05, 0.5 and 5 m2/s. Model results show that the increased viscosity acts to reduce the strength of the boundary currents, flatten isopycnals, and reduce the thickness of the sea-ice in Canada Basin. The reduced strength of the Beaufort Gyre corresponds to a decrease of surface convergence of cold water, hence helps to reduce the ice thickness. However, the signature of major traditionally recognized circulation patterns are removed if large viscosity values of 0.5 and 5 m2/s are used. (Abstract ID 9753)

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CONTRASTING SEMIDIURNAL AND INERTIAL MODES OF NUTRIENT FLUX AND COASTAL PHYTOPLANKTON DYNAMICS

In stratified shelf seas, variability is often concentrated in the inertial and semidiurnal frequency bands. The semidiurnal internal tidal mode is responsible for large horizontal fluxes of nitrate to the coastal waters of the Southern California Bight (SCB). At a similar latitude, St. Helena Bay, South Africa, has weak baroclinic tides but strong diurnally variable winds. The wind forcing is nearly resonant with the local inertial frequency, driving large amplitude oscillations. The St. Helena Bay phytoplankton population is much more productive than the SCB assemblage; much of this enhancement is due to subinertial cross-shelf flows. However, the dynamical differences between the semidiurnal and inertial variability lead to distinct cross-shelf exchanges of nutrients and phytoplankton. Phytoplankton tend to form subsurface maxima in the SCB. This subsurface maximum undergoes vertical displacements driven by the internal tide but is subject to little cross-shore advection. In contrast, phytoplankton are often uniformly vertically distributed in the surface mixed layer in St. Helena Bay. The horizontal excursions and horizontal density gradients associated with near-inertial oscillations lead to frontal accumulation, cross-shore transports, and large inputs of nutrients to the surface. Finally, the phase-locked sea-breeze driven circulation contrasts with the phase-smearred internal tide, potentially leading to circadian adaptation in the St. Helena Bay coastal phytoplankton. (Abstract ID 11849)

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Utilizing satellite sensors to remotely collect data on environmental variables, “satellite remote sensing” is increasingly becoming an important component of a comprehensive ecosystem-based approach to coral reef management and research. For the past decade, remote sensing products provided by NOAA's Coral Reef Watch (C RW) have used satellite-derived sea surface temperature (SST) measurements to inform and alert coral reef managers, scientists, and the public about SSTs that impact coral reef ecosystems over broad spatial scales. Recently, enhanced and future operational remote sensing products that collect data on additional environmental variables are being developed at NOAA's Center for Satellite Applications and Research (STAR). Non-SST based monitoring products such as ocean color hold great promise, not only for the cost-effective and data-rich perspective they provide but also for improving the quality and effectiveness of coral reef management in the United States’ coastal marine jurisdictions. This poster introduces results from a newly reduced report describing NOAA's recent and forthcoming remote sensing products and correlates their applicability to U.S. jurisdictional coral reef management priorities and NOAA Coral Reef Conservation
FLUID INTERACTIONS THAT ENABLE STEALTH PREDATION BY THE UPSTREAM FORAGING HYDROMEDUSA CRASPEDACUSTA SOWERBYI

Unlike most medusae which forage with tentacles trailing behind their bells, several species forage upstream of their bells using aborally located tentacles. It has been hypothesized that these medusae forage as stealth predators by placing their tentacles in more quiescent regions of flow around their bells. Consequently, they are able to capture highly mobile, sensitive prey. In this study, we used digital particle image velocimetry (DPIV) to quantitatively characterize the flow field around Craspedacusta sowerbyi, a freshwater upstream foraging hydromedusa, to evaluate the mechanics of its stealth predation. We found that fluid velocities were minimal in front and along the sides of the bell where the tentacles are located. As a result, the shear stress rates in the regions where the tentacles are located are low, below the threshold strain rate required to elicit an escape response in several species of copepods. Estimates of their encounter rate volumes were examined to evaluate the potential feeding impact of individual medusae. (Abstract ID 10319)

OXYGEN AND HEAT FLUX IN THE BENTHIC BOUNDARY LAYER OF A SHALLOW LAKE

We collected simultaneous measurements of oxygen, temperature, and three velocity components to derive the vertical oxygen- and heat-flux using the eddy correlation technique. The sensors were 95 mm above the silty bottom in 1 m of water near the outflow of Beaver Lake, Saniah, British Columbia. We used an acoustic Doppeler velocimeter in conjunction with two oxygen sensors (a polarographic and a galvanic sensor), which were compared directly. Whereas both oxygen sensors agreed on time scales longer than 10 seconds, the galvanic sensor showed a lower noise level than the polarographic sensor. In addition, a 19-hour time series with a galvanic oxygen-temperature sensor pair was analyzed to examine diurnal changes of oxygen- and heat-flux. The Reynolds stress derived from the velocity measurement was downward and significantly different from zero. The DO flux was also downward. The peak of the oxygen and heat flux spectra is at $k_{x}$ ~ 10 cm$^{-1}$. When scaled by the turbulent overturning length scale $L_{o} = 0.05$m, $k_{x}$ is close to values obtained in the oceanic surface mixed layer, suggesting a universality of the flux spectrum. (Abstract ID 12607)
Regional responses to hurricanes Rita (2005) and Ike (2008). Models included in the testbed are ADCIRC, FVCOM, SELFE, SLOSH, SWAN, SWAVE, WMW and WMII. Testbed activities include both the evaluation of model skill vs observed data and the inter-comparison of model results. Outcomes include documentation of model skill, computational efficiency, and sensitivity to implementation issues such as model physics and grid resolution. The testbed is led by the Southeastern Universities Research Association (SURA) with funding provided by the NOAA IOOS program. (Abstract ID 12493)

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PEERING INTO THE GULF OF MEXICO’S CIRCULATION

Recent field programs and modeling advances have reduced the uncertainties about the Gulf of Mexico circulation. The Gulf behaves as two uncoupled layers divided at 800-1,200 m. The upper layer, with mean anticyclonic circulation, is dominated by the Loop Current and anticyclonic eddies of varying sizes. What drives the Loop’s intrusions and its irregular eddy separations remains unresolved. The lower layer, contrary to preconceptions, is an energetic and dynamic environment; and its cyclonic circulation appears dominated by TRWs, eddies, or their combination. While high kinetic energy in the lower layer is observed near topographic gradients, measurements in smooth areas reveal higher energies as well. Observations point to the Loop and upper eddies as the energy source for the deep circulation, but a mechanism for transferring energy is lacking. Vorticity and baroclinic instabilities are strong candidates. Two major ongoing programs by BOEM should increase our knowledge of the circulation, improve performance of models, and shed light on larvae or pollutants dispersal. Additional studies in Mexican waters and other Gulf initiatives provide an optimistic outlook for the Gulf’s oceanography. (Abstract ID 11331)

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SURPRISING ABYSSAL TIDAL SIGNALS AT STATION ALOHA

The real-time ALOHA Cabled Observatory (ACO) has operated at Station ALOHA at 4728 m since June 2011. The ACO pressure sensor shows a dominant M2 tidal signal with a range of ~0.7 dbar. The difference from the TPXO7.2 barotropic tide model has a comparable range and frequency, but it is sharply peaked near high tide, which cannot be simply due to model M2 amplitude and phase errors. The ACO acoustic Doppler profiler 2.5 m above the bottom (mab) consistently measures the flow from 20 to 70 mab, revealing tidal flows with a range of 0.2 m/s while TPXO7.2 predicts a barotropic tidal range of ~0.04 m/s. Currents are weaker below 30 mab, as expected for a boundary layer. However, the structure above that is not simply barotropic, consistent with earlier moored measurements at the site. Occasional short duration accelerations occur with downwelling and upward phase lag. These episodes are sometimes seen in temperatures and salinity mab, with unexpectedly large temperature range of 0.01K and salinity range of 0.005. These may be turbulent bursts in the benthic boundary layer. (Abstract ID 1257/8)

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REDUCING MODEL UNCERTAINTY AT THE NAVAL OCEANOGRAPHIC OFFICE USING THE NAVY COUPLED OCEAN DATA ASSIMILATION SYSTEM

The Naval Oceanographic Office uses the Navy Coupled Ocean Data Assimilation (NCODA) system to perform data assimilation for ocean modeling. This system runs on the DoD Supercomputing Resource Center (DSRC). Currently the system uses a 3D multivariate optimum interpolation (3DMVOI) algorithm to produce outputs of temperature, salinity, geopotential, and u/v velocity. NCODA is run in a stand-alone mode to support automated ocean data quality control (OcnQC) and to test software updates. NCODA is also coupled with the tide-resolving high-resolution Regional Navy Coastal Ocean Model (RNCOM). Reduction of modeling error in the RNCOM/NCODA system is being carried out via three complementary approaches: (1) improvements to the data assimilation algorithm by transitioning from the 3DMVOI method to a 3D variational (3DVar) method; (2) running ensembles of RNCOM/NCODA to get a better representation of the best model state; and (3) performing adaptive sampling and prediction (ASAP) to reduce errors in the analysis and forecasts, by placing observations in the best possible locations to reduce the future forecast bias and root mean square (RMS) error. The ensemble output will also be used to create uncertainty/threshold maps which in turn can be used in assigning Risk Assessment Codes (RAC). (Abstract ID 10393)

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The Labrador Sea is one of key regions for deep water formation, contributing to the Atlantic Meridional Overturning Circulation (AMOC). Hydrographic observations have shown the subpolar North Atlantic experienced significant changes in last 60 years. Understanding what is driving the changes of water properties in the Labrador Sea is crucial in the study of AMOC and the Earth’s climate.

**MODEL INVESTIGATION OF THE INTERANNUAL VARIABILITY OF POTENTIAL TEMPERATURE IN THE CENTRAL LABRADOR SEA**

The Labrador Sea is one of key regions for deep water formation, contributing to the Atlantic Meridional Overturning Circulation (AMOC). Hydrographic observations have shown the subpolar North Atlantic experienced significant changes in last 60 years. Understanding what is driving the changes of water properties in the Labrador Sea is crucial in the study of AMOC and the Earth’s climate. We conduct a set of numerical experiments with an eddy resolving regional ocean model without any nudging or data assimilation to study the interannual variability of potential temperature over depth in the central Labrador Sea. The simulations reproduce reasonably well the variations of potential temperature as observed by the repeat hydrographic survey and Argo profiling floats. The strong warming trend during late 1990s and 2000s and deep convective events in the winters of 2009 and 2009 are well captured by the model. Analysis of our suite of numerical experiments shows in the central Labrador Sea the interannual variability of potential temperature is highly correlated with local atmospheric forcings, while boundary current contributes most of warming trend in potential temperature recorded in the XXI century. (Abstract ID 9999)

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**THE FINE SCALE DISTRIBUTION OF SYPHONOPHORES AND A NARCOCOMMUNE BLOOM ACROSS A FRONT IN THE SOUTHERN CALIFORNIA BIGHT**

Gelatinous organisms are becoming increasingly recognized as important components of marine ecosystems, but knowledge of their course, and particularly fine scale spatial-temporal distributions are often lacking. Using the towed In Situ ichthyoplankton Imaging System (ISIS), which images plankton using a shadowgraph technique, we sampled a frontal feature in the Southern California Bight in October 2010 along three cross-front transects where ISIS was undulating from the surface to 140m. We present preliminary data on the distribution of gelatinous zooplankton with respect to the physical environment, the scaling of patch dynamics, and their co-occurrence within a community context. Siphonophores of five taxa where quantified:Sphaeronectes spp, Diphyidae, Physonectae, Lysogony spp, and Prayidae, listed in order of abundance (27 to 2 individuals/m³). Additionally, we discovered blooms of the seldom-observed narcocumese Solenian rhodosoma coincident with the frontal feature, with highest concentrations exceeding 1350 individuals/m³. Through this research, we are able to begin examining the biophysical drivers of and the role of certain taxa within the community dynamics of gelatinous hydromedus. (Abstract ID 10357)

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**MODELING SPRING BLOOMS IN SOUTHERN LAKE MICHIGAN**

A coupled physical-biological model was used to simulate the ecosystem characteristics in Lake Michigan. The model was calibrated using measurements during EGGLE (Episodic Events - Great Lakes Experiment) project in 1998. The major features of phosphate for nutrient, phytoplankton, zooplankton, and detritus in 1998 were captured. During March to May, a doughnut-like phytoplankton bloom appeared in southern Lake Michigan, which was measured by both satellite and in situ data. The spatial distribution of the spring bloom was captured. The pattern of bloom was forced by the coupling between the rapid growth of phytoplankton due to increasing temperature and solar radiation in spring and wind-induced gyre circulation. Some experiments were carried out to evaluate the contribution of external forcing including wind, shortwave and net heat flux. The complexity and formation mechanisms were also discussed. (Abstract ID 10066)

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**ESTIMATE OF GLOBAL NITROGEN FIXATION RATES AND Diazotrophic BIOMASS COMPARING CCSM MODEL AND OBSERVATIONAL DATABASE**

Diazotrophs are a key functional group in marine pelagic ecosystems. The biological fixation of dinitrogen (N₂) bioavailable nitrogen forms provides an important nitrogen source for pelagic marine ecosystems and influences primary productivity and organic matter export to the deep ocean. As one of a series efforts of collecting biomass and rate data from different phytoplankton functional groups and model intercomparison, we have constructed a diazotrophic database for global pelagic ocean by collecting direct field measurements of N₂ fixation rates and diazotrophic abundances from microscopic counts and m¹f¹ gene counts. More than 7,000 data points have been collected covering open oceans, inner seas and coastal regions. Abundance data are converted to diazotrophic biomasses by using cell-size estimated biomass conversion factors. The data are used to parameterize and validate the results from the Community Climate System Model (CCSM) model. The model results show a comparable pattern to the database. The global marine N₂ fixation rate, diazotrophic biomass and the turnover time of cellular N due to N₂ fixation are estimated by accommodating the database and the modeling results. (Abstract ID 9371)

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**PROJECTED CHANGES IN THE PACIFIC SUBTROPICAL MODE WATERS UNDER GLOBAL WARMING**

Global warming may change the formation and evolution pathways of the Subtropical Mode Waters (STMW) in the Pacific Ocean. This study investigates the changes by comparing solutions from a set of Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment
Report (AR4) models between a present-day climate (the 20C3M experiments) and a future, warmer climate (the SRESA1B experiments). Under the warmer climate scenario, the STMW in the North Pacific are produced on lighter isopycnal surfaces and are significantly weakened in terms of their formation and evolution. These changes are due to a more stratified upper ocean and thus a shoaling of the winter mixing depth resulting mainly from a reduction of the ocean-to-atmosphere heat loss over the subtropical region. In sharp contrast, however, the warmer climate induces a significantly increased volume of the South Pacific Eastern Subtropical Mode Water (SPESTMW) resulting mainly from an intensification of the southeast trade winds. (Abstract ID 11500)

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HISTORICAL GLOBAL UPPER OCEAN HEAT CONTENT RELATIVE TO ARGO

Before 2004, spatial and temporal patterns of global in situ temperature sampling were largely irregular. By 2004, the Argo array of autonomous profiling CTD floats began to provide near-global coverage of the upper ice-free oceans. We use Argo measurements to estimate means and a seasonal cycle for ocean heat content in the 0–100 m, 0–300 m, 0–700 m, 700–900 m, and 900–1800 m layers of the global ocean for 2004–2010. This new climatology is used to define heat content anomalies relative to a uniformly well-sampled time period. These anomalies avoid spatio-temporal biases that are introduced relative to “mixed-era” climatologies constructed from the irregularly sampled historical dataset. Annual global integrals of ocean heat content anomalies are estimated back to 1955. Uncertainties of these integrals and their multi-year trends are estimated based on in situ sampling patterns, mapping methodology, and XBT bias correction variance as available. (Abstract ID 9526)

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NONLINEAR AND VISCOUS TSUNAMI TRANSFORMATION OVER SHALLOW SHELVES

The focus of this talk will be on the evolution of large tsunamis as they approach and propagate over the continental shelf. The source mechanism of the tsunamis of interest will typically be from submarine landslides or asteroid impacts, such that the waves are weakly or strongly nonlinear when first reaching the shelf. While these waves are rare, they are of particular interest to sensitive coastal facilities, such as nuclear power plants. In extreme cases, the tsunami breaks and becomes a turbulent bore immediately after hitting the shelf; in this limiting case the entire shelf margin can be considered as a wide shelf zone. In most other cases, amplitude dispersion effects at the tsunami front can lead to a fission process, transforming the front into a long train of shorter, dispersive waves. Here, bottom friction can play a significant role. There is a wide range of possible fates for these waves, from near simultaneous, offshore breaking of numerous short waves and condensation back into a single large bore front to repeated beach breaking of the individual pulses. (Abstract ID 10037)

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DIFFERENTIAL UTILIZATION OF CARBON SUBSTRATES BY AGGREGATE-ASSOCIATED AND WATER-ASSOCIATED HETEROTROPHIC BACTERIAL COMMUNITIES

Carbon-source utilization within the water column is not a bulk property because microbial communities are patchily distributed on suspended organic aggregates, e.g., marine snow, organic detritus. To assess the biogeochemical relevance of this multiscale distribution, Biological Ecosystems were used to evaluate the metabolic capacity of heterotrophic bacterial communities associated with aggregates compared to that of the surrounding water. Overall, aggregate-associated microbial communities demonstrated higher levels of metabolism, metabolic versatility and functional redundancy, and a more consistent pattern of carbon-source utilization compared to water-associated communities. In addition, aggregate-associated communities more effectively exploited available resources, including representatives from several biochemical guilds and nitrogen-containing carbon sources. Within the aggregate-associated microbial community, metabolic activity was significantly higher in the presence of polymers, amino acids, and carbohydrates as compared to amino and carboxylic acids. In comparison, metabolic activity of water-associated communities exceeded a threshold value for only 2 of the 5 guilds (polymers and carbohydrates) evaluated. These results suggest that compared to their free-living counterparts, aggregate-associated communities are more plastic because they have a greater capacity to respond to a wider array of carbon inputs. (Abstract ID 11291)

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EDUC NUMERICAL STUDY OF TURBULENT BUBBLE FLOW UNDER SURFZONE BREAKING WAVES

Wave breaking in the surf zone entrains large volumes of bubbles into the water column. These bubbles are involved in intense interactions with mean flow and turbulence, producing a complex two-phase bubbly flow field which increase bubble retention and contributes to determining the time scale for degassing and return to optical clarity of the water column. In this presentation, we describe a three-dimensional large eddy simulation of polydisperse bubbly flow and investigate the detailed interactions between coherent structures and bubble entrainment under a laboratory scale surfzone breaking wave. We describe the dynamics of breaking waves using an Eulerian two-phase (gas-liquid) flow with appropriate bubble size distribution. The model captures large-scale turbulent structures well, including obliquely descending eddies and downbursts of turbulent fluid. It is found that these coherent turbulent structures play an important role in turbulent kinetic energy and momentum transport as well as bubble entrainment. These flow structures contribute to the vertical transport of bubbles more deeply into the water column. The bubbles also play a role in suppressing turbulence and altering the vorticity field of the liquid phase. (Abstract ID 11770)

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SEASONAL VARIABILITY IN SETTLEMENT AND ABUNDANCE OF THE NON-INNOCUOUS ASCIDIAN, BOTRYLLUS SCHLOSSERI, IN A SUBARCTIC HARBOUR

Population dynamics remain enigmatic for the non-indigenous temperate ascidian, Botryllus schlosseri, which was identified on the south coast of Newfoundland in 2006. This represents a unique opportunity to study B. schlosseri in subarctic waters characterised by a short productive season. The seasonal cycles of colony abundance and larval settlement rates were determined in Arnold's Cove, Newfoundland, by (1) deploying an experimental array of artificial settlement plates and (2) surveying a transect of 140 wharf pilings using HD video. Coincident with maximum seasonal temperatures, peak settlement was at 30-40 m^2 in September and peak cover of colonies was 3% in October. Settlement rate was greater at 1 and 2.5 m than 4 m depths and on PVC in preference to aluminum and wood substrates. These results have ecological, economic, and management implications as they address competition of space in subtidal benthic communities, potential threats to sustainable bivalve aquaculture, and the implementation of monitoring and mitigation efforts. (Abstract ID 10249)

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DISTRIBUTION AND PHYSIOLOGY OF THECOSONME PTEROPODS IN THE EASTERN TROPICAL PACIFIC: A NATURAL EXPERIMENT IN CO2 EXPOSURE

The cosmopolitan pteropods are a group of holoplanktonic mollusks that are believed to be especially sensitive to ocean acidification because of their aragonitic shells. Despite this concern, there is very little known about the distribution of these animals in relation to regions of naturally high CO2. This study examines the distribution of thecosome pteropods in the Eastern Tropical Pacific above an oxygen minimum zone. In this location carbon dioxide levels reach ~1000 ppm and aragonite is undersaturated by ~20%. To explore the physiological sensitivity of pteropods in the region to CO2, we used end-point experimentation experiments that measured the oxygen consumption and ammonia excretion of five pteropod species under conditions of normocapnia (390 ppm) and hypercapnia (1000 ppm). Depth stratified net samples show that several species of pteropod naturally migrate into hypercapnic oxygen minimum zones. The oxygen consumption and ammonia excretion of these migratory species was not affected by CO2 treatments. Non-migratory species responded to high CO2 conditions with reduced oxygen consumption and ammonia excretion. This indicates that the natural chemical environment of individual species influences their resilience to ocean acidification. (Abstract ID 9997)

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IS BAROCLINIC EXCHANGE THROUGH STRAITS INCREASED BY ROUGH TOPOGRAPHY?

Many fjords, estuaries, and marginal seas have silts or straits that limit baroclinic exchange with the ocean. The exchange flow in turn controls important processes such as residence time, productivity, hypoxia, and the melting of glaciers. Baroclinic exchange is well-known to be limited by hydratides for steady flow. The addition of barotropic tidal currents may decrease the exchange by causing stronger turbulence, or it may increase the exchange by tidal pumping.
The addition of rough topography in a Strait would seem at first to be a sure way to decrease exchange because headland eddies and internal lee waves strongly increase mixing. However, headlands may also trap fluid, shielding it from tidal transport during certain phases of the tide. This may enhance baroclinic exchange. This process is explored using particle tracking experiments in a realistic numerical simulation of Admiralty Inlet, the controlling sill of the headlands may also trap fluid, shielding it from tidal transport during certain phases of the exchange because headland eddies and internal lee waves strongly increase mixing. However, TOS/AGU/ASLO 2012 Ocean Sciences Meeting will illuminate. (Abstract ID 11563)

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CONTROL VOLUME, MICROSTRUCTURE, AND OVERTURBULENCES: UNRAVELING THE HETEROGENEITY OF TURBULENCE IN A NEAR-FIELD RIVER PLUME

The near-field region of a river plume, defined as the region with supercritical internal Froude numbers immediately seaward of the river mouth, is an energetic region characterized by intense mixing of the buoyant outflow with ambient ocean waters. The presentation will utilize data from recent field efforts in the Merrimack River plume (Massachusetts), associated with the Merrimack River Mixing And Divergence Experiment (MERMAD) to describe the heterogeneity of the turbulent field. Turbulence estimates are derived from both a control volume method (bulk estimates) and microstructure measurements (point measurements) utilizing shear probes mounted on an autonomous underwater vehicle. Co-located CTD data is also used to evaluate turbulent dissipation from overturn scales. Comparison of overturn and control volume estimates suggests a ratio of Oziadev to overturn scales of order one, and also indicates that the turbulent field is extremely heterogeneous, with over 90% of the mixing occurring in less than 10% of the volume. Comparison of overturn scales with microstructure suggests that turbulent microstructure persists significantly longer than well-defined overturns, yielding important information about the evolution of turbulence at small scales. (Abstract ID 10553)

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ANATOMY OF A FLOODING WARM-CORE EDDY

Warm-Core Eddies (WCE) can play an important role in marine ecosystems. One such WCE formed from a retroreflection of the East Australian Current (EAC) in late 2008. To investigate this eddy, an approximately 3 km resolution version of the Regional Ocean Modeling System (ROMS) is configured for the coast off south-east Australia. Datasets from recent cruises and deployments around a WCE eddy in 2008 are used to assess the model. Particle paths, a variety of tracers, and streamlines are used to investigate the structure and evolution of the eddy. The eddy becomes flooded with EAC waters which flush out some of the original eddy. The remainder of the core is pushed down 10–90 m. Water is expelled from the eddy between 300 m and 100 m depth and upwells up the side of the eddy. There is also, uplift in the EAC waters as water is drawn up to replace the flooding water. This flooding is self-perpetuating as temperature gradients created during the flooding then drive the flooding process. (Abstract ID 10776)

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FATE AND EFFECT OF THE MACONDO HYDROCARBON DISCHARGE

The 84-day discharge of oil and gas following the blowout of BP’s Macondo well in 2010 created genuinely unique phenomena in the benthic and mid-water ocean environment. Hydrocarbon seeps have been documented in the Gulf of Mexico at ages of ~50 Ky: Natural oil and gas seeps, miniscule in comparison to the BP discharge, are a perennial Gulf feature. The geologic record includes blow-out craters from large-scale releases of hydrocarbon and reports of substantial, natural oil discharges are found in historic accounts. However, it is unlikely that a hot, highly pressurized discharge from a reservoir ~4000 m sub-bottom has ever been ducted directly to the floor of the deep ocean by natural processes. These extreme circumstances posed severe challenges throughout the emergency response effort and they should inform our thinking as we seek to understand the science of the discharge. Many of the factors under investigation have no precedent in nature. The purpose of this presentation is to outline the major aspects of the discharge and introduce categories of investigation that the topical presentations to follow will illuminate. (Abstract ID 11563)

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INVASIVE ALGA REMOVAL ACCELERATES SEDIMENT FLUSHING IN MAUNALUA BAY, HAWAII

Invasive species are a worldwide problem and have altered both terrestrial and marine ecosystems in Hawaii. *Arthroclisis annulata* is one marine invader that has changed the Paiko Lagoon Peninsula (PLP) reef flat ecosystem. PLP also has a sediment accumulation problem worsened by the dense presence of the alga. Community-based groups, in partnership with governmental agencies, have attempted to restore PLP by manually removing ~5,000 tons of *A. annulata*. This study investigated the effectiveness of this restoration approach in the removal of accumulated fine sediment at PLP We collected data at least once monthly for 14 months using a sediment resuspender and turbidity meter. Our model found that the removal of *A. annulata* is essential for the flushing of sediment out of PLP and is a necessary first step in improving habitat quality. Although restoration can be challenging and slow, success can still be achieved through effective community and governmental partnerships. (Abstract ID 9498)

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GEOPHYSICAL EVIDENCE OF SHALLOW HYDRATES FORMATION AND ACCUMULATION AT WOOLSEY MOUND, MISSISSIPPI CANYON BLOCK 118

The Gulf of Mexico Hydrates Research Consortium, led by the Center for Marine Resources and Environmental Technology at the University of Mississippi, has been conducting multidisciplinary studies of natural gas hydrates occurrence for more than a decade. Since 2005, these studies have been focused on the Woolsey Mound, a complex hydrate-carbonate system located in about 900m water depth over the Mississippi-Alabama continental slope. At this site the Consortium is completing the installation of a permanent seafloor observatory that will provide in situ measurements of the hydrates stability zone. In order to define the Woolsey Mound hydrates system and to build the most compelling model to guide monitoring strategy, Consortium members have designed and conducted a wide suite of geophysical investigations including multiple resolution seismic data (chirp, 3d multichannel, single-channel deep-towed), potential field surveys (EVM resistivity), and, just recently, an Ocean Bottom Seismometer survey appositively designed to collect shear wave information. These studies reveal a system of extreme geological complexity, tectonic activity, and hydrocarbon fluids regime. The goal of this contribution is to present results relevant to hydrates genesis and accumulation mechanisms. (Abstract ID 9539)

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WHY ARE ORANGE GUAYMAS BASIN REGGIAIO ORANGE?

Microbial mats dominated by large, filamentous, vacuolated *Reggiatia* (*Marinreggiatia*) species often cover sediments and chimney structures around hydrothermal vents in Guaymas Basin (Mexico). Orange filaments are concentrated in mat centers, while genetically distinct white *Reggiatia* dominate the fringes. Evidence to date suggests *Reggiatia* gain energy by sulfide oxidation coupled to nitrate reduction. Taking advantage of an orange filament genome sequence, we identified an abundant soluble pigmented protein from an orange mat as an octaheme cytochrome, whose closest characterized relatives oxidize hydroxylamine to nitrite in ammonia-oxidizing bacteria. The *Reggiatia* protein oxidizes both hydroxylamine and hydroxylamine *in vitro*, but its abundant production by a presumably nitrate-reducing species is puzzling. The genome includes putative membrane-bound and periplasmic nitrate reductase genes, but appears to lack a nitrite reductase. Octaheme cytochrome nitrite reductases were recently identified in other Gammaproteobacteria; however, the *Reggiatia* genome encodes a second putative octaheme cytochrome more similar to these. Disentangling the physiological roles of the several octaheme cytochromes encoded by the genome of bacteria living at 2000 m depth will be challenging. We hope white-filament genome sequences will provide some clues. (Abstract ID 12548)

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OBSERVING A DIURNAL TIDAL EFFECT ON SEA ICE CONVERSION IN THE ROSS SEA USING AMSR-E SATELLITE DATA

The northwest corner of the Ross Sea experiences large amplitude diurnal tidal currents, which are thought to contribute to near surface stress divergence, modifying sea ice concentration and producing increased radiation and atmosphere-ocean exchanges. This area (72S, 172E) experiences about 9 consecutive months of sea ice coverage varying between 60-100%, thus giving a sufficiently long time series for tidal analysis. Despite the non-uniform time sampling of ice concentration by the AMSR-E satellite, ice concentration data extracted from individual swaths (3-4x per day) can be analyzed for the principal tidal constituents. From this analysis we obtained the expected major diurnal tidal constituents (O1 and K1) that combine to produce a strong spring/neap (~2 weeks) cycle in ice concentration. (Abstract ID 9934)

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MODELING THE CONTINUUM: UNDERSTANDING DOWNSCALE ENERGY TRANSFER AND MIXING FROM BREAKING INTERNAL WAVES

Energy is input into the internal wave field by the tides and winds primarily in the form of low-mode waves, yet is dissipated by the breaking of high modes. The transformation from large to small-scale waves in the ocean interior is thought to occur largely through nonlinear wave-wave interactions. The process is mediated by an internal-wave continuum, which is in turn shaped and sustained by these interactions. Even at mixing 'hot-spots' near wave generation sites, much of the dissipation involves a flow of energy through the continuum rather than direct breaking of forced waves. The spatial decay scale of enhanced mixing in these locations is hence controlled by the relative timescales of wave-wave interaction and wave propagation. Here we use an idealized numerical model to investigate 1) how energy is transferred out of a narrowband frequency peak like the internal tide to a wide range of waves, 2) how the energy redistribution can create (from almost nothing) and sustain a Garrett-Munk-like broadband background, and 3) how the resultant energy transfer/loss relates to several candidate dissipation parameterizations. (Abstract ID 12330)

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ESTUARINE SEDIMENT DYNAMICS IN INTERTIDAL AND SUBTIDAL ENVIRONMENTS: DIFFERENCES AND SIMILARITIES IN FORCING AND RESPONSE

Oceanographic data were collected in a cross-shore transect of northern San Francisco Bay that spans the transition from intertidal to subtidal mudflat, and are used to determine the controls on sediment concentration and flux, and how they differ between these two environments. A general framework for understanding each site is provided by a decomposition of measured sediment fluxes, which yields the relative importance of the residual flow field, tidal dispersion, and Stokes drift. Within this framework, the details of each flux mechanism are explored by examining specific time periods controlled by distinct forcing mechanisms: tides, wind events, and intertidal waves. The spatial decay scale of enhanced mixing in these locations is hence controlled by the relative timescales of wave-wave interaction and wave propagation. Here we use an idealized numerical model to investigate 1) how energy is transferred out of a narrowband frequency peak like the internal tide to a wide range of waves, 2) how the energy redistribution can create (from almost nothing) and sustain a Garrett-Munk-like broadband background, and 3) how the resultant energy transfer/loss relates to several candidate dissipation parameterizations. (Abstract ID 12330)

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OCURRENCE OF SOLUBLE MANGANESE(III) IN THE MARINE ENVIRONMENT

Recent research shows that soluble manganese(III) [Mn(III)aq] is present in natural waters (Black Sea, Chesapeake Bay, Baltic Sea), comprising a large fraction of the total dissolved Mn pool within the suboxic zone. Currently, little is known about the extent or geochemical controls of Mn(III)aq, in a variety of marine environments. One of the most redox stable suboxic zones occurs in marine sediments. Data to be presented, using a novel spectrophotometric method for Mn(III)aq determination in sediment porewaters, confirm Mn(III)aq also exists in sediment porewaters of the Saint Lawrence Estuary and a Delaware salt marsh. In all samples, Mn(III)aq accounts for up to 80% of the total dissolved Mn pool and up to 80 μM in the upper 10 cm of sediment. These results suggest Mn(III)aq is ubiquitous in all environments with a redox gradient and likely plays a role in several important geochemical cycles. (Abstract ID 10531)

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NITROGEN CYCLING IN PERMEABLE SEDIMENTS UNDERLYING THE OMZ OFF THE COAST OF SOUTHERN CALIFORNIA

The availability of oxygen strongly affects biogeochemical processes in the water column and underlying sediments in OMZs. It is not well understood whether sediments represent a sink or a source of reactive nitrogen. In July 2011 we investigated sediments underlying the CMZ off Southern California at 5 stations ranging from 670 - 2000 m water depths. 3 stations of low oxygen bottom water concentrations (~20 μM or ~0.45 ml l-1 O2) were compared to the fringe of the OMZ (1500 m; 67μM or 1.5 ml l-1 O2) and to outside of the OMZ (2970 m; 162μM or 3.6ml l-1 O2). The investigations focused on sandy sediments of comparably lower porosity and organic carbon content. Despite very low bottom water concentrations oxygen penetrated several mm into the sediment and pore water analyses revealed high nitrate concentrations throughout the upper 10 cm, while ammonium concentration was low and nitrite concentrations were at the detection limit. Microprofiles of nitrous oxide showed elevated concentrations above the sediment-water interface. Sediment incubation experiments are being conducted to determine rates of nitrification and denitrification. (Abstract ID 12042)

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ON THE NATURE AND VARIABILITY OF THE EAST GREENLAND SPILL JET

Recent evidence suggests that a significant amount of dense water south of Denmark Strait does not participate in the overflow, but instead cascades off the shelf. This phenomenon forms...
During Summer 2003, more than half of the largest Spill Jet transport values are of the latter case, surface cyclones associated with DSO deep domes initiate the spilling process. Kinematic analysis of the model results suggests two different types of spilling events. In the first case, a local perturbation results in dense waters descending over the shelf break. In the second case, surface cyclones associated with DSO deep domes initiate the spilling process. During Summer 2003, more than half of the largest Spill Jet transport values are of the latter type. (Abstract ID 9888)

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STATISTICAL PREDICTION OF COASTAL AND ESTUARINE EVOLUTION

Seabeds are constantly evolving, driven by a combination of tidal, wave and surge effects, as well as the supply and the type of sediment in the area. However, our ability to analyse and forecast estuarine and coastal geomorphic evolution remains limited, such that in situations where significant long term change is anticipated, expert judgement is usually employed. In the present project a data-driven model was developed using 12 multibeam surveys near the ebb-tidal delta of the Ese Estuary, on the South West of the UK, taken between 2006 and 2011. These surveys were used to develop and autoregressive model to predict seabed evolution. Averages of the data and of the forecasts were computed and compared to one another. The forecasts were also compared against the measured data by computing the autocorrelation functions (ACF) for both at several locations. There was relatively good agreement between the actual and the predicted average bathymetries and their associated ACFs. Computations and comparisons of additional statistical properties of data and forecasts are in progress, following these encouraging preliminary results. (Abstract ID 11134)

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AN OUTREACH CASE STUDY ON COASTAL ENGINEERING AND MARINE RENEWABLES

In this contribution we present activities done with final year high school students introducing them to coastal engineering and marine renewables. These activities take place within a day and involve around 30 pupils from around the UK who have been selected to participate in the Headstart Programme (see http://www.etrust.org.uk/headstart.cms). The Coastal Engineering Research Group at Plymouth University, has been running for the past three years a one-day workshop including; introduction to marine renewables lecture, hands-on marine renewable prototype development and testing, keynote lecture on coastal processes and structures, and an afternoon boat visit to the Plymouth Sound and the Plymouth breakwater. The marine renewable prototypes the pupils design, build and test during workshop are a Heave device, an Oscillating Water Column device, and a Tidal Energy device. The programme is extremely popular and has resulted in several participants choosing to come to Plymouth University for their undergraduate degree. (Abstract ID 11877)

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LATE-HOLOCENE NORTH ATLANTIC SEA-SURFACE TEMPERATURE VARIABILITY

Thirty-six paleoceanographic proxy records were examined to determine temporal and spatial trends in sea-surface temperature (SST) during the last 20,000 years of the late Holocene interglacial period. We used published proxy records including oxygen isotopes in foraminifera, alkenones, and planktonic foraminiferal and ostracode Mg/Ca ratios with temporal resolutions ranging from sub-annual to centennial. Many of these records come from the North Atlantic Ocean and from the equatorial Atlantic. To examine temporal SST patterns, the individual proxies were compared to mean values to obtain annually interpolated and normalized regional temperature anomalies. Applying a low-pass filter to the records revealed multi-century climatic patterns within the Little Ice Age and Medieval Climatic Anomaly. The filter at time scales of 25 years showed that the post-AD1950 warming is evident throughout the Atlantic. Empirical orthogonal functions will be presented to reveal spatial patterns in time throughout the domain. Reconstructed SST patterns will be applied to studies of ocean dynamical changes over decadal to centennial timescales and to estimates of sea-level variability during the late Holocene. (Abstract ID 12505)

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EFFECTIVE PRACTICES FOR CONNECTING SHIPBOARD RESEARCH WITH SHORE-BASED SCIENCE EDUCATION

Onboard education officers sail regularly on deep-sea research expeditions aboard the IODP drillship JOIDES Resolution. During IODP Expedition 336 Mid-Atlantic Ridge Microbiology, approximately 40 videoconferences were held with classrooms in the US, France, Spain, England and Australia; students ranged from 5th grade to university. Blogs were posted daily, written by the onboard education officer and several of the scientists. Daily updates were posted on Facebook and Twitter, and included photos, videos, links, and lesson plans. Two complementary education programs were also conducted during the expedition: Adopt-a-Microbe, which presented weekly activities and content focused on microbiology, and Classroom Connection, a structured curriculum that was developed in conjunction with a special needs classroom. Teachers use these tools in different ways in the classroom, and it is important for distance educators to know where to focus their efforts to have the greatest impact on classroom education. This session will explore the tools that teachers find most useful for engaging their students, inspiring them to pursue STEM careers, and meeting curriculum requirements such as national and state standards. (Abstract ID 12437)

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WIND- AND EDDY-ENHANCED PRODUCTIVITY AT THE ICE EDGE: MODEL-BASED PROCESS STUDIES IN THE BEAUFORT SEA

The premature poleward retreat of sea ice from the Beaufort shelf exposes slope waters to surface and a wind-stress curl at the ice edge during the spring. This generates a tilt in the isopycnals, which results in baroclinic instability and the formation of eddies. The energetic eddy field is responsible for a vertical flux of nitrate and enhanced productivity at the ice edge during the spring. Using a process study ocean model, we examine the effect of the winds, local stratification and ice cover on the eddy-driven nitrate flux and productivity in this region. (Abstract ID 12651)

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AEROSOL-INDUCED VARIABILITY OVER THE TROPICAL ATLANTIC AND AFRICA

A new high resolution (0.9x1.25) time-dependent global tropospheric aerosol dataset with monthly resolution is generated using Community Atmosphere Model (CAM4) coupled to a bulk aerosol model and forced with the latest estimates of surface emissions for the latter part of the twentieth century. Regression analysis of 20th century experiments with the spectral configuration of CAM4 over tropical Atlantic and Africa reveals that increasing dust aerosols can cool the north African landmass and shift convection southwards from west Africa into the Gulf of Guinea in the spring season. Further, we find that an increase in carbonaceous aerosols emanating from the southwestern African Savannas can cool the region significantly and increase the marine stratocumulus cloud cover over the southeast tropical Atlantic ocean off the west African coast by enhancing the inversion layer by diabatic heating of the free troposphere. Experiments conducted with CAM4 coupled to a slab ocean model reveal that present day aerosols can induce a southwards shift of the FTCZ as compared to pre-industrial aerosols. Results from the experiments further suggest that thermodynamic feedbacks between the atmosphere and ocean mixed layer over southeast tropical Atlantic can amplify the increase in marine stratocumulus cloud cover initiated by overlying carbonaceous aerosols and reduce the ocean mixed layer temperature beneath. (Abstract ID 12437)

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OCEAN GOVERNANCE IN THE WIDER CARIBBEAN REGION: IS AN EFFECTIVE
REgime complex emerging?

The wider Caribbean region comprises 44 countries and territories. This presents significant challenges for governance of transboundary living marine resources. Marine ecosystems are affected by overfishing, pollution (land and sea based) and habitat degradation. Emerging governance efforts have thus far resulted in a variety of regional and subregional organisations with various responsibilities for ocean governance. Countries show little inclination to consolidate ocean governance in the region. Therefore, enhancement of ocean governance must strengthen the emerging regime complex through a ‘learning by doing’ approach. Countries are addressing this reality explicitly through a GEF LME Project to strengthen the regional governance architecture and networking needed for the regime complex to function effectively. This includes assessing relationships among regional and subregional organizations (gaps, overlaps, interactions), role of the Caribbean Sea Commission as an overarching policy body, national-regional interfaces, and information needs of regional science-policy interfaces. Governance arrangements for key ecosystems are also being assessed with purpose designed methodology. These assessments are expected to provide insights into the current status of the regime complex and guide appropriate interventions for strengthening it. (Abstract ID 9311)

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Phytoplankton Seasonal Dynamics and Ecological Interactions in the Lower Columbia River

This study combined hourly biogeochemical data with monthly phytoplankton zooplankton abundance and species composition analysis to examine the role of river discharge on ecological interactions in the lower Columbia River: In-situ monitoring of chlorophyll concentrations allowed for adaptive sampling to track annual seasonal succession of diatom species and to quantify algal loss mechanisms (grazing, lethal parasitism) at various points of river discharge from 2009-2011. Chlorophyll peaked multiple times in spring and was inversely related to river discharge. Elevated river discharge throughout 2011 was reflected in substantially lower peak chlorophyll during the spring bloom compared to 2010. Higher prevalence of parasitic fungal infection of diatoms corresponded to peak chlorophyll levels, and grazing rates decreased during the spring freshet. Observations based on high resolution in-situ data support previous research that suggests increased water retention time and decreased turbidity due to dams has “greened” the Columbia River. In addition, the data indicate that changes in river discharge not only affect phytoplankton biomass, but alterations in river flow may also influence ecological interactions and the transfer of organic matter in the food web. (Abstract ID 10488)

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Determination of Particulate and Dissolved Thorium-228 Using Delayed Coincidence Counter

The application of Thorium-228 towards understanding particles dynamics is limited because of the associated sampling and analytical challenges. However Thorium-228 (t1/2=1.9 years) when applied in conjunction with the more commonly used Thorium-224 (t1/2=24.1 days) can provide us with important information on processes like (i) particle cycling e.g. aggregation-disaggregation rates, (ii) seasonal variability in POC export, (iii) lateral advection of coastal water mass, that neither one of these two isotopes can provide individually. The goal of this work is to examine whether we can utilize delayed coincidence scintillation counters (Moore & Arnold 1996) to non-destructively measure both particulate and dissolved Thorium-228 samples via the decay of its daughter Radium-224 to Radium-220. This will provide us with a less analytically challenging and more economical method for measuring Thorium-228, leading to wider application of this isotope in the aquatic system. Dissolved and particulate samples were collected from upper 1000 m of water column at BATS in September 2009. Samples were analyzed via traditional alpha counting as well as delayed coincidence method to investigate the potential application of this new method. (Abstract ID 11455)

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We present a new method for optimally estimating the historical pCO2 at the sea surface and use it to quantify the air-sea pCO2 flux and the time rate of change pCO2 from 1980 through 2010. The method inverts data from surface pCO2 measurement databases using Markov Chain Monte Carlo methods and a simple model for the time evolution pCO2. An ocean general circulation model forced with atmospheric reanalysis provides estimates of the seasonal and interannual variability in surface pCO2 which can reduce the bias introduced by the globally sparse sampling. The diagnosed surface fluxes of CO2 are consistent with time-averaged estimates from other methods and also provide estimates of interannual variability, trends and a full treatment of uncertainty. We demonstrate that the trends in surface pCO2 generally point to increasing fluxes into the ocean over the last three decades. Finally, we discuss how this method may be used in the future for detecting and attributing changes in the carbon cycle and the observational schemes necessary to achieve accurate carbon budgets. (Abstract ID 11893)

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Near Inertial Kinetic Energy Distribution at the Arabian Sea Mooring

We use the Arabian Sea Southern mooring (15.7°N, 61.2°E) to examine the near-inertial kinetic energy budget of the mixed layer. At the near-inertial frequency, mixed layer is shear free. However persistent near-inertial shear seems to dominate the mixed layer base. To investigate the origin of this shear we first start with the basic momentum equation for a slablike mixed layer, and compute near-inertial energy flux from the wind. We further estimate the amount of energy exchange at the mixed layer base. Our study suggests that the strength of near-inertial shear deposited at the mixed layer base, highly correlates with the near-inertial energy input from the wind. The propagation of energy from the mixed layer base into the transition layer is consistent with phase propagation of WKB-stretched zonal velocities when one-dimensional heat budget holds. (Abstract ID 12205)

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Indication of M2 Internal Tide in Lifamatola Passage, Lombok and Karimata Straits, Indonesia

Because of complex coastline geometry and bathymetry with many narrow passages, strong tidal current and stratification, the eastern Indonesian Seas are favorable places for internal tide generation. Indonesian Seas provide a seepage allowing transfer of water from the tropical Pacific and Indian Ocean known as Indonesian Throughflow. Through the INSTANT (The International Nusantara Stratification and Transport) mooring data analysis in the Lifamatola Passage and in the Lombok Strait indicated strong baroclinic condition and Internal Tides occurrences. The tidal ellipse construction in the Lifamatola Passage confirmed the strong baroclinic condition by changing of the magnitudes and orientations of tidal currents. The Internal tide occurred due to interaction of tides and sill (1000 meter depth). The obliquely motion for M2 internal tides in the Lombok Strait were captured by the M2 tidal band above the sill depth (350 meter). The Lombok Strait provided strong baroclinic condition through the M2 tidal current and stratification, the eastern Indonesian Seas are favorable places for internal tide generation. Indonesian Seas provide a seepage allowing transfer of water from the tropical Pacific and Indian Ocean known as Indonesian Throughflow. Through the INSTANT (The International Nusantara Stratification and Transport) mooring data analysis in the Lifamatola Passage and in the Lombok Strait indicated strong baroclinic condition and Internal Tides occurrences. The tidal ellipse construction in the Lifamatola Passage confirmed the strong baroclinic condition by changing of the magnitudes and orientations of tidal currents. The Internal tide occurred due to interaction of tides and sill (1000 meter depth). The obliquely motion for M2 internal tides in the Lombok Strait were captured by the M2 tidal band above the sill depth (350 meter). The Lombok Strait provided strong baroclinic condition through the Brunt Vaissala frequency calculation. In comparison with the Eastern Indonesian Seas there are no internal tides indication in the Western Indonesian Sea (Karimata Strait) since this Strait shallow and has simply bottom topography (Abstract ID 11624)

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Multiscale Analysis and Simulation of the Wind-Driven Ocean Surface Boundary Layer

A primary challenge in physical oceanography is to understand the interaction between small-scale turbulent mixing processes in the upper ocean, such as Langmair circulation (LC), and...
submesoscale eddies, fronts, and their associated instabilities. This problem is computationally
challenging because LC is strongly non-hydrostatic, only weakly affected by the Earth’s
rotation and density stratification, and has length scales commensurate with the ocean surface
boundary layer, O(50) m. In contrast, submesoscale flows are approximately hydrostatic,
strongly affected by Coriolis accelerations and density stratification, and have O(10) km lateral
scales. In this investigation, we take a first step toward developing a physically consistent and
computationally efficient model of this inter-scale coupling using multiscale asymptotic analysis
and multiscale pseudospectral numerical simulations. Using this formulation, we demonstrate
over an order of magnitude acceleration of our computations relative to brute-force simulations
using a single-scale algorithm. (Abstract ID 12067)

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RESPONSE OF THE ATLANTIC OCEAN CIRCULATION TO GREENLAND ICE SHEET MELTING

The sensitivity of the Arctic Meridional Overturning Circulation (AMOC) to freshwater input
from the Greenland Ice Sheet (GIS) is considered one of the Achilles’ heels in climate change.
Considering the importance of the AMOC for the climate system, and the vulnerability of the
GrIS to global warming, assessing this sensitivity is critical for climate change projections.
Here we present a set of numerical experiments to investigate the adjustment of the North
Atlantic Ocean circulation to enhanced freshwater fluxes from Greenland. In particular we
compare the response in a global, strongly-eddy ocean model and an ocean model typical of
the current generation of climate models. We ﬁnd that the short term response to freshwater
input is stronger in the low-resolution model, due to an almost immediate and complete
shut-down of deep convection in the Nordic and Labrador Seas. On decadal time scales,
however, the AMOC in the strongly-eddy model is more sensitive than in the non-eddy model.
This result suggests that the ocean thermohaline circulation may be more sensitive to
freshwater anomalies than thought up to now. (Abstract ID 12720)

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DON THE SEASONAL RELATIONSHIP BETWEEN AIR-SEA GAS FLUXES AND ATMOSPHERIC OBSERVATIONS: THE SOUTHERN OCEAN CASE

The seasonal variations in the atmospheric O$_2$/N$_2$, Ar/N$_2$ ratios and N$_2$O mole fraction
are partly controlled by the physical and biogeochemical ocean processes, especially in the
southern hemisphere where land influence is minimal. The seasonal thermal cycle of the ocean
mostly controls the seasonal variations in air-sea fluxes of Ar and N$_2$, and the corresponding
variations in the Ar/N$_2$, ratio while ocean ventilation and biogeochemical processes also
affect the seasonal dynamics of air-sea fluxes of O$_2$ and N$_2$. We combine atmospheric
measurements and ocean modeling to help understand the main controls on gas exchange
on seasonal time scale. An eddy-permitting physical-biogeochemical model of the Southern
Ocean has been conﬁgured to include these gases and forced by present-day climatic state.
We separate the different ﬂux components due to different processes. We test model results against
the ratio of the amplitudes of the seasonal cycles in the atmospheric O$_2$/N$_2$, and Ar/N$_2$ ratios
which can constrain the thermal and biological inﬂuences on O$_2$. We report results for this
comparison between gas ﬂuxes and atmospheric observations exploring the role of different
oceanic processes. (Abstract ID 12585)

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MIXING AND CIRCULATION OF ICE SHELF AND OCEAN WATERS IN PINE ISLAND BAY DERIVED FROM SST AND SEA ICE

We derive sea-ice motion in Pine Island Bay (PIB) from high-resolution (MODIS) images, and
compare to circulation patterns visible in the bay in ice-free SST data products. Landsat thermal
images of the sea surface skin layer show warm sub-shell outflow mixing into the persistent
PIB cyclonic gyre also delineated by shipboard Acoustic Doppler Current Profiling. We review
multiple satellite thermal products and discuss which are sensitive enough to detect the warm
sub-shell outflow. (Abstract ID 9919)

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PIEB cyclonic gyre also delineated by shipboard Acoustic Doppler Current Profiling. We review
multiple satellite thermal products and discuss which are sensitive enough to detect the warm
sub-shell outflow. (Abstract ID 9919)

DetaiLED FLOW CYTOMETRIC CHARACTERIZATION OF PICOPHOTO plankton ACROSS THE UPPER BOUNDARY OF THE OXYGEN MINIMUM ZONE IN THE EASTERN TROPICAL NORTHERN PACIFIC

Oxygen minimum zones (OMZs) in the eastern tropical Paciﬁc and Arabian Sea are
characterized by the development of a secondary chlorophyll maximum if suboxic water
penetrates the lower euphotic zone. In the eastern tropical north Paciﬁc, picophytoplankton
within the primary chlorophyll maximum at the base of the mixed layer include
Prochlorococcus and multiple populations of Synechococcus and picophytoeukaryotes. While
all picophytoplankton decreased in abundance from the primary chlorophyll maximum to the
upper boundary of the OMZ, the fate of phytoplankton within the OMZ varied signiﬁcantly.
Picophytoeukaryotes disappeared while Prochlorococcus increased by an order of magnitude,
to peak in abundance at the secondary chlorophyll maximum. Synechococcus abundance either
increased within the OMZ, or stayed relatively constant across the suboxic boundary. The
abundance of Synechococcus in suboxic water was higher than expected, with Synechococcus
accounting for up to 20% of total cyanobacteria numbers. However, chlorophyll ﬂuorescence
per cell in Prochlorococcus increased across the suboxic boundary to a greater extent than
observed in Synechococcus. We hypothesize that Prochlorococcus is a more effective competitor
for nutrients (perhaps iron) at the suboxic boundary than Synechococcus. (Abstract ID 12561)

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DESIGN AND TESTING OF A PORTABLE MASS SPECTROMETER FOR SHIPBOARD MEASUREMENT OF DISSOllVED NITROUS OXIDE

Measurements of a suite of noble gases in surface waters can be used to quantify air-sea
exchange, due to their widely varying physiochemical properties. We are developing a
portable mass spectrometer that is capable of measuring Ne, Ar, Kr, and Xe in seawater.
Equilibrator inlet mass spectrometers have recently been used to collect continuous at-sea
measurements of O$_2$/Ar ratios in seawater. The instrument uses a cartridge filled with a
membrane that is permeable to gas but not water to equilibrate gases between the seawater
and a headspace. The headspace is continuously sampled and flows through a capillary into a
capodudrop mass spectrometer. We compare the use of porous versus nonporous membranes
for fully equilibrating of all the noble gases (which, unlike O$_2$, Ar, and Kr have a wide range
of permeabilities). To improve the instrumental detection limit, we use chemical purification to
isolate the inert noble gases in the gas stream. The relative effectiveness of two different getter
alloys for this purpose is discussed. The instrument will enable noble gas measurements with
unprecedented resolution in surface water. (Abstract ID 1891)

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BIOGEOCHEMICAL AND OPTICAL ANALYSIS OF COASTAL DOM FOR SATELLITE RETRIEVAL OF TERRIGENOUS DOM IN THE U.S. MIDDLE ATLANTIC BIGHT

Estuaries and coastal ocean waters experience a high degree of variability in the composition
and concentration of particulate and dissolved organic matter (DOM) as a consequence
of riverine/estuarine ﬂuxes of terrigenous DOM, sediments, detritus and nutrients into coastal
waters and associated phytoplankton blooms. Our approach integrates biogeochemical
measurements (elemental content, molecular analyses), optical properties (absorption)
and remote sensing to examine terrestrial DOM contributions into the US, Middle Atlantic
Bight (MAB). We measured lignin phenol composition, DOC and CDOM absorption within the
Chesapeake and Delaware Bay mouths, plumes and adjacent coastal ocean waters to derive
empirical relationships between CDOM and biogeochemical measurements for satellite
remote sensing application. Lignin ranged from 0.03 to 6.6 ug/L between estuarine and outer
shelf waters. Our results demonstrate that satellite-derived CDOM is useful as a tracer of
terrigenous DOM in the coastal ocean. (Abstract ID 12093)

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**Long-term variability of sea surface temperature (SST) annual cycle in the subpolar North Atlantic under a changing climate is investigated. SST annual cycle variation impacts the hydrographic conditions and local ecosystems in the upper ocean, and is studied using a 140-year global SST product (HadSST1). Statistical techniques show the amplitudes of the annual cycle, represented by the differences between the coldest and warmest SSTs in each year, have changed on a multi-decadal scale. Variation peaks in the mid-20th century in shelf areas, whilst approaching a minimum in the open ocean. Annual cycle amplitudes increase more rapidly after 1995 compared with previous decades. After 1995, warmer basin-wide summers, warmer eastern subpolar winters, yet colder western subpolar winters are observed. Winter and summer SST variations in the open ocean show slight differences, compared with stronger differences in shelf seas. Basin-wide and local SST controlling processes are dependent on season (Winter/Summer) and location (Shelf Sea/Open Ocean). Observed variations are explained in the context of variability in atmospheric forcing and large-scale ocean circulation. (Abstract ID 9485)**

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**Physiology and Life-cycle traits explain the different phenologies of co-occurring Calanus congeners in the sub-Arctic St-Lawrence Estuary**

The understanding of planktonic species biogeography can be improved by a better mechanistic understanding of physiological and behavioural responses of individuals to their environment. We developed a generic ecospace model that implements development, growth and the key life-cycle traits based on first principles of biology and physiology. This model was successfully parameterized and tested for three Calanus congeners. It is now applied to the sub-Arctic St-Lawrence Estuary where C. finnarchicus, C. glacialis and C. hyperboreus co-occur. Climatological records of Calanus spp abundances show distinct phenologies with C. hyperboreus, C. glacialis and C. finnarchicus recruiting successively. Using life-time egg production integrated over successive generations as a measure of fitness, we show that the different phenologies of the three congeners can be explained by key elements of their life-cycle strategies: the ability to produce eggs from lipid stores, to withstand starvation as a nauplii and to remain dormant at depth during an extended period of the year at different development stages. The potential for competitive exclusion by predation on eggs is also explored. (Abstract ID 12425)

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**OXYGEN AND DI-NITROGEN (N2) DYNAMICS IN THE HYPOXIC ZONE OF THE ST-LAWRENCE ESTUARY**

Di-nitrogen (N2) is the terminal end product of denitrification and ammonox that eliminates...
fixed-N from ecosystems. N loss is critical given the key role of N in coastal eutrophication. The Lower St-Lawrence Estuary (LSLE) is a heavily stratified ecosystem, where persistent hypoxic conditions have established and steadily increased over the last 30 years. In order to estimate N loss, we tracked the change in N contents along an isopycnal that progressively loses oxygen as it moves landward from the Laurentian Channel into the LSLE. We found a strong relationship between N excess and the O2 deficit in the LSLE, where excess N could be predicted with an r^2=0.84. We estimate fixed-N losses from the change in N excess along the isopycnal of around 685-1370 μmol N m^-2. Compared with other methods estimating fixed-N loss, we found that our lower estimate corresponds with the higher estimates determined in core incubations, whereas our higher estimate, corresponds to the lower estimate as predicted using N. Using excess N represents however the most integrative approach at the basin scale. (Abstract ID 12520)

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DECadal CHange and Regional Trends of pH throughout the Southern Ocean
Recent studies show that the Southern Ocean is experiencing changes in its carbon chemistry due to the uptake of anthropogenic carbon dioxide (CO2) from the atmosphere, a process that lowers the pH. These changes have reduced the surface carbonate concentration of the Southern Ocean by more than 10% when compared to preindustrial levels. Here, we use total alkalinity, dissolved inorganic carbon, and the partial pressure or fugacity of CO2 to quantify the change of pH throughout the Southern Ocean. We calculate pH at every location where two of the parameters were measured on over sixty hydrographic cruises, creating an array of new pH data. Profiles of decadal pH change from multiple repeat cruises are used to determine focus regions where pH change is most dramatic for further trend analysis. Using measurements from the 1970s to the present day we examine the vertical and spatial heterogeneity in trend patterns, and comment on the statistical significance of pH trends. Implications of these results will be used to assess carbon-climate model performance. (Abstract ID 10862)

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SEA Surface Observations in the Vicinity of a Shelf Sea Front
A comprehensive set of observations of the sea surface has been collected in 09/2011 in the vicinity of a sharp tidal front in the Iroise Sea (shelf sea to the West of France). The data set comprises air/sea momentum and heat fluxes, atmospheric boundary layer wind profile, measured using a shipborne LIDAR, IR skin SST measurements and sea state observations, direct and acoustic noise measurements, C-band disdrometry and stereo photography. The influence of the SST front on these parameters will be presented. (Abstract ID 11017)

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RESPONSE OF OCEAN ECOLOGY TO CLIMATE CHANGE: AN INITIATIVE FOR ATS EARTH SYSTEM MODEL INTER-COMPARISON
We assess the response of ocean ecology to 21st century climate change across some of the new IPCC AR5 Earth System Models. These models have very different ocean ecology models, resulting in different phytoplankton community structures and complexities, different surface chlorophyll and productivity, and ultimately different ecological responses to climate change. Here we provide an assessment of climate driven changes in the extent, productivity, community composition and organic matter export across the major biogeochemical provinces in the ocean in our model suite. We observe different phytoplankton behavior in the Northern and Southern Hemispheres subpolar and subtropical regions; we verify whether this hemispheric asymmetry is driven by the different shifts in the midlatitude westerlies in the Northern and Southern hemispheres. We employ both new and old tools and metrics to relate trends in stratification, mixing and wind patterns to changes in ecology and biogeochemistry under climate change. (Abstract ID 12779)

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FROM CHLOROPHYLL TO ADVANCED OCEAN COLOR PRODUCTS: A REVIEW
From the infancy of satellite ocean color with CZCS to the current generation of global ocean color sensors (SeaWiFS, MODIS, MERIS), the subsurface chlorophyll-a concentration is the historical, most known and most used satellite ocean color product. However, over the last decade, a variety of new and innovative products have been derived from ocean color satellite measurements. Spectral apparent and inherent optical properties, Net Primary Production (NPP), Phytoplankton Functional Types (PFTs), particle size indices, components of the carbon pool or merged products from multiple sensors are examples of these new products now available for marine biogeochemistry and carbon cycle research. Here, we review some of these products, their possible use in ocean science and the remaining challenges for the future. (Abstract ID 11456)

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DOES CHANGJIANG DISCHARGE INFLUENCE NANO-MICROPLANKTON SIZE STRUCTURE IN THE EAST CHINA SEA?
Size structure of marine plankton has been suggested to be good indicators of ocean environmental conditions in some cases, while results are ambiguous in others. More empirical validation of the efficacy of size-based indicators is needed. Here, we examined abundance, biomass, and size spectra of nano-microplankton, as well as physicochemical parameters, at 42 stations during 13 cruises in the East China Sea. We hypothesize that nano-microplankton (< 200 μm) size structure is mainly controlled by the physicochemical environment and therefore, should vary with changing conditions. We found the highest N and Si nutrients and N/P ratios along the China coast, as expected. Following the same spatial pattern, the distribution of total nano-microplanktonic biomass showed greatest values at the shallow coastal stations. However, nano-microplanktonic size spectra did not show a similar spatial pattern. Our results challenge the bottom-up based argument in explaining plankton size spectra. We suggest that top-down control on nano-microplankton might be responsible for weakening the signal of environment/ size structure relationships in the nano-microplankton size spectra analysis. (Abstract ID 9682)

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ROSSBY WORMHOLES
The influence of bottom topography on the westward propagation of long, baroclinic Rossby waves is studied in a two-layer ocean model. In the limit of a thin upper layer, scaling analysis suggests that the waves should be insensitive to variable bottom topography; however, this can break down over closed /H contours, where f is the Coriolis parameter and H the ocean depth. An integral constraint is derived in the planetary-geostrophic limit, showing that the net radiative flux of upper layer thickness anomalies into a closed f/H contour, at its eastern margin, is balanced by an equivalent radiation of upper layer thickness anomalies out of the closed f/H contour at its western margin. The consequence is that westward-propagating upper layer thickness anomalies can partially disappear on one side of a closed f/H contour and, near instantaneously, reappear on the other - a "Rossby wormhole". This partial (upwelling) westward propagating upper layer thickness anomalies across an /H contour is accomplished by conversions between the baroclinic and barotropic wave modes, and the generation of transient barotropic recombinations around the f/H contour. The Rossby wormhole mechanism is illustrated in a series of numerical calculations. A corollary is that reduced-gravity models of the large-scale ocean circulation can break down in the presence of closed f/H contours, even when conventional scaling requirements for its validity appear to be satisfied. (Abstract ID 11306)

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DIAGNOSING THE OBSERVED SEASONAL CYCLE OF ATLANTIC SUBTROPICAL MODE WATER USING POTENTIAL VORTICITY AND ITS ATTENDANT THEOREMS
The flux form of the potential vorticity equation and its attendant theorems are used to map the creation and subsequent circulation of potential vorticity subshell mode waters (STMW) in the North Atlantic using analyzed f

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ESTIMATING FIXED-N LOSS, WE FOUND THAT OUR LOWER ESTIMATE CORRESPONDS WITH THE HIGHER
elds of ocean circulation. Novel mapping techniques are applied to render the seasonal cycle and annual-mean mixed layer vertical flux of potential vorticity (PV) through outcrops, extracting PV from the mode water layer in winter, over and to the south of the Gulf Stream. The subsequent path of STMW is also mapped using Bernoulli contours on isopycnal surfaces. Both buoyancy loss and wind forcing contribute to the extraction of PV, but we
Spatial and temporal variability in pH and pCO2 at Conch Reef, Florida Keys Marine Sanctuary on the outer reef tract off Key Largo, were monitored in situ for eight days as part of an ocean acidification study during an Aquarius Reef Base (ARB) saturation dive mission, August, 2011. Continuous pH measurements were made by one SEASII and two Atlantic SeafET instruments. Continuous pCO2 measurements were made by underwater membrane inlet mass spectrometry (MMIS-Monitor Instruments). SEASII and MIMS instruments operated in cabined mode providing near real-time data. Power and communications were provided by the ARB Life Support Buoy (LSB). SeafET instruments operated as independent, diver-deployed pH sensors using battery power. Experiments were focused on quantifying the roles of local benthic respiration and water transport on near-bottom aragonite saturation over coral, algal and sponge substrates. CTD measurements, optode oxygen and MIMS argon and other gas measurements accompanied data collection. Sponge-dominated benthic respiration and local water transport controlled observed pH variations. Aragonite undersaturation was enhanced in the benthic boundary layer. In situ sensor comparisons revealed strong correlations between independent pH and MIMS pCO2 data. (Abstract ID 12087)

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DECADAL VARIABILITY OF PHYTOPLANKTON ABUNDANCE IN THE SUBPOLAR NORTH ATLANTIC THROUGH ATMOSPHERIC AND OCEANIC CONNECTIONS

Modeling studies diverge about the past decadal evolution of phytoplankton in the subpolar North Atlantic. Long time series of phytoplankton observations are actually available in this region. They have not yet been investigated in parallel with physical forcing to understand their variability. Here, we investigated the multi-decadal variability of phytoplankton and the underlying mechanisms, using five years (1990s to present) of in situ observations from the continuous plankton recorder survey, combined with satellite ocean color observations, model reanalyses and products. We show parallel phytoplankton increase and deepening of the mixed layer depth (MLD) since the 1960s. This MLD deepening was related to a strengthening of the winds and net heat loss of the ocean after the mid-1980s, in agreement with the low frequency signal of the North Atlantic Oscillation. Moreover, the decadal increase of sea surface temperature (SST) reported in this region was not associated with shallower MLD. Therefore, our results run counter to the usual paradigm that a global-warming-induced increase in stratification in subpolar areas should be paralleled by a SST increase and a phytoplankton decrease. (Abstract ID 11131)

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MODELLING OF THE INTERACTION BETWEEN LANGMUIR CIRCULATION AND A TIDAL CURRENT THROUGH LES COMPUTATIONS

Langmuir circulation is known to serve as an effective mechanism for sea surface renewal of low concentration fluid and thus is known to increase mass transfer fluxes at an air-ocean interface. We study the impact of a current on the turbulent structure of a wind driven flow with and without Langmuir circulation. Large Eddy Simulation with a solid bottom and a free surface is used to evaluate the effect of a current crossed with the wind stress and colinear with the wind stress with equal contribution of each component to a constant bottom stress. The results obtained are compared to those of similar computations of pure wind driven or pure current flow with the same methodology and show that despite a strong contribution of current to the bottom stress, Langmuir circulation remains the dominant process in the flow. (Abstract ID 11578)

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NEAR-INERTIAL INTERNAL WAVES AND MIXING ON THE BEAUFORT CONTINENTAL SLOPE

In the Arctic, internal wave induced mixing is small due to weak tides and a weak wind-generated internal wave field that is damped by sea ice. Using data from a yearlong (August 2008-2009) deployment of a moored array on the Beaufort continental slope, we examine the evolution of the near-inertial internal wave field from ice-free to ice-covered conditions and how changes in the strength of the ice pack between these two extremes both allow and inhibit internal wave generation and mixing. Near-inertial kinetic energy (KE) is largest when the moorings are ice-free and decreases when ice-covered. In winter, near-inertial KE ‘bursts’ comparable to ice-free conditions are observed propagating 500m into the ocean interior. Reduced ice-cover or ice pack strength may allow for the observed wintertime generation. Strong atmospheric forcing does not always produce a near-inertial response in water or ice motion, suggesting the ice structure inhibits internal wave generation. Reductions in seasonal and multiyear ice may increase the extent of ice conditions favorable for internal wave generation, allowing more internal wave induced mixing in the Arctic. (Abstract ID 12121)

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AUTONOMOUS OBSERVATIONS OF PH DYNAMICS ACROSS MULTIPLE ECOSYSTEMS

ISFET pH sensors have recently gained popularity in the oceanographic community. Since 2009, an increasing number of these sensors have been employed to autonomously record the pH of seawater. Sensors built at SIO have been deployed in a variety of ecosystems including: polar, tropical, open-ocean, coastal, keel forest, and coral reef. These observations reveal a continuum of month-long pH variability with standard deviations from 0.004 to 0.277 and ranges spanning 0.024 to 1.490 pH units. The nature of the observed variability is also highly site-dependent, with characteristic diel, semi-diurnal, and stochastic patterns of varying amplitudes. These biome-specific pH signatures disclose current levels of exposure to both high and low dissolved CO2 and demonstrate a highly dynamic pH environment in many coastal settings that may be an important consideration for those planning CO2 perturbation experiments for Ocean Acidification studies. (Abstract ID 11522)

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OCEAN ACIDIFICATION IN THE SUBARCTIC WESTERN NORTH PACIFIC OCEAN

Rising atmospheric CO2 contents have led to greater CO2 uptake by the oceans, lowering both pH and CaCO3 saturation states due to declining CO2*. Here we found that pH in winter mixed layer calculated from total alkalinity (TA) and dissolved inorganic carbon (DIC) was decreasing at -0.0010 ± 0.0004 pH yr⁻¹ from 1997 to 2011 in the western subarctic gyre; this region is a source of atmospheric CO2 in winter due to vertical mixing of deep waters rich in DIC. This rate was lower than that expected from oceanic equilibration with increasing atmospheric CO2 (−0.0021 pH yr⁻¹), which is caused by the reduction of CO2 emission in winter due to the increase of TA. Below the mixed layer, the calcite saturation horizon (~190m) has shoaled at -2.7 ± 0.9 m yr⁻¹ induced by declining carbonate ion (-0.023 ± 0.009 µmol/kg). Between 200m and 300m, the acidification (~0.0051 ± 0.0011 pH yr⁻¹) was the highest in the open North Pacific. This enhanced acidification is influenced by the increases of oceanic CO2 uptake and biological carbon remineralization, which suggests the increase of dissolution of CaCO3 particles. (Abstract ID 11041)

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BLACK CARBON: DOES IT SINK OR FLOAT?

Black carbon (BC) is a major component of marine sedimentary organic matter, playing an important role in the long-term burial of carbon in the Earth system. However, the processes by which BC travels from fires to deep-sea sediments remain unclear. Understanding the role of BC in the ocean will require understanding the controls on these input fluxes. Density and porosity are fundamental characteristics of any environmental material, and for BC, these properties help determine the likelihood of rapid, long distance fluvial transport to the ocean or of long term residence in soils. However, little density data and no porosity data exist for BC, at least in part because of the analytical challenges associated with measuring these properties in highly porous materials. Here we review techniques available to measure the density and porosity of BC, focusing on two measurements: skeletal density (the density of the solid component of BC), and envelope density (the mass of a BC sample divided by the volume of its exterior envelope). We present skeletal and envelope density data for a series of laboratory-produced charcoals, showing that the skeletal density of charcoal is significantly greater than 1.0 g/cm³, while the envelope density is significantly less than 1.0 g/cm³. This difference means that one control on the environmental fate of particulate BC is the speed with which interior pores fill with water. (Abstract ID 11768)

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FRONTAL CREATION AND DETECTION IN THE GALAPAGOS REGIONAL NAVY COASTAL OCEAN MODEL

The operational Galapagos Regional Navy Coastal Ocean Model (GALAP-NCOM) encompasses the domain from central Baja California to the southern extent of the South Equatorial Current (SEC). The fidelity of the modeled frontal region between the SEC and the North Equatorial Counter Current (NECC) will be compared to the Tropical Atmosphere-Ocean (TOGA)/TAO) array data, which were not assimilated into the model. Also, the Naval Oceanographic Office is implementing an operational automated frontal detection algorithm to be used on model output. Results from the GALAP-NCOM domain evaluation will be shown, and the multi-parameter front detection procedure will be discussed. Generally, the model compared well with the array data, and the automated front detection software captured the important fronts in this area. (Abstract ID 10364)

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A SIMPLE, MANUALLY-OPERATED, FREE-RISING CTD; COMPARISON WITH CONVENTIONAL CTD.

The mechanical control of a simple, cost effective, free-rising CTD is described. The instrument is based on a conventional CTD model, but produces undisturbed profiles with good resolution up to the sea surface. The free-rising CTD allows the depth-correction of the pressure changes introduced by low frequency surface waves. Depth corrected data are shown and compared with conventional CTD profiles. Daytime profiles off the northern Baja California Pacific coast usually demonstrated a near surface (~2m) temperature stratification particularly evident during a red tide event. (Abstract ID 12765)

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CONTROL MECHANISMS OF VOLUME AND FRESHWATER EXPORT THROUGH THE CANADIAN ARCTIC ARCHIPELAGO

This study examined volume and freshwater fluxes through the Canadian Arctic Archipelago (CAA) and into the Labrador Sea using a high resolution coupled ice-ocean model of the pan-Arctic region to investigate control mechanisms of this exchange. In Naes Strait and Lancaster Sound, volume flux anomalies were controlled by the sea surface height (SSH) gradient anomalies along the straits and freshwater anomalies were highly correlated with the volume anomalies. At least half of the variance in the time series of SSH gradient anomaly was due to SSH anomalies in northern Baffin Bay. The West Greenland Current (WGC) exhibits
seasonality, with cross shelf flow (into the Labrador Sea) peaking in winter, while reducing the northward flow across eastern Davis Strait. We hypothesize that the eddy-reduced northward flow of WGC results in the lower volume and SSH in Baffin Bay. This maximizes the SSH gradients between the Arctic Ocean and Baffin Bay, leading to maximum winter volume fluxes through Nares Strait and Lancaster Sound. (Abstract ID 12621)

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LOW FREQUENCY VARIABILITY OF THE SURFACE WATERS OF COASTAL BRITISH COLUMBIA

Long term records of monthly mean data from lighthouse stations are used to characterize climatic variability and secular trends in sea surface temperature (SST) and sea surface salinity (SSS) over coastal British Columbia waters. The leading modes in a principal component analysis of SST and SSS anomalies represent 68% and 59% of the variance, respectively. These modes show in-phase co-variability along the entire coast on interannual to decadal time scales. A red noise power spectrum provides a good fit to the leading principal components. While the de-correlation time scale for temperature is similar to that of Station P in the northeast Pacific, the de-correlation time scale for salinity is much shorter, suggesting that local processes drive SSS variability. The principal component for temperature, on the other hand, is closely related to the Pacific Decadal Oscillation (PDO), indicating that coastal SSS are driven by large-scale atmosphere/oceanic processes that are associated with those that drive the PDO. Unusual changes are observed at certain individual stations, including a pronounced non-stationarity in the SSS record that may be associated with changes in the local hydrological cycle. (Abstract ID 9338)

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DEVELOPMENT OF AN EDDY-PERMITTING MARINE ECOSYSTEM MODEL (MEM)

In order to explore impacts of climate change on marine ecosystem, we developed a marine ecosystem model with a horizontal grid spacing of 0.28 x 0.19 degree. The computational domain covers the global ocean. The ecosystem model, MEM 1.3 is coupled with the physical part by an offline method. In the physical part, we used data calculated in MIROC4 (The Model for Interdisciplinary Research on Climate), which consists of five component models: atmosphere, land, river, sea ice, and ocean. The ecosystem model considers two types of phytoplankton, three types of zooplankton, and four nutrients: dissolved nitrate, ammonia, silicate, and iron. The model simulates well distribution of nutrients and chlorophyll. Too much biological production around the equator which often arises in ecosystem models does not occur in the model. The spatial distribution of the species composition of zooplankton is comparable with that obtained by remote sensing. (Abstract ID 11176)

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OBSERVING A YEAR OF BENTHIC COMMUNITY RESPONSES TO FLUCTUATING HYPoxic CONDITIONS THROUGH THE VENUS Cabled NETWORK

This study examines the response of macrofauna to oxygen levels over the course of a year. Saanich Inlet, on the west coast of Canada, is a highly productive fjord where extreme hypoxia has a seasonal signal. One study site on VENUS, a cabled subsea observatory, is located in the hypoxic zone at 104 m depth. We conducted a high-resolution time-series photographic survey to determine animal abundances in relation to changes in environmental variables. Photographs were taken with a remotely-controlled still camera every 2 to 3 days over 13 months, and we examined community composition, species behaviour and microbial mat features. Dissolved oxygen concentrations varied between 0.1 and 2.5 ml l-1 showing seasonal change. However, variability on short time-scales (hours) was very high. During extreme hypoxia, microbial mats developed then disappeared as a spirotrichon shrimp appeared in high densities despite near anoxia. The slender sole was abundant in extreme hypoxia and may be responding to changes in the depth of the diurnal migration of zooplankton. While squat lobsters were common at all times, juveniles disappeared in fluctuating conditions. Animal densities were high indicating that risk from hypoxia is balanced by factors such as food availability and escape from predators. Saanich historical data document a decline of average oxygen at this depth and it is likely the benthic community has shifted away from less tolerant commercial species. (Abstract ID 9611)

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SHELFBREAK FRONTS AND CROSS-SHELF EXCHANGES IN WESTERN BOUNDARY REGIONS

We discuss the formation of shelfbreak fronts and the mechanisms controlling cross-shelf exchanges in regions bounded by cyclonic and anticyclonic western boundary currents. Our discussion is based on a series of highly idealized, process-oriented, numerical simulations. We investigate the sensitivity of the shelfbreak fronts and the magnitude of the cross-shelf exchanges to the intensity of the local and the global wind stress forcing, the slope of the bottom topography and the stratification of the basin. It is shown that the confluence of the western boundary currents leads to the formation of a density compensated front over the shelf, which is a preferential region for cross-shelf exchanges. Our analysis is complemented with the discussion of realistic simulations of the southwestern South Atlantic region and observations. (Abstract ID 11524)

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OCEAN ALCIFIDICATION AND THE SUPPRESSION AND UNDERSATURATION OF CARBONATE MINERAL SATURATION STATES IN THE PACIFIC-ARCTIC REGION

Rising carbon dioxide levels (CO2) in the atmosphere and ocean have lead to an anthropogenically induced acidification phenomenon in high latitude seas, which are projected to become permanently undersaturated with respect to important carbonate minerals as early as mid-century. However, seasonal undersaturations have already been observed in surface and shallow subsurface waters in the continental shelf seas surrounding Alaska, where multiple biogeochemical influences impact pH and carbonate mineral saturation states. Some calcifying marine organisms, including pteropods, foraminifera, and mollusks that could be susceptible to reduced calcification rates under increasing ocean acidity are keystone species in the Pacific-Arctic region. Here, we present new data from recent ship-based observations and moored platforms in the northern Gulf of Alaska, the Bering Sea, and the Western Arctic Ocean that show the extent and controls on ocean acidification in each region. These unique findings show that the intrusion of anthropogenic CO2 is only one of several factors that include riverine and glacial runoff, the biological pump, and sea ice that control seasonal carbonate mineral suppression and undersaturation in the Pacific-Arctic region. (Abstract ID 9478)

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THE AUTONOMOUS POLAR PRODUCTIVITY SAMPLING SYSTEM (APPSS)

We examine the long-term, seasonal variability of chlorophyll, particulate organic carbon, nitrate and dissolved oxygen concentrations, temperature, and salinity in the Greenland Sea in summer 2011, using an APPSS profiling APEX/APEX float. Deep water values (1000 m) are used to detect sensor drift. Our goal is to record data throughout the year, but only report in open water conditions, while avoiding sea ice. Delicate buoyancy management in APEX floats is required to overcome the extreme stratification recently observed in the western Arctic Ocean. Sensors include an angled Iridium antenna; Wetlabs FLBR fluorometer / backscatter sensors (700 nm; 470/695 nm); an ISUS nitrate sensor; a Seabird CTD; and an Aanderaa optode O2 sensor. This combination of sensors will allow time series of warming, stratification/ mixed layer depth, estimated phytoplankton biomass and derived primary production, as well as to estimate seasonal new production and net community production. These very new data will be placed into a larger context, e.g., to determine the extent to which lateral advection might also be influencing the results by using satellite ice concentration, SST, and ocean color imagery as well as document the full annual growth season. (Abstract ID 12492)

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SUBAREAL CHLOROPHYLLMAXIMUM IN THE WESTERN PACIFIC SUBARCTIC GYRE DURING EARLY SUMMER

Phytoplankton abundance is often developed during early summer in the western Pacific subarctic gyre. This enhances the export carbon flux into the ocean interior. We conducted the hydrographic observations repeatedly between June and July in 2006 at the time-series station in this region and observed high concentration of chlorophyll-a which exceeded 1 µg/l at the surface in early June. Surface mixed layer became shallow in association with developing thermal stratification from mid-June. Development of phytoplankton abundance is expected in
the shoaled surface mixed layer, because light condition will be improved by reduced mixing. However, chlorophyll-a concentrations were decreased in that layer and its vertical profiles showed subsurface maximum. Chlorophyll-specific primary productions were further increased after the mid-June than before, while primary production was occasionally inhibited by decreasing of surface irradiance due to a dense sea fog. Ammonium concentrations increased with decreasing chlorophyll-a in the surface mixed layer, probably because the produced ammonium through grazing and decomposition exceeded consumption by phytoplankton. It suggested that subsurface chlorophyll maximum was formed due to enhanced zooplankton grazing in the shoaled surface mixed layer. (Abstract ID 10155)

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BODY CHEMICAL CONTENTS AND GUT PIGMENTS OF COPEPODS IN THE WESTERN ARCTIC OCEAN DURING SUMMERS OF 2008 AND 2010

To evaluate the effects of drastic sea-ice reduction on copepods, we studied body chemical contents (water and ash-free dry mass content) and gut pigments of large copepods in the western Arctic Ocean during summers, 2008 and 2010. Calanus glacialis had the highest ash-free dry mass, Calanus hyperboreus the highest water content, and Metridia longa the highest gut pigment. These species-specific differences in chemical contents and gut pigments presumably relate with their life cycle patterns (i.e. diapause or active feeding). For dominant copepods, ash-free dry masses (indices of lipid accumulation) were higher in the western area 2008 than those in the other areas and 2010. Hydrography in the western area 2008 was characterized by high salinity and high nutrients because of less ice-needle water. In the middle and eastern areas during 2010, intensive sea-ice reduction increased ice-melt water, and decreased nutrients and primary production, and it was thought to result in less lipid accumulation by the copepods. Thus, the drastic sea-ice reduction would have a negative impact (less lipid accumulation by copepods) in the Arctic Ocean. (Abstract ID 9692)

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SIGNATURES OF MICROPYCNIC-LIKE AMINO ACIDS (MAAs) IN LIGHT ABSORPTION SPECTRA OF COLORED DISSOLVED ORGANIC MATTER (CDOM) IN ICE MELT CHUCHKI SEA WATER

Colored dissolved organic matter (CDOM) plays various roles in physical and biogeochemical processes. We investigated light absorption coefficients of CDOM [aCDOM(dimethyl)] and using a UltraPath liquid waveguide system (WPL Inc.) equipped with a 2 m capillary tube, in the Chukchi Sea during ice-melting in spring as part of the ICESCAPE2010 Arctic expedition. Absorption bands in aCDOM(dimethyl) spectra at 330 and 360 nm were clearly observed especially in ice-melt water seas. Both microtrophic and high-performance liquid chromatography (HPLC) analyses confirmed that dimethylfaggulates were present in these waters. Based on those results, the bands in aCDOM(dimethyl) were considered as originating from micropyenic-like amino acids (MAAs). Using a simple index, we detected the signatures of MAAs from aCDOM(dimethyl) spectra in the Chukchi Sea. This spatial distribution was significantly correlated with the decrease in sea ice concentration from June to July 2010 (p < 0.01). Implications of the presence of MAAs for Arctic waters in the context of recent sea ice reduction are discussed. (Abstract ID 11179)

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RESONANT INTERACTION OF NEAR-SURFACE BUOYANCY DRIVEN CURRENTS WITH AMBIENT STRATIFICATION

Buoyancy-driven surface currents, such as river or rain-formed plumes, are an important component of the oceanic environment. These currents contribute to the vertical and horizontal water mass exchange. We simulate the dynamics of low-density plumes and their interaction with ambient near-surface stratification (e.g., a thermoline). High-resolution numerical simulations of near-surface buoyancy-driven currents in a stratified ambient were conducted using the computational fluid dynamics (CFD) software ANSYS Fluent. As the near-surface plume propagates into the stratified environment, the interaction with the ambient stratification can lead to internal waves and a fragmentation of the plume. These results are consistent with observations of freshwater plumes in the Western Equatorial Pacific during TOGA COARE. We combine the results from the CFD model with a radar imaging algorithm to simulate the sea surface signature in synthetic aperture radar (SAR) images. SAR satellite imagery can be an important tool to monitor processes in the near-surface layer of the ocean. The fragmentation of the plume can be seen as alternating bands in the sea surface signature in the simulated radar images. (Abstract ID 11477)

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TEMPORAL AND SPATIAL DEPENDENCE OF PLANKTON PARAMETERS IN A BIOLOGICAL OCEAN MODEL

Using a statistical emulator technique, we estimate time-dependent values for two parameters of a 3-dimensional biological ocean model. We obtain values for the maximum phytoplankton carbon-to-chlorophyll ratio and the maximum zooplankton growth rate by minimizing the misfit between simulated and satellite-based surface chlorophyll. The misfit is measured by a spatially averaged, time-dependent distance function. A cross-validation demonstrates that the influence of outlying data can be diminished by smoothing the distance function in time. The optimal parameter values estimated on the smoothed distance function exhibit a strong time-dependence. Using these time-dependent parameters, we derive state estimates that agree better with the observations than model estimates with optimal, constant parameters. The time-dependence of the parameters can be motivated biologically by naturally occurring seasonal changes in the composition of the plankton community. Our results suggest that optimal time-dependent parameters will result in a better representation of plankton dynamics in typical biological models. We further demonstrate that emulator techniques are valuable tools for data assimilation and for analyzing and enhancing biological ocean models. (Abstract ID 9425)

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THREATS TO THE CORALS OF THE GALÁPAGOS ISLANDS AND THE EASTERN EQUATORIAL PACIFIC OCEAN

Matthew Ware Christopher Newport University Senior, Dept of Organismal & Environmental Biology J. Keith Moore University of California, Irvine Dept of Earth System Science Irvine, CA Galápagos straddles the equator 1,000 km off of Ecuador. The seasonal and ENSO timescale variability of the currents in this region expose corals here to numerous environmental conditions, creating a patchy distribution with reduced cementation. These corals may be a proxy for coral development in future temperature- or pH-stressed oceans. This project compares present day conditions in Galápagos and the Eastern Equatorial Pacific to potential future conditions described by the Community Earth System Model (CESM2/CCLM). We examined a time series of AVHRR satellite SST, SeaWiFS ocean-color chlorophyll data, and compiled field observations from this region for comparison to CESM simulated temperature, pH and dissolved inorganic carbon chemistry from the 1990s and model-predicted environmental conditions from the 2090s, under the strong-warming RCP8.5 scenario. Assuming no adaptation, coral development in Galápagos will be seriously threatened under the projected 2090s conditions. SSTs would be above the current bleaching threshold, while lower pH/higher pCO2 would decrease Larag. Increasingly patchy distributions and increased mechanical and biological erosion would be expected at reefs across the Eastern Equatorial Pacific as corals would have difficulty replacing damaged sections. (Abstract ID 10233)

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MONITORING METHANE FLUXES WITH AN INTEGRATED SEAWATER EQUILIBRATOR AND CAVEY RING-DOWN SPECTROMETER (CRDS): SYSTEM VALIDATION AND APPLICATION

We constructed a compact greenhouse gas flux analysis system that quantifies methane and carbon dioxide fluxes across the air-water interface. The device includes a cavity ring-down sensor...
spectrometer (CRDS) for measuring methane and CO₂ concentrations from the atmosphere and the headspace of a commercially-available Weiss-type equilibrator. The design is a modified version of one deployed in the Gulf of Mexico and elsewhere. The CRDS and equilibrator are linked by an automated gas handling system that alternately supplies the CRDS with gas from the atmosphere and equilibrator headspace. Dissolved concentrations are calculated from headspace gas concentrations using a model of exponential relaxation to thermodynamic equilibrium. Wind speed, water temperature, salinity, and positional data from a sonic anemometer, CTD sonde, and GPS were collated with the CRDS data and time stamped with an NTP server. In August 2011, we conducted laboratory trials and a field trial in an area of active permafrost degradation in the shallow Beaufort Sea AK in tandem with a system of similar design. Both systems measured similar levels of continuous surface water supersaturation during a 110 km survey. (Abstract ID 12130)

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OCEANOGRAPHIC DECISION SUPPORT SYSTEM, A TOOL TO IMPROVE EFFICIENCY OF BIOLOGICAL OCEAN STUDY

The Controlled, Agile, and Novel Observing Network (CANON) team is creating new ways to remotely assess biological ocean conditions and collect samples of microorganisms. In addition to science, the CANON program has an engineering component. The coordination of multiple science objectives and multiple mobile platforms provides a rich problem domain for engineering. MBARI engineering studied the workflow of the CANON science campaigns created requirements for an Oceanographic Decision Support System (ODSS). The team has fielded the ODSS software tool in several CANON experiments. The ODSS has successfully facilitated the scientists to adaptively follow, sense and sample the changing conditions of upwelling driven algal bloom phenomena. The tool provides a set of perspectives that map to the workflow of the experiment. The high level functionality provided in the tool: 1) Situational Awareness: platform trajectory and real time data 2) Logistics and planning of asset deployment. 3) Collaborative discussion workspace 4) Real-time mobile platform control and coordination 5) Data access and analysis The engineering team is following an iterative development process and is hosting the software as an open source project. The presentation will cover the high level requirements, architecture, implementation overview and lessons learned in the CANON experiments. (Abstract ID 12460)

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LABORATORY STUDY OF THERMAL IMPRINTS OF BREAKING INTERNAL WAVES USING INFRARED IMAGERY

Recent studies have suggested that oceanic internal waves, when breaking near the surface, impart a particular thermal imprint that can be detected and identified using airborne infrared (IR) imagery. Characteristics include a narrow warm water front, a broader and colder trailing wake and a series of surface renewal ‘boils’ in the wake. Unfortunately, due to numerous difficulties, it has not previously been possible to fully utilize IR imagery to study breaking internal wave structure. A laboratory experiment has been conducted to generate internal waves (bouncing and non-bouncing) in a stratified water tank (fresh/salt water) and measure corresponding thermal impressions using an IR camera. Thermal gradients are created using colder water in the lower layer and applying overhead heat prior to the test. This project allows for detailed IR imagery at the surface as well as breaking structure visualization using laser-induced fluorescence (LIF) to obtain, for the first time, quasi-3D views of the breaking process. Results should help improve interpretation of field IR imagery to better quantify both the magnitude and prevalence of open-ocean internal wave breaking events. (Abstract ID 10423)

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DYNAMICS OF MARINE DEBRIS, SIMULATED WITH NUMERICAL MODELS

Statistical and diagnostic models are used to study long-term dynamics of objects floating at the sea surface. The statistical model is based of the particle displacement probability density function, derived from trajectories of drifting buoys, and is supplemented by the probability of running aground. The diagnostic model (SCUD) utilizes satellite data of altimetry and wind to assess near-real time surface velocities and its parameters are optimized using drifter trajectories. Numerical experiments with various sources and life times of the model debris help to understand main pathways of the tracer and distributions of its properties within and across individual oceans. The same models are also used to monitor and forecast motion of debris field from tsunami of March 11, 2011. (Abstract ID 12897)

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MASS, NUTRIENTS AND OXYGEN BUDGETS FOR THE NORTHEASTERN ATLANTIC OCEAN

A surface to bottom North-East Atlantic Ocean budget for mass, nutrients (nitrate and phosphate) and oxygen is determined using an optimization method based on climatological data from the World Ocean Atlas 2009 and three surveys of the OVIDE transect (from Greenland to Portugal). Budgets are derived for two communicating boxes representing the North Eastern European Basin and the Irminger Sea. Net biological source/sink terms point to the Irminger Sea as a net heterotrophic system while the North Eastern European Basin is in turn an autotrophic region. Air-sea oxygen fluxes indicate an oceanic oxygen uptake in the two regions. Partitioning the air-sea oxygen flux into abiotic and biotic components, it is found that both contributions are of a similar amplitude in the Irminger Sea while the former is about four times the latter in the North Eastern European Basin. The decomposition of the abiotic flux into a thermal and a mixing component — driven by the mixed layer dynamic — furthermore shows the crucial role played by the latter in estimating the total air-sea oxygen flux. (Abstract ID 11172)

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ON THE SENSITIVITY OF THE DRAKE PASSAGE TRANSPORT TO AIR-SEA MOMENTUM FLUX

An eddy-permitting state estimate and its adjoint are used to analyze the influence of wind stress perturbations on the transport of the Antarctic Circumpolar Current system (ACC) through Drake Passage. The transport is found to be sensitive to wind stress perturbations both along the ACC path and also in remote regions. The time-scale of influence of wind stress perturbations is order 100 days. Regarding spatial scales, the sensitivity of transport to wind stress is relatively smooth in regions of flat topography. In boundary regions and regions with complex topography, however, the sensitivity is enhanced and characterized by shorter length-scales of order 100 km. Positive perturbations to the zonal wind stress usually increase the ACC transport, though the wind-stress curl is of primary influence where the currents are steered by topography. Highlighting locations where the ACC is especially responsive to air-sea momentum fluxes reveals where an accurate determination of atmospheric winds may best enhance ocean model efforts. (Abstract ID 11560)

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A COMPARISON BETWEEN WIND AND TOPOGRAPHICALLY INDUCED VERTICAL VELOCITIES IN THE SOUTH AND SOUTHEAST BRAZILIAN CONTINENTAL SHELVES

When wind blows over the continental shelves, moving with the coast on its right in the Southern Hemisphere, water is directed offshore by Ekman transport. The presence of the coast, acting as a natural barrier, creates a divergence of the flux, and due to conservation of mass, vertical velocities are produced, which is commonly referred to as "coastal upwelling". Vertical velocities in the coastal ocean can also be induced by other mechanisms, such as wind stress curl, known as the Ekman pumping, and due to coastline and bathymetric irregularities that can cause the currents to curve and also produce along-shelf variations in the cross-shelf horizontal shear. A Z-layer steady, wind-driven analytical model is applied to Cabo de Santa Marta (CSM) and Cabo Frio (CF) regions, S and SE Brazil, and comparisons between the wind role and topographic effects on the vertical velocities over these regions are estimated. Results show that for CSM both horizontal shear and "coastal upwelling" dominates, whereas at CF the horizontal shear, coastline curvature and "coastal upwelling" have the same order of magnitude. (Abstract ID 10003)
corresponding to σ_l reduction, following introduction of unleaded gasoline. In contrast, we show here that a similar relationship is evident. Lead concentrations in the Atlantic Ocean clearly show the oceanic response to pollution sources. Along Line P in the Northeast Pacific Ocean PB concentrations and isotopic composition in time and space differ from those along Line P sampled in August 2010. All vertical Pb profiles exhibit maxima at 150-200m corresponding to σ_l = 26.5 – 26.8, however this feature was least prevalent at Station P-26 (aka "Papa") – the furthest offshore station. Calculation of the spiciness parameter along these density surfaces appears to discern two or more distinct water masses with differing Pb concentrations. Identifying the sources of Pb to the northeast Pacific is therefore of interest to interpret the observed spatial and, the lack of temporal, variability, and thus Pb isotopic ratios are being measured. Information regarding Pb sources assists in unraveling the dichotomy of the Atlantic Ocean while assisting in identification of water mass composition and transport, providing potential sources of other micronutrient trace elements. (Abstract ID 12856)

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STRUCTURE AND DYNAMICS OF CROSS-SHELF CIRCULATION IN THE NORTHERN CALIFORNIA CURRENT SYSTEM

Data collected from four mid continental shelf moorings (site depths 47-92 m) deployed on an along-coast distance of 230 km that includes the region impacted by the Columbia River plume (Washington to Oregon) are used to provide a description (through EOF and momentum term analysis) of subtidal cross-shelf flows. Initial results show the vertical structure of the baroclinic cross-shelf circulation consists predominantly of offshore flow at the surface (for equatorward winds) and onshore flow below, as expected. Vertical structure is markedly similar at all sites, but the amplitude is several times greater at the site nearest the Columbia River mouth. Variability is well correlated with local along-shore wind stress off Oregon (r = 0.7 at 2 h lag), but the correlation tends to decrease to the north. Correlations are higher in summer, when winds are predominantly upstream-favorable, than in spring, when winds fluctuate more frequently. Estimates of cross-shelf divergence terms are also larger off Oregon, consistent with decreasing latitude and a steeper bottom slope. Relationships to stratification and low salinity events imparted by the Columbia River plume will be discussed. (Abstract ID 12516)

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OBSERVED OCEAN TURBULENCE SPECTRA FROM ARGO PROFILING FLOATS

The spectral characteristics of turbulence and eddies in the ocean are examined using ARGO profiling float data. Many theories predict the spectral slopes associated with the statistics of ocean macro-turbulence, but there are few observations at depth to guide these discussions. Here, a method developed for estimating the structure function of atmospheric macro-turbulence using rawinsondes is adapted to estimate the structure function and corresponding spectral slope of oceanic macro-turbulence using data collected by ARGO profiling floats. Horizontal structure functions over a range of depth and latitude bands, as well as in eddy-rich and eddy-poor regions will be shown. The structure function evaluated at pressure levels differs from that evaluated along potential density surfaces, consistent with the internal wave boundary. We advocate new approaches to aquatic ecosystem research based on: 1) a new breed of software tools in which semantic provenance is automatically created and used by the system, 2) the use of open standards based on RDF and Linked Data to facilitate sharing of data and provenance annotations, 3) the use of workflows to represent explicitly all data preparation and processing steps. As ecosystem data management systems are built we need to also build an overall strategy for the "business process" of scientific data management. When data management practitioners have tools that let them define, execute, and archive workflows then metadata capture becomes automated, greatly enriching the description of data. Richly described data is inherently more usable, especially to disciplines beyond the one that originally performed the collection. Workflows are key to providing convergence between aquatic ecosystem science disciplines. (Abstract ID 12652)

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INTERCOMPARISON OF AEROSOL MODEL SELECTION FOR MODIS, SEAWIFS, AND MERIS OCEAN COLOR IMAGERY

We examine the impact of aerosol model selection on bio-optical property estimates (remote sensing reflectance, chlorophyll absorption, and backscattering coefficients) derived from satellite ocean color imagery (MODIS, SEAWIFS, and MERIS). We compare the satellite-derived values from these three sensors have been observed, even for scenes covering the same region of interest with overpasses at approximately the same time, especially in coastal regions. This could be due to differences in atmospheric correction. To address this, we examine the variability in, and effect of, the aerosol model selection for each of the sensors during processing with consistent atmospheric correction routines. When discrepancies exist, we force the sensors to use the same aerosol models, and perform similar comparisons of the retrieved bio-optical properties. These analyses will facilitate sensor intercomparisons and data blending from multiple sensors. (Abstract ID 12094)

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RESOLUTION OF FINE BIOLOGICAL STRUCTURE INCLUDING SMALL NARCOMEDUSA A CROSS A FRONT IN THE SOUTHERN CALIFORNIA BIGHT

We sampled a front south of San Nicolas Island in the Southern California Bight over three days in October 2010. We found higher fluorescence, higher zooplankton volumes, and greater cladoceran, decapod, and euphausiid densities in the front indicating increased primary and secondary production. Mesopelagic fish were most abundant in oceanic waters to the west of the front, market squid were abundant in the front associated with high zooplankton displacement volume, and jack mackerel were most common in the front and on the shoreward side of the front. Egg densities peaked to either side of the front, consistent with offshore (for oceanic squid and mesopelagic fish) and shelf origins (for white croaker and California halibut).

We discovered unusually high concentrations of predatory narcomedusa in the surface layer of the frontal zone. Potential ichthyoplankton predators were more abundant either in the front (decapods, euphausiids, and squid) or shoreward of the front (medusae, chaetognaths, and jack mackerel). For pelagic fish like sardine which can thrive in less productive waters, the front (decapods, euphausiids, and squid) or shoreward of the front (medusae, chaetognaths, and jack mackerel). For pelagic fish like sardine which can thrive in less productive waters, the front (decapods, euphausiids, and squid) or shoreward of the front (medusae, chaetognaths, and jack mackerel).

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MESOSCALE AIR-SEA INTERACTIONS IN A FINE RESOLUTION EARTH SYSTEM MODEL

Realistically simulating mesoscale phenomena in ocean general circulation models is needed to better understand their importance in air-sea interactions. Their horizontal resolutions can be increased so that they are largely eddy-resolving, however the meshes of the reanalysis atmospheric flux forcing the models are coarser than the spatial scales of some of the mesoscale frontal structures. Recently Earth System Models have been run using weather-scale atmospheres and largely eddy-resolving oceans, affording us the opportunity to study mesoscale air-sea interactions on their true dynamical scales. Available to us is a 20-year fully coupled Community Climate System Model (CCSM) simulation that has 0.1-deg ocean and ice, and 0.25-deg atmosphere and land. A stand-alone 0.1-deg POP simulation, forced with interannually varying CORE atmospheric fluxes, is used for comparative studies. We compare eddy energetics and upper ocean variability from surface drift buoys and altimeter-derived sea surface height anomaly with the two models and then show examples of mesoscale air-sea interaction in the Western Pacific and in the Agulhas Current Retrécification. Particularly Agulhas eddy pathways are more realistic in CCSM than in stand-alone POP. (Abstract ID 11423)

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TIME SERIES OF PCO₂, PH AND ARAGONITE SATURATION STATE IN WAQUOIT BAY NATIONAL ESTUARINE RESEARCH RESERVE – ESTUARINE ACIDIFICATION AND SHELLFISH

Rising atmospheric carbon dioxide concentrations will tend to increase the dissolved inorganic carbon content (DIC) of coastal waters, lowering their pH and aragonite saturation state (Ωar) values. However, this acidification will be superimposed on the pre-existing carbonate system chemistry of these waters, which in turn reflects both natural processes and human perturbations (e.g., eutrophication). A three-year monthly time series of alkalinity and DIC data from the Waquoit Bay National Estuarine Research Reserve reveals striking annual cycles in seawater DIC and pH. Summer DIC values are below 700 ppmv throughout the bay, with values above 2000 ppmv in a sub-embayment with restricted flushing; summer pH(total) values were below 7.8 throughout the bay, and below 7.3 in the sub-embayment. These summertime values above 2000 ppmv in a sub-embayment with restricted flushing; summer pH(total) values were below 7.8 throughout the bay, and below 7.3 in the sub-embayment. These summertime values above 2000 ppmv in a sub-embayment with restricted flushing; summer pH(total) values were below 7.8 throughout the bay, and below 7.3 in the sub-embayment. Two loci were dinucleotide repeats and two were trinucleotide repeats. Of those, only loci containing trinucleotide repeats could be amplified in T. gravida. Initial results indicate that these loci may be polymorphic and can be used to identify genetically distinct clonal lineages of T. gravida. We are currently amplifying these loci as well as sequencing the tRNA from single cell isolates collected from the Iceland Basin, the Labrador Sea, and the Gulf of Maine to quantify the genetic diversity associated with blooms of T. gravida. (Abstract ID 11886)

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HIGH-RESOLUTION MAPPING OF SINKING PARTICLE FLUXES AND SIZE DISTRIBUTIONS ALONG THE WESTERN ANTARCTIC PENINSULA

The highly productive waters above the continental shelf of the western Antarctic Peninsula (WAP) support large fluxes of sinking particulate organic carbon (POC) that sequester carbon away from the atmosphere and nourish a rich benthic ecosystem. We present measurements of the particle concentration size distribution (CSD) from high-resolution deployments of an in situ imaging system along the WAP. We found large spatial and temporal variability in the particle abundance and CSD and show that these spatial patterns are linked to water masses and biological parameters. Furthermore, by combining measurements of the CSD with local calibrations of the average flux velocity and particle carbon densities, we are able to estimate the fluxes of sinking POC across the study region. We discuss the relative contributions of fluxes derived from the euphotic zone versus those transported laterally from the coast and shallow shelves. An export flux budget for the WAP is also presented. These high-resolution flux estimates offer important new insights into the functionality and variability of the WAP’s biological pump, and enable greatly improved sampling resolution relative to conventional sediment traps. (Abstract ID 10269)

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AN ASSESSMENT OF REAL-TIME DATA USE IN UNDERGRADUATE CLASSROOMS

The National Science Foundation’s Ocean Observatories Initiative (OOI) is constructing observational and computer infrastructure that will provide sustained ocean measurements to study climate variability, ocean circulation, ecosystem dynamics, air-sea exchange, seafloor processes, and plate-scale geodynamics for the coming decades. The Education and Public Engagement (EPE) Implementing Organization for OOI, which we represent, was recently established and is tasked with providing a new layer of cyber-interactivity for educators to bring real and near real time data, images and video of our Earth’s oceans into both formal and informal learning environments. Here we will share the results of a recent study to assess how undergraduate professors are currently using oceanographic data in their classrooms. A total of fourteen professors from community colleges and universities, teaching both science and non-science majors were interviewed for the study. Participants shared their current teaching practices and made recommendations on how OOI software developers can design tools to improve undergraduate students’ ability to interpret and analyze oceanographic data. Subsequent usability testing with early adopter undergraduate professors is planned to help inform the development of quality tools. (Abstract ID 11695)

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THE INTERNATIONAL THERMODYNAMIC EQUATION OF SEAWATER (TEOS-10): USING THE NEW SALINITY AND TEMPERATURE VARIABLES

The Thermodynamic Equation of Seawater - 2010 (TEOS-10) has been adopted by SCOR, IAPSO, IAPWS and IOC as the new thermodynamic description of seawater for use in describing and interpreting water temperature, salinity and density. The Thermodynamic Equation of Seawater - 2010 (TEOS-10) has been adopted by SCOR, IAPSO, IAPWS and IOC as the new thermodynamic description of seawater for use in describing and interpreting water temperature, salinity and density. The Thermodynamic Equation of Seawater - 2010 (TEOS-10) has been adopted by SCOR, IAPSO, IAPWS and IOC as the new thermodynamic description of seawater for use in describing and interpreting water temperature, salinity and density. The Thermodynamic Equation of Seawater - 2010 (TEOS-10) has been adopted by SCOR, IAPSO, IAPWS and IOC as the new thermodynamic description of seawater for use in describing and interpreting water temperature, salinity and density.
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OCEAN ACIDIFICATION EXPERIMENTS IN AN ECOLOGICAL CONTEXT

For the majority of ocean acidification species-response experiments, treatments are exposure to seawater equilibrated to global average atmospheric CO2 concentrations at the current time (~387 ppm) and some projected future scenario (e.g., 750 ppm by 2100). A challenge with interpreting these studies is that few organisms experience global atmospheric CO2 concentrations for extended periods of time because pH/CO2 varies in time and space. In this study, we evaluated the relationship between species response to pH and the range of pH/CO2 conditions that species likely experience in the field. We estimated species response to pH from published studies and determined each species’ distribution and depth range. To the extent possible, we then matched both the specific collection location and species distribution (including depth) with existing observations of the range of pH/CO2 pH values. Due to substantial limitations in both the field pH/CO2 pH data and fine-scale habitat selection of study species, the analysis provides only a rough approximation of the conditions that focal species may experience in nature. The analysis indicates that many of the existing pH/CO2 species-response experiments do not account for the existing range of pH/CO2 values that species currently experience. Understanding the range of pH/CO2 values species currently experience in nature provides insight into the potential for species acclimation and adaptation to ocean acidification. (Abstract ID 12508)

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DISTRIBUTION AND ECOLOGY OF ZOOPLANKTON AND JUVENILE PELAGIC FISHES IN THE COPPER RIVER PLUMES

The Copper River is the largest point-source of fresh water to the Gulf of Alaska, and is an important development environment for a variety of local pelagic fish. Salmon smolts and other juvenile fishes are known to subsist on zooplankton, but their feeding patterns are little studied in the region. The influence of the plume biochemistry and physical dynamics creates a non-homogeneous distribution of zooplankton and other forage material that correlates with fish feeding behavior. For the first time small unmanned aircraft systems (SUAS) were flown and recovered from icebreaking ships in the arctic, within 100 miles of both the true and magnetic North Pole. For the first time small unmanned aircraft systems (SUAS) were flown and recovered from icebreaking ships in the arctic, within 100 miles of both the true and magnetic North Pole. The 4.2lb RQ-11A “RAVEN” SUAS, used extensively by the military, includes standard and infrared video systems which transmitted to video terminals on the ships’ bridge. The RAVENs were hand launched and retrieved with <1hour endurance and <10kilometer range. Nighttime IR imaging was particularly useful for ice ridge detection. RAVEN imagery can be integrated into the US Coast Guard icebreaker HEALYS MapServer, which overlays satellite ice images. Using the SUAS for ice reconnaissance avoids the time, cost and risk of using manned helicopters, and the cost, time delays and resolution limits of satellite ice imagery, while providing the high resolution data on ice ridging needed to monitor changes in sea ice due to climate dynamics. These SUAS can be used to evaluate critical habitats for marine mammals including ice seals, which vary in their preference for different ice ridge habitats. Additional icebreaker unmanned aircraft operations are planned for 2012. (Abstract ID 11745)

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TRACE-METAL CLEAN AUTOMATED CULTURE SYSTEM FOR OCEAN ACIDIFICATION EXPERIMENTS

The interactive effects of trace-metal speciation and changing ocean pH on marine primary producers are largely unknown. Research indicates the bioavailability of trace metals may...
change substantially with ocean acidification, due to changes in speciation of metals in seawater. In addition, for open ocean studies and laboratory experiments that are designed to mimic the natural low trace metal environment, it is essential to work under trace metal clean conditions. In response, a trace-metal clean culture system was developed that controls pH and trace metal levels in 12 culture tanks. Automated pH measurements were obtained through computer- controlled, acid-free and spectrophotometrically controlled systems. The ship-board system has been used to study nutrient fluxes and bacterial processes in sub-tropical oligotrophic waters and calculating phytoplankton in the Southern Ocean. However, the system and trace-metal clean methodology are easily adapted to a range of marine organisms. (Abstract ID 9957)

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INITIATION AND IMPACTS OF AN ANNUAL NOCTILUCA BLOOM IN SIMPSON BAY, PRINCE WILLIAM SOUND, ALASKA: CONTRIBUTIONS TO THE FOOD WEB

Prince William Sound (PWS), Alaska supports many commercially important fisheries, large mammal populations, and a great diversity of birds. The biological mechanisms at the base of the food web which support such a high biomass are not completely understood. In other ecosystems, annual spawning events of both salmon and coral have been demonstrated as important pulses of nutrients. Herring may represent a similarly important source in PWS. Samples for nutrients, pigments, POC/N, and export were collected in the summers of 2008, 2009, and 2010 and faunal samples for stable isotopes were collected in 2010. A consistent pattern was observed: a large Noctiluca sp. bloom in June was followed a spike in water column nutrients; corresponding to the timing of the herring spawn. Further support for this relationship comes from the stable isotopes data. Marine derived nutrients injected into this system via herring spawning and entrained by the Noctiluca sp. bloom, represent an important external source of nutrients in Simpson Bay. The timing and intensity of these blooms is likely modulated by the herring fishery and timing of spawning events. (Abstract ID 1872)

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SOURCES AND COMPOSITION OF PARTICULATE ORGANIC MATTER IN THE DELAWARE ESTUARY

Estuaries are important regions for organic matter (OM) to be produced and reworked before entering the coastal ocean. They are also regions where OM from terrestrial, anthropogenic, and marine sources are mixed and where OM is subject to modification by physical, biological, and chemical processes. We used the Delaware Estuary as a model system for studying the sources and dynamics of OM along the estuarine salinity gradient. Particulate organic matter was collected along the Delaware River Estuary in August 2010, October 2010, and March 2011 to determine the sources of OM to the Delaware Estuary under different physical and biological conditions. Differences in the sources of POM to the Delaware Estuary were evaluated using chlorophyll a concentrations, particulate C:N elemental ratios, particulate stable isotopes (δ13C and δ15N) and lipid biomarkers. (Abstract ID 9533)

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SPATIAL VARIATION IN THE SMALL-SCALE DISTRIBUTION OF JUVENILE WALLEYE POLLOCK (THERAGRA CHALCGRAMMA) IN THE SOUTHEASTERN BERING SEA

Juvenile walleye pollock (Theragra chalcogramma) are an important prey item for bird and mammal predators in the Bering Sea and support a large commercial fishery. An understanding of the abundance and distribution of juvenile pollock is needed to estimate the effects that climate variation may have on this important resource and the predators that depend on it. During the summers of 2008 and 2009, surveys were conducted near the Pribilof Islands in the southeastern Bering Sea using multi-frequency acoustic, environmental sensors, and targeted trawls. Acoustic sampling showed that juvenile pollock were distributed in small, dense schools that were aggregated into larger clusters. These schools varied in depth with year, time of day, and temperature structure (e.g. thermocline depth). Patches of pollock varied in their density, spacing, and depth with oceanographic zones and by year. In 2008, juvenile pollock were more abundant and shallower in the water column. In 2009, juvenile pollock schools were found over a larger depth range and pollock were larger. These factors likely affected the behavior of predators seeking to use this resource. (Abstract ID 12291)

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IMPROVING STUDENT UNDERSTANDING OF POLAR ENVIRONMENTAL PHENOMENA USING AUTHENTIC OCEANOGRAPHIC, CLIMATIC, AND POLAR DATA. TURING STUDENTS INTO SCIENTISTS.

Information on climatic change, ocean acidification, and the melting of polar ice sheets fill today’s headlines. Students typically lack experience in finding, collecting, or interpreting real polar, oceanographic or climatic data. They are usually provided with datasets that are not current or representative of actual environmental conditions, or of interest to current scientific investigations. As a result, most students do not have an appreciation of the scope or impact of environmental changes occurring both in the past and in the present. The focus of this study included climatic change, ocean drilling core data from the Integrated Ocean Drilling Program (IODP), phytoplankton/zooplankton studies, the GLOBE program, LIPMETS (Long-term Monitoring Program and Experimental Training for Students) data and satellite studies of the Monterey Bay, the Arctic, and areas of Paleoclimatic interest. Researchers compared student understanding of paleoclimatic concepts, along with present day oceanographic, climatic, and polar phenomena, when taught using authentic and data analysis with non-inquiry based instruction. Techniques used in the study by students included the visualization of ocean cores and analysis of cataloged ocean core data. (Abstract ID 12598)

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OBSERVATIONS OF BEDFORM EVOLUTION IN AN INLET

Observations of bedforms ranging in size from sand ripples to sand waves were obtained with repeated high-resolution multi-beam sonar surveys in the fall of 2011 within the inlet leading to Hampton Seabrook Harbor, NH. The inlet is approximately 1 km in length and 300 m wide, with bottom sediments consisting of medium to coarse grained quartz sand. Sand waves, on the order of 1 m in amplitude and 10 m in wavelength, extend across the width of the inlet, and sand ripples on the order of 0.10 m in amplitude and 2 m in wavelength, are present between the sand waves. The large sand waves are more well-defined and larger in amplitude toward the northern side of the inlet with diminishing amplitudes trending to the south. Observations show that while the large sand waves maintained their basic morphology throughout the three week study period, they migrated horizontally up to 15 m. Bedform evolution will be compared to current measurements collected within the inlet using both moored and vessel mounted ADCPs. (Abstract ID 12025)

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CONTAMINATED SEDIMENT TRANSPORT IN THE STRONGLY STRATIFIED DUVANISH RIVER ESTUARY

Continuously modified since 1890, the Duvanish River estuary near Seattle WA has lost 98% of its intertidal area and accumulated enough legacy contaminants to justify four EPA-designated Superfund sites. Yet the estuary has retained a surprising amount of biological activity. The primarily hydrophobic contaminants sorb onto fine sediments and are concentrated in the bed, thus predicting the fate of the contaminants requires an understanding of the mechanisms suspending, transporting, and depositing the sediments. Sediment transport processes are well studied in partially-mixed estuaries and the strongly stratified Duvanish provides an opportunity to examine these processes in a salt-ward estuary. We use monthly observations beginning in May 2011 to characterize tidal-scalar hydrodynamic and sediment transport processes. We observe that low riverflow in the summer maintains the contaminated reach continuously within the salt-ward. High winter discharges push the toe downstream, periodically exposing the contaminated bed to the higher stresses upstream of the toe. Measuring the present sensitivity of the system to tidal and fluvial forcing provides a framework to explore the impacts of sea-level rise and riverflow variability expected by climate change models. (Abstract ID 12686)

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PHYSICAL DRIVERS OF BIOGEOCHEMICAL AND CARBON CYCLING IN LAKE SUPERIOR

The biogeochemistry and ecology of Lake Superior, the world’s largest lake by surface area, has significant spatial heterogeneity that must be quantified if reasonable carbon budgets are to be developed from sparse observations. Numerical modeling indicates that volumetric rates of respiration vary by two orders of magnitude across the lake, which leads to enormous spatial variability in the net metabolic balance; and this is likely a first order cause of the observed
biogeochemical and ecological variability. We investigate the physical mechanisms driving this heterogeneity and discuss implications for the Lake's carbon budget. (Abstract ID 11799)

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FUNCTIONAL CONNECTIVITY OF CORAL REEF FISHES IN A RED SEA CORAL REEF SEASCAPE ASSESSED BY COMPOUND-SPECIFIC STABLE ISOTOPE ANALYSIS

Tropical marine habitats are under mounting anthropogenic pressure, leading to declines in their function and resilience on a global scale. Maintaining functional connectivity among these habitats is critical for maintaining population resistance and resilience in these systems. However, quantifying movements of individuals within seascapes remains a major challenge. We provide the first use of a new compound-specific stable isotope technique to determine connectivity of a reef fish within a coral reef seascape. Our data revealed significant plasticity in juvenile nursery use that was not apparent from traditional visual surveys. Contrary to the current paradigm of a linear abundance gradient from presumed wetland nurseries to adult reef habitat, we found that seascape configuration played a critical role in determining functional connectivity among habitats. While some juveniles migrated over 30 km from coastal nurseries to coral reefs, others settled into shallow areas around a continental island or directly into adult reef habitats. Identifying linkages among distinct habitats within tropical seascapes will be necessary when developing management strategies to sustain coral reefs and the fisheries they support. (Abstract ID 11607)

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TWO-LOCUS MOLECULAR CHARACTERIZATION OF MORPHOSPECIES WITHIN THE ORDER TINTINNIDA (CILIOPHORA, SPIROTRICHEA): IMPLICATIONS FOR TAXONOMY AND DIVERSITY

We evaluated the SSU and LSU rDNA genes for their ability to discriminate morphospecies of tintinnids by sequencing multiple individuals from 29 morphospecies (21 new for SSU and all of them new for LSU). We found a high degree of intraspecific variability in lorica characteristics, but in some morphospecies small differences in lorica shape were consistent with discrimination based on the genetic markers. Of the two loci, LSU was more useful as a potential “barcoding” tool. It showed a smaller difference between the number of morphospecies and the number of terminal taxa in distance trees, compared to SSU. The concordance between LSU and identified morphospecies was greater when only our carefully identified specimens were included. SSU, on the other hand, was less consistent, sometimes lumping together very distinctive morphospecies, even at the 1% level of sequence divergence. We recommend continued efforts to expand genetic databases to include more tintinnids, especially for LSU, and that LSU barcoding procedures be developed for rapid assessment of tintinnid biogeography and ecology. (Abstract ID 12070)

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ANTARCTIC COASTAL OCEAN ACIDIFICATION: THE LARGE DISPARITY BETWEEN NATURAL AND ANTHROPOGENIC DRIVERS, IMPACTS AND RESILIENCE

The coastal waters surrounding the Antarctic continent are particularly vulnerable to ocean acidification since aragonite-secreting Pteropods have been shown to represent up to 65% of total zooplankton biomass, while unique biogeochemical processes bring those waters closer to “corrosive” undersaturation with respect to aragonite than elsewhere in the ocean. Natural variations over annual cycles can either suppress or accelerate the onset of ocean acidification, yet our understanding of these natural cycles in the Antarctic is lacking. Here, we present data that illustrates large seasonal variations in carbonate properties from two different coastal ocean locations, and how those natural cycles can significantly delay the onset of anthropogenic ocean acidification over the 21st century. We also bring in sediment trap data to speculate over whether the local pteropod population is resident or vulnerable to the already large natural variations we find for aragonite saturation and pH in the Antarctic. (Abstract ID 9659)

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METHODS FOR EXTRACTING BEACH EVOLUTION, RUNUP AND WAVE BORE HEIGHTS FROM AN AUTOMATED TERRESTRIAL LASER SCANNER

An automated dune-mounted terrestrial laser scanner in Duck, NC, is used to continually measure beach and foreshore topography simultaneously to water elevation on the swash and inner surf zone (precision 1.5cm), operating during storm and calm conditions. These simultaneous, precise, measurements of beach morphology and waves provide novel data critical for understanding sediment exchange between the beach and inner surf-zone. The laser collects hourly 20-minute scans at 2.5Hz across a beach profile, providing elevation and intensity returns from the foreshore, swash, and incoming waves. In addition, the laser collects hourly spanning scans of three-dimensional beach morphology within 100m of the laser. New algorithms are developed to separate waves from foreshore, enabling extraction of runup time-series, swash and inner-surf zone energetics, volumetric foreshore change, mean water level, and wave bore heights. Wave and water level measurements from the laser compare well with water level measurements from Paros pressure sensors deployed in the inner surf-zone. Interestingly, observations are higher than Paros measurements, perhaps due to the difference between the height of aerated bores and their pressure. (Abstract ID 1144)

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ARE THERE INTERNAL WAVE “BEACHES” ON CONTINENTAL SLOPES AND SHELVES?

If we define a beach as the place where surface waves come to rest, might we consider the possibility of conceptually analogous subaqueous, semi-permanent “beaches” for internal wave energy? Although internal-wave transport is scrutinized for its potential to deliver nutrients and pollutants to very shallow waters, nonlinear internal bores often dissipate offshore, by the time they reach the inner or mid-shelf. Even narrow shelves host baroclinic responses to multiple forcings, with deeper regions perhaps characterized by tidal pumping and propagating bores/ boluses while shallower regions are dominated by wind forcing. If distinct dissipation zones do indeed exist they would be modulated by shifts in alongshore currents, upwelling, and other changes to stratification and thermocline position. Disparate data sets suggest persistent depth zones for shelf boundary layers associated with internal waves, and the geometry of shelf shape and layer thicknesses could constrain dissipation spatially. Analogous zones may exist on continental slopes. Our understanding is hampered by limited observations, but such regions may affect the distribution of mud belts, benthic ecosystems, and particle and organism transport on continental margins. (Abstract ID 12463)

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ENVIRONMENTAL AND PHYSIOLOGICAL INFLUENCES ON C13 ISOTOPE CONTENT OF ZOSTERA MARINA (EELGRASS)

The carbon isotope signature in seagrasses is influenced by a variety of conditions including: (i) the source and concentration of inorganic carbon; (ii) water temperature altering the solubility of CO2 in seawater; (iii) viscous boundary layers affecting diffusion of CO2 across the leaf; (iv) internal recycling of CO2 in the lacinia; and (v) light availability. Boundary layers have been explored little with respect to 813C in seagrasses and studying this effect may provide insight for understanding the dynamics of carbon isotope fractionation in seagrasses leaves, and scaling productivity up to whole ecosystems. This study investigated the influence of CO2 permeability, controlled by biochemical, physical, and physiological mechanisms on photosynthesis and 613C composition of Chesapeake Bay Zostera marina. We scaled photosynthesis to Prxna providing a dimensionless value between 0 and 1 for photosynthesis (P). The linear relationship between modeled productivity and measured stable isotope fractionation provided a simple calculation to model 613C. The ability to accurately model productivity and C isotope content of a seagrass population supports a comprehensive understanding of the influence of light, carbon assimilation and environmental conditions on photosynthesis. (Abstract ID 12500)

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TROPHODYNAMICS AND CARBON ASSIMILATION PATHWAYS IN BENTHIC COMMUNITIES IN THE NORTHEASTERN CHUKCHI SEA, ALASKA

The shallow shelf of the Chukchi Sea, a region of interest for oil and natural gas extraction, supports a rich and diverse benthic fauna community. The species-level trophic structure determined for the region showed that the benthic shelf consists of four trophic levels. Some second trophic level organisms clearly reflected 6°C values of phytoplankton, such as the
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THE INTERACTION OF TOPOGRAPHY WITH THE MEAN FLOW: THE IMPORTANCE OF BOUNDARY RESOLUTION.

Eddies and jets are important for global momentum and heat budgets but are typically unresolved in low resolution global climate models. Their formation and structure are detailed using an idealised model set-up based on barotropic flow, past a cylinder on a beta-plane. The model used, Fluidity-ICOM, uses unstructured meshes and a new stable mixed discontinuous/unresolved in low resolution global climate models. Their formation and structure are detailed (e.g. the 8°C value of bivalve Astarte borealis=-19.81±0.31‰). The enriched 8°C value of organisms including A. borealis is attributed to the assimilation of benthic microalgae, a benthic 13C-enriched carbon source. Mixing equations using the disparate values of stable carbon isotopic end-members is available to consumers (i.e. phytoplankton and benthic microalgae) reveals that the proportion of body carbon derived from benthic microalgae for some consumers is >50%. Carbon assimilation pathways provide a framework of potential pathways of oil industry contaminants. (Abstract ID 12044)

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SUBMESOSCALE PHENOMENA, DYNAMICS, AND CONSEQUENCES

An overview is presented for submesoscale circulation and material distributions generated through downscale processes from mean and mesoscale flows. Their structures are typically fronts, filaments, vortices, waves, agostrophic instabilities, and emitted inertia-gravity waves. They are especially active in the upper ocean and in broad zones around topographic slopes, which partly overlap with the surface and bottom turbulent boundary layers. Their existence and evolution are significantly in conflict with the expectations of quasigeostrophic dynamics in rotating, stratified fluids, which has served well for many mean and mesoscale phenomena. Submesoscale flows provide a forward cascade of energy as a route to dissipation for the general circulation, and they induce important lateral and diapycnal mixing where they are active. (Abstract ID 10468)

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NEXT TASK: TRENDS?

With the publication of the global synthesis, “River Discharge to the Coastal Ocean” (2011) -- an effort that might not be repeated for decades to come -- we are faced with the question: What next? Our next systematic global assessment might well be of the changes over decadal time scales. But we cannot assess time trends without clearly understanding the sampling and assessment of the sampling and analytical methods. And more serious attention needs to be paid to calibrating new methods with older ones. Considering the reluctance of many authors to expose their methods in sufficient detail that would allow them to be repeated for comparative measurements by other investigators, or even allow their methods to be cross-calibrated with other methods, do we have the determination and stamina to pursue the definition of trends within acceptable error limits? (Abstract ID 12879)

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DISTRIBUTION OF DISSOLVED TRACE ELEMENTS IN THE UPPER 1000 M OF THE SOUTH PACIFIC DURING THE CLIVAR S4P CRUISE.

During the CLIVAR S4P cruise, Feb–April 2011 we collected 671 samples at 56 stations using the CLIVAR TM rosette system. Shipboard data show several interesting patterns of dissolved Al, Fe and Mn in both the Ross Sea and along the flow path of the Antarctic Circumpolar Current (ACC). Three sections into the shelf regions in the Ross Sea at Cape Adare (170E), Hillary Canyon (170W) and along 150W all show the effect of coastal processes in adding these reactive trace elements to the water column. A distinctive gradient in dissolved Al concentrations between the 170W and 150W transects however suggests circulation processes within the Ross Sea may be playing a prominent role in redissolving these coastal features. The extensive section along 67S from 177E to 73W provides a semi-synoptic view of trace element concentrations along the flow path of the ACC. Within the ACC dissolved Al values of ~1.2 nM and Fe values of ~0.1 nM are fairly uniform but the depth to which dissolved Fe is depleted increases suggesting continual scavenging along this advective flow path. (Abstract ID 11899)

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DECADAL CHANGES IN OXYGEN AND TEMPERATURE-SALINITY RELATIONSHIPS ALONG 32°S IN THE INDIAN OCEAN THROUGH 2009

Observations from the 2009 reoccupation of a trans-Indian Ocean hydrographic section nominally along 32°S as part of the U.S. CLIVAR/CO2 program add evidence of continuing decadal oscillations in isopycnal temperature-salinity relationships and oxygen concentrations. Within the Subantarctic Mode Water (SAMW), apparent oxygen utilization (AOU) has increased (oxygen decreased) along with cooling and freshening from 2002 to 2009. This finding confirms, together with previously reported observations (oxygen increase/salinification from 1987 through 1995 to 2002; oxygen decrease/freshening from 1982 to 1987) that SAMW properties here undergo decadal oscillations. In contrast, isopycnals around the underlying Antarctic Intermediate Water (AAIW) have been almost continuously freshening from 1962 to 2009, consistent with an increase of the hydrological cycle under global warming conditions. AAIW AOU changes are smaller than SAMW changes, exhibit similar decadal variability, and appear to be decoupled from the salinity trends at this depth. We also compare observed AOU variability to changes in transit times inferred from transient tracer data (CFCs and SF6) to address whether increases in AOU from 2002 to 2009 represent a renewed slowdown of the gyre circulation. (Abstract ID 10467)

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TRACKING THE FATE OF DISSOLVED ORGANIC MATTER IN THE AMAZON RIVER TO OCEAN CONTINUUM

The composition of the dissolved organic matter (DOM) in the Amazon River to Ocean Continuum has been analyzed by ESI FT-ICR MS. The analysis generated mass spectra for each of the 36 samples collected with over 3300 identifiable peaks. Principal component analysis (PCA) shows that three major groups are present with respect to DOM composition, namely riverine, plume and oceanic. The first PCA (69% of total variance) is highly correlated with the percentage of terrigenous DOC in the samples. The second PCA (4% of total variance) represents transformation processes in the plume, capturing the production of molecules in this transition region, as well as the consumption and degradation of molecules that were present in the riverine and oceanic samples. That variability seems to be driven by microbial activity in the plume. Dark incubation experiments of riverine waters reveal that the composition of the Amazon DOM is stable to microbial degradation on the scale of several days, with only few compounds removed from the DOM pool. (Abstract ID 10321)

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PHYTOPLANKTON GROWTH ALLOMETRY AND SIZE-DEPENDENT CN STOICHIOMETRY REVEALED BY A VARIABLE QUOTA MODEL

Size scaling of phytoplankton growth rate and size-dependent carbon to nitrogen (CN) stoichiometry determine phytoplankton size structure and coupling of carbon and nitrogen cycling of marine ecosystems. They are critical in predicting the growth of phytoplankton...
spanning a wide range of sizes and their consequences for the biological pump in marine ecosystem models. The size scaling of phytoplankton growth and size-dependent C:N stoichiometry are modelled by embedding size-dependent light-harvesting, nutrient acquisition and storage into Droop's quota-dependent phytoplankton growth model. The size-scaling exponent of maximum growth rate of phytoplankton is α = 0.17 (which is higher than the universal size-scaling exponent of α = 0.25 predicted by the metabolic theory of ecology) under saturated light and NO3. The size-scaling exponent of growth rate (α) decreases with increasing light under saturated NO3, and decreases with decreasing NO3 concentration under saturated light. The allometry of equilibrium cellular C and N quota varies with light and NO3 concentrations. We identified the uncertainty of the size-scaling exponent of μ associated with key parameters, for which more data need to be collected in the lab and field. (Abstract ID 10449)

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Concentrations. We identified the uncertainty of the size-scaling exponent of μ associated with universal size-scaling exponent of –0.25 predicted by the metabolic theory of ecology) under stoichiometry are modelled by embedding size-dependent light-harvesting, nutrient acquisition spanning a wide range of sizes and their consequences for the biological pump in marine ecosystem models. The size scaling of phytoplankton growth and size-dependent C:N stoichiometry are modelled by embedding size-dependent light-harvesting, nutrient acquisition and storage into Droop's quota-dependent phytoplankton growth model. The size-scaling exponent of maximum growth rate of phytoplankton is α = 0.17 (which is higher than the universal size-scaling exponent of α = 0.25 predicted by the metabolic theory of ecology) under saturated light and NO3. The size-scaling exponent of growth rate (α) decreases with increasing light under saturated NO3, and decreases with decreasing NO3 concentration under saturated light. The allometry of equilibrium cellular C and N quota varies with light and NO3 concentrations. We identified the uncertainty of the size-scaling exponent of μ associated with key parameters, for which more data need to be collected in the lab and field. (Abstract ID 10449)

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OCEANOGRAPHY IN 2030: OBSERVING THE OCEANS WITH LIMITED SHIPTIME

Given the ever-increasing fuel charges and other factors, there will be extreme pressure to limit shiptime in 2030. As a consequence: (1) Cruises will serve teams of PI's. Ships and the platforms deployed will be heavily equipped with suites of sophisticated sensors. These co-located measurements will lead to breakthroughs in understanding. (2) Autonomous vehicles will become prevalent within, above, and at the surface of the ocean. Ocean gliders will make repeat transects, do on-station profiling and exploratory surveys, and then dock to seafloor cables and moorings to recharge batteries and upload data. Able to transit entire ocean basins, gliders will be deployed and recovered from convenient locations. Likewise, autonomous surface vehicles will become a popular choice for air-sea interaction studies. (3) Satellite observations and numerical models that assimilate observations will become the primary "datasets" used. In situ observations will need to be justified in terms of how they improve these products, or why they are superior: (4) Most oceanographers in 2030 will have never been to sea. (Abstract ID 11679)

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COMMUNICATING SEA LEVEL RISE

The Coastal Areas Climate Change Education Project (CACCE), an NSF-GCCE project, focuses on the social and economic effects of sea level rise (SLR) on coastal areas in the eastern Gulf of Mexico and the Caribbean. The broad target audiences include professionals in planning and other professions, policy makers, and educators in formal and informal settings. CACCE helps them understand options of how to respond and develop adaptation strategies. We engage skeptics of human contributions to climate change and help them accept proactive approaches to change, especially "no and least regret" strategies. CACCE helps learn about change by using people's own experiences and concerns in local settings. CACCE approaches the professional and policy-maker communities by sharing facts with their everyday life and explaining the nature of science. It explains SLR, presents methods used to obtain scientific observations, and describes trends and experimental uncertainties that determine the trustworthiness of observations. We then introduce models that explain these observations, how these have been tested, and what future SLR scenarios may look like. We include an unvarnished presentation of assumptions underlying predictions. (Abstract ID 10467)

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THE AQUARIUS SALINITY RETRIEVAL ALGORITHM: CALIBRATION AND VALIDATION

The Aquarius L-band radiometer/scatterometer system is designed to provide monthly salinity maps at 150 km spatial scale to a 0.2 psu accuracy. The sensor was launched on June 10, 2011, aboard the Argentine CONAE SAC-D spacecraft. The L-band radiometers and the scatterometer have been taking science data observations since August 25, 2011. The salinity retrieval algorithm transforms Aquarius antenna temperatures into brightness temperatures at a flat ocean surface, which are then matched to a salinity value using a surface emission model that is based on a model for the dielectric constant of sea water and an auxiliary field for the sea surface temperature. The scatterometer radar backscatter measurements are used to correct for the effects from the wind roughened ocean surface. Before the salinity algorithm can be operationally implemented and its accuracy assessed by comparing versus in situ measurements, an extensive calibration and validation (cal/val) activity needs to be completed. This is necessary in order to tune the inputs to the algorithm and remove biases that arise due to the instrument calibration. (Abstract ID 10546)

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ESTIMATES OF SEDIMENT CALCIUM CARBONATE DISSOLUTION RATES IN A CORAL REEF ENVIRONMENT

Under aerobic conditions and constant salinity, temperature and pH, carbonate dissolution and biogenic precipitation of calcium carbonate are the dominant processes affecting the total alkalinity (TA) in seawater. The increased emission of carbon dioxide (CO2), one of the major greenhouse gases in the atmosphere produced by the burning of fossil fuels, is changing ocean carbonate chemistry and affecting tropical benthic marine life. As biogeochemical processes in coral reef sediment porewaters induce dissolution of carbonate mineral phases, quantification of these rates is necessary for deriving net community calcification rates as measured at the benthic boundary layer. Reported calcium carbonate dissolution rates for sandy environments range from 0.05 - 3 mmol m-2 h-1. Based on observed changes in TA and estimates of vertical flux of TA in sediment porewaters, carbonate dissolution is estimated at 0.2 mmol m-2 h-1 at Cato Enrique, a mid-shelf coral reef on the southwest coast of Puerto Rico. On an annual basis, this corresponds to 175 g CaCO3 m-2 year-1, a significant fraction of gross calcification rate estimated at 825 g CaCO3 m-2 year-1. (Abstract ID 10471)

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SENSITIVITY OF THE PACIFIC OCEAN STATE TO THE FORMULATION OF THE VERTICAL PROFILE OF INTERNAL-TIDE DRIVEN MIXING

Diapycnal mixing plays a key role in maintaining the ocean stratification and meridional overturning circulation. The breaking of internal-tides is a major source of diapycnal mixing. Many recent climate models parameterize it using the scheme of SLaurent et al. (2002). While this parameterization dynamically accounts for the generation of internal-tides, the vertical distribution of the resultant mixing is ad hoc, prescribing the energy to decay exponentially with a fixed length scale. Recently, Polzin (2009) formulated a dynamically based parameterization in which the vertical profile of energy dissipation decays algebraically with a varying vertical decay scale, and accounts for the variable stratification using WKB stretching. We compare two simulations using the SLaurent and Polzin formulations in the GFDL-CM2G coupled model, with identical internal-wave energy input at the bottom. Focusing mainly on the Pacific Ocean, where numerous internal-tide generation sites are found, we show that there is a significant sensitivity of the ocean state to the vertical profile of internal-tide driven mixing. Therefore, not only the energy input to the internal-tide modes, but also where in the vertical it is dissipated. (Abstract ID 10208)

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CONSISTENCY OF THE MULTI-MISSION RECORD OF OCEAN COLOR MARINE REFLECTANCE FOR CLIMATE RESEARCH

The consistency and uncertainties of global remote sensing reflectances Rr derived from ocean color missions are analyzed in the context of climate research. For each spatial bin, daily matching pairs of Rr spectra are accumulated over periods of mission overlap. From this, the random error r of the uncertainty budget is derived from calculations of variance and covariance terms. This approach affords spatial and seasonal views of r that can be propagated through bio-optical algorithms to characterize the uncertainties of ocean color products. For SeaWiFS, MERIS, and MODIS-Aqua, r spectrally decreases on average from ~0.0009 to 0.0006 sr from blue to red wavelengths. This is compared with validation results obtained for the main satellite missions from radiometric field data series. Secondly, inter-mission biases are investigated to create a bias predictor. These activities rely on a robust band-shift correction to account for differences in sensor wavelengths. Implications for data merging and the creation of a Rr climate data record are presented in the framework of the Ocean Colour Climate Initiative of the European Space Agency and the MyOcean project. (Abstract ID 11004)
Heterotrophic protist (<200 µm) grazing and size-fractionated phytoplankton growth rates were measured at a coastal station in west Greenland from April to May 2011. Dilution experiments were conducted on 9 days in 24-hr incubations in situ light and with 3 temperature treatments: in situ (+1°C), +3°C and +6°C without acclimation. The sampling period spanned the development of a phytoplankton spring bloom (max 13 µg Chl a l-1). Phytoplankton growth rates did not differ across temperature treatments. Protozoan predators grew rapidly and consumed a significant fraction of phytoplankton primary production at in situ temperatures. Cell counts suggested that dinoflagellate species grew >0.8 d-1 and ciliates ~0.44–d-1. Predator growth rates were temperature dependent and declined 30–60% at 6°C. Average grazing rates at 6°C (0.15–d-1) were significantly lower than at the two lower temperature treatments (0.23–d-1). Maximum in situ grazing pressure consumed ~94% of primary production (NPP), 100% at 3°C and decreased significantly at 6°C (80% NPP). Thus, food web function is expected to be robust even over significant temperature increases. Ultimate dramatic increases in temperature will decrease heterotrophic abundance and grazing pressure. (Abstract ID 10532)

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TRACKING OF THE DEEPWATER HORIZON HYDROCARBONS AND THE DISPERSANT IN THE GULF OF MEXICO USING EEM AND PARAFAC MODELING

A simple and sensitive method is needed to monitor the fate of the subsurface spilled oil constituents in the Deepwater Horizon. We evaluated the use of excitation and emission matrix (EEM) fluorescence and parallel factorial analysis (PARAFAC) modeling techniques for monitoring large oil components in the dispersed oil reservoir. For the four times of the derived PARAFAC loadings were associated with the spilled Macondo crude oil. The fluorescence of the associated benzene and naphthalene-like components of crude oil exhibited maxima at ~1200 cm in the water column. The maximum fluorescence of the component associated with the dispersant (i.e., COREXITEC950A) was also observed in the same depth. The observed high fluorescence of the crude oil and the dispersant-associated components at ~1100–1200 cm were pronounced near the Deepwater Horizon Macondo well blowout. The plume observed at this depth was likely the result of residual oil, including the fluorescent PAH markers, remaining after dispersant addition at the wellhead. The results from this study demonstrate the ability of using EEM and PARAFAC techniques in monitoring residues of the Macondo crude oil and the dispersant in the water column after the Deepwater Horizon oil spill and discriminate fluorescence signals related with CDOM. The same techniques may be applicable for studying other oil spills. (Abstract ID 10073)

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AN EXAMPLE OF AEGOSTERIC INSTABILITY IN A ROTATING STRATIFIED FLOW

In the ocean large- and meso-scale flows are nearly balanced in momentum between Earth's rotation and density stratification effects. In this regime advective cross-scale interactions mostly drive energy toward larger scales (i.e., inverse cascade). However, viscous energy dissipation occurs at small scales. So how does the energy reservoir at larger scales leak toward smaller-scale dissipation? Here we solve the linear instability problem of a balanced internal jet driven by rotation and density stratification effects. In this regime advective cross-scale interactions are analyzed in the transformed Eulerian-mean (TEM) formalism, showing that they act to homogenize the Ertel potential vorticity isentropic gradient near both its zero surface and a critical surface. (Abstract ID 11669)

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REQUIREMENTS TO SUSTAIN GLOBAL OCEAN COLOR OBSERVATIONS

Ocean color satellites provide a unique vantage point to measure global phytoplankton

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A CASE STUDY OF MULTIPLE, MIGRATING QUASI-ZONAL JETS IN THE EASTERN NORTH PACIFIC

Low-frequency motions in the eastern part of the subtropical North Pacific are dominated by multiple, alternating quasi-zonal jet-like features (stratifications), which slowly, at a speed of about 0.3 km/day, propagate toward the equator. While propagating, these features grow in amplitude until they encounter the North Pacific Equatorial Current, where they disappear in a rather chaotic mesoscale eddy field. We study energetics of these features using two data sets: satellite sea level anomaly observations and output of the Ocean general circulation model for the Earth Simulator (OGES). The time-averaged transient kinetic energy spectra are observed to exhibit a characteristic 'dumbbell' shape near the origin, qualitatively consistent with the beta-plane turbulence theory. Yet, we find that a significant correlation exists between the energy conversion term due to baroclinic instability of the large-scale meridional flow and the growth rate of the stratifications' amplitude. While the rate of transfer of eddy kinetic energy to zonal mean kinetic energy exhibits large oscillations, presumably associated with the eddy life-cycles, it can not explain the stratifications' growth and in the time mean is barely distinguishable from zero. (Abstract ID 11093)

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SPECTRAL ENERGY DISSIPATION DUE TO SURFACE-WAVE BREAKING IN THE GULF OF TEHUANTEPEC EXPERIMENT (GOTEX).

A semi-empirical determination of the wavenumber (k) dependence of energy dissipation due to breaking is presented, and used to model the spectral dependence of the breaking strength parameter, b, defined in Phillips’ (1985) formulation of wave-breaking dynamics. The dissipation is based on closing the radiative transport equation for fetch-limited waves in GOTEX (Romero and Melville 2010). The spectral dependence of the breaking strength, b, uses Kleiss and Melvilles (2010) measurements of the breaking statistics, and the spectral energy dissipation. A model for b is proposed that uses laboratory data, which can be represented by b = a(S−S0)−n, where S is a measure of the wave slope at breaking, a is a constant, S0 is a threshold, and n = 3 is a threshold constant with the inertial wave dissipation model and measurements (Drazen et al. 2008). The relationship between b(S) in the laboratory and b(k) in the field is based on the saturation of the wave field. The results are discussed in the context of wave-energy modeling and improved field measurements of breaking. (Abstract ID 11542)

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HETEROTROPHIC PROTIST GRAZING RATE AND TEMPERATURE RESPONSE DURING AN ARCTIC PHYTOPLANKTON SPRING BLOOM

In the ocean large- and meso-scale flows are nearly balanced in momentum between Earth’s rotation and density stratification effects. In this regime advective cross-scale interactions mostly drive energy toward larger scales (i.e., inverse cascade). However, viscous energy dissipation occurs at small scales. So how does the energy reservoir at larger scales leak toward smaller-scale dissipation? Here we solve the linear instability problem of a balanced internal jet driven by rotation and density stratification effects. In this regime advective cross-scale interactions are analyzed in the transformed Eulerian-mean (TEM) formalism, showing that they act to homogenize the Ertel potential vorticity isentropic gradient near both its zero surface and a critical surface. (Abstract ID 11669)

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abundance and their contribution to marine ecosystem health, the global cycle of nutrients, oxygen, and carbon, and their response to climate change. However, the United States risks losing access to ocean color data because the SeaWiFS has ceased operation, MODIS is aging and planned new satellite missions might not be able to acquire data at the accuracy levels required for climate research. Given the importance of maintaining the ocean color time-series, NOAA, NASA, NSF, and ONR asked the National Research Council (NRC) to convene a committee of experts to review the minimum requirements to sustain global ocean color measurements for research and operational applications, and identify options to minimize the risk of a data gap. The poster will summarize recommendations regarding improvements to the VIIRS/NPP mission. The poster concludes that NASA’s climate continuity and decadal survey missions PACE/ACE, GEOCOPE and HyPSI4 are required to advance ocean color science and to extend and improve operational and research uses of the data. (Abstract ID 11646)

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SEASONALITY OF THE SUBMESOSCALE DYNAMICS IN THE GULF STREAM REGION.

The formation of submesoscale features in the mixed layer of the Gulf Stream Region (CSR) and their seasonality are investigated. Instabilities developing along surface density fronts are thought to be one of the most important processes in the formation of submesoscale dynamics and their development is conditional to the frontogenetic activity. To attack this problem, HYCOM is run in a realistic configuration of the CSR at a resolution of 1/48th degree, resolving part of the submesoscale dynamics, and for more than a year, resolving the annual variability. Results are compared with a non-submesoscale resolving simulation with a resolution of 1/12th degree. It is found that submesoscale ageostrophic features in the model are more apparent during the winter than in the summer season. The reason of this evidence is traced to an enhancing mechanism of weak stratification and strong wind forcing on frontogenesis during the winter season, in contrast to the summer season where the strong stratification suppresses the secondary ageostrophic circulation inhibiting frontogenesis as well as the formation of mixed layer instabilities. (Abstract ID 12118)

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A CLIMATE DATA RECORD FOR SEA SURFACE TEMPERATURE FROM ALONG TRACK SCANNING RADIOMETERS

A climate data record (CDR) of sea surface temperature (SST) has been developed from satellite observations – specifically the Along Track Scanning Radiometer (ATSR) sensors. This new CDR is designed to be independent of in situ observations, and therefore provides a means of critical assessment of existing in situ and blended time-series of SST and the methods used to create them. The CDR is shown to have low bias (generally of order 0.1 K) and excellent stability (drift less than +/-0.003 K/yr for 1993 to 2010). Comparison with Hadley Centre in situ observations shows changes in the whole water column and evidenced large variations (up to 50% of the lowest value) in the Meridional Overturning Circulation (MOC) intensity, computed in density coordinates across the Greenland-Portugal OVIDE section. A significant correlation is found between the MOC intensity, the North Atlantic Current transport and the net heat flux across the OVIDE section. The time scales of the MOC variability between 1993 and 2010 are further evaluated using a MOC index built from satellite altimetry and Argo. (Abstract ID 10322)

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Six oceanic surveys carried out between the south-east tip of Greenland and Portugal, from 1997 to 2010, revealed remarkable changes in the large scale circulation. The observations showed changes in the whole water column and evidenced large variations (up to 50% of the lowest value) in the Meridional Overturning Circulation (MOC) intensity, computed in density coordinates across the Greenland-Portugal OVIDE section. A significant correlation is found between the MOC intensity, the North Atlantic Current transport and the net heat flux across the OVIDE section. The time scales of the MOC variability between 1993 and 2010 are further

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SYNCHRONOUS INTENSIFICATION AND WARMING OF ANTARCTIC BOTTOM WATER OUTFLOW FROM THE WEDDELL GYRE

Antarctic Bottom Water (AABW), the densest water in the global overturning circulation, has warmed in recent decades, most notably in the Atlantic. Time series recorded within the boundary currents immediately upstream and downstream of the most significant outflow of AABW from the Weddell Sea indicate that raised outflow temperatures are synchronous with stronger boundary current flows. These changes occur rapidly in response to changes in wind forcing, suggesting that barotropic dynamics and the response of the bottom Ekman layer are significant. The observed synchronicity indicates that the previously-detected weakening of the export of the colder forms of AABW from the Weddell Sea need not be associated with a reduction in the total flux of AABW exported via this route. These points need careful consideration when attributing the observed AABW warming in the Atlantic, and when determining its contribution to global heat budgets and sea level rise. (Abstract ID 9503)
OCEAN ACIDIFICATION AND SPERM MOTILITY IN THE GIANT SEA SCALLOP, Wahle, R. A., University of Maine, Walpole, USA
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The Republic of the Marshall Islands (RMI) is a low-lying group of atolls and islands that is vulnerable to wave-driven flooding events. Of particular concern is the potential impact of sea-level rise on the frequency and duration of flooding events, as populated areas at RMI typically are only 1-3 m above mean sea level. The driving factors behind recent inundation events at RMI are examined using observations from a two-year field experiment, and the influence of background water level changes on wave transformations over protective fringing reefs is specified. Conditions leading to flooding during a spring tide/low wave event (February 2011) and a moderate tide/storm wave event (December 2008) are examined. The sum of the predicted components of wave-driven inundation, namely wave setup and runup at wind wave and infragravity frequencies, agree with observed flooding levels during the two events, and the importance of background water level to well transmission across the reef and wave setup amplitude are demonstrated. Prospects for future coastal inundation risk at RMI are considered based on different sea-level rise scenarios. (Abstract ID 11586)

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THE RESPONSE OF BLUE CRAB, CALINECTES SAPIDUS, HEMOCYCTES TO OCEAN ACIDIFICATION

Hemolymph is the fluid in the circulatory systems of invertebrates that contains both hemocytes and dissolved components (i.e., calcium ions) needed for growth, shell formation, and defense against tissue damage and infection. To investigate how ocean acidification would affect blue crab (Calinectes sapidus) hemolymph, we used two fluorescent, biochemical probes SNARF-5 (for pH 6.8-7.3) and Fluor-4 and Fluor-Red (for intracellular calcium, Ca²⁺). The pH of granular hemocytes was 7.1-7.4 which was not significantly different from agranular hemocytes that were between pH 7.0-7.3 (p = 0.024). Preliminary, in vitro experiments exposed hemocytes to pH 7.3 and 6.7; pH dropped immediately but pH recovered within 10 minutes. For the calcium probes, only the granular cells stained, and there was a slight decrease Ca at the lower pH. These results suggest that hemocytes maintain intracellular pH. How ocean acidification affects the hemocytes might provide valuable information about the overall physiological response of an organism to ocean acidification. (Abstract ID 9480)

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OCEAN ACIDIFICATION AND SPERM MOTILITY IN THE GIANT SEA SCALLOP, PLACOPECTEN MAGELLANICUS

The ocean is being acidified by increasing levels of atmospheric CO₂. Ocean p[H] is predicted to decline from current levels of pH 8.0 to as low as 7.6 by 2100. Few have examined the reproductive consequences of acidification in marine organisms. We suspect that gametes of the giant sea scallop might provide valuable information about the overall physiological response of an organism to ocean acidification. (Abstract ID 11586)

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IODP: ENGAGING NEW STAKEHOLDERS WHILE MAINTAINING ESTABLISHED RELATIONSHIPS

The Integrated Ocean Drilling Program (IODP) is an international marine research program that brings to the surface new insights into climate and environmental change, tectonics and earthquake genesis, and the nature of life in extreme environments. The program crosses disciplines, international boundaries, and generations in a collaborative effort to collect subsurface cores and data for studying the planet. IODP faces similar challenges to those confronted by many established research programs; particularly, how does a program engage early career scientists and new participants without diminishing the value and expertise of more experienced community members and researchers? This presentation will discuss some of the community engagement activities undertaken by the U.S. IODP program member office to address this challenge. (Abstract ID 12864)

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SHELL GROWTH STRONGLY COUPLED WITH POSITIVE ARCTIC OSCILLATION AND NORTH ATLANTIC OSCILLATION PHASES: INSIGHTS FROM A SCLEROCHRONOLOGICAL AND GEOCHEMICAL STUDY

Arctic island shell material was collected alive from the small island of Igloolik located at the boundary between the Barents and Norwegian Seas within the Arctic. This site is an ideal location for study of atmosphere/ocean dynamics because it is situated at the northernmost extent of the North Atlantic Current, an oceanographic region that is influenced by the North Atlantic and Arctic Oscillations (NAO/AO). Comparing annual oxygen isotope data from the cored shells to monthly sea surface temperatures (SST) from Igloolik revealed that the growing season begins in March and continues through October, with most of the growth occurring in May (r = 0.83; p < 0.002). A two-year lag has been observed between the shell growth chronology and AO/NAO records from this site, showing a stronger coupling during the more positive phase of the NAO (i.e., 1970 to present). These results suggest that benthic communities within this region of the Arctic are influenced by atmospheric dynamics that lead to strong AO/NAO modes. This hypothesis will be evaluated by extending the master shell chronology into previous centuries. (Abstract ID 11728)

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HIGH RESOLUTION DATA FOR DISSOLVED MANGANESE(II) IN THE WATER COLUMN OF THE CENTRAL BALTIC SEA USING A NEW WET CHEMICAL IN SITU ANALYZER

Manganese plays an important role in the biogeochemistry of stratified marine environments. In the Central Baltic Sea where stratification separates oxygenated from anoxic waters Mn is mainly present in two oxidation states, which are thermodynamically stable under oxic [Mn(IV)] and anoxic [Mn(II)] conditions, respectively. Continuous flow analysis for soluble Mn(II) species in the water column was performed with a colorimetric method using 1-(2-pyridylazo)-2-naphthol (PAN) as a spectrophotometric reagent. PAN is a widely used azo dye and has a rapid color formation. In the Baltic Proper the primary potential interferents are Fe(II) and Cu(II) respectively. The iron-specific chelating agent deferoxamine (DFO) was used to avoid any interference. The long-term goal is a deeper insight into the dynamics of...
the concentration dynamics of Mn(II). The kinetics of episodic events and their transition phases in the biogeochemical cycle of manganese could be accurately documented by high-resolution measurements of the wet-chemical analyzer used in this study. (Abstract ID 11001)

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BIOCHEMICAL COMPOSITION OF ARCTIC FIRST-YEAR SEA ICE: SCALES OF VARIABILITY AND IMPLICATIONS FOR CARBON CYCLING

The Arctic cryosphere is changing fast, with rapidly declining sea ice extent, decreasing multi-year ice, delayed freeze-up and advanced melt, and impacts on ice-associated food webs. The Canadian Arctic Archipelago hosts very productive first-year ice algal communities, with the highest biomass reports in the Arctic. Yet, the cycling of the abundant dissolved and exopolymeric substances (EPS) also present in first-year ice is poorly understood. This study assessed the regional variability in first-year ice communities in the eastern Canadian Arctic Archipelago in spring 2010 and 2011. We collected sea ice and water samples at 36 stations across oceanographic gradients during the ice algal bloom and measured nutrients, primary biomass and production, protist and bacterial abundance, dissolved organic carbon, and carbohydrates abundance, composition and size-fractions. Carbohydrates were also characterized in middle and top sections of ice cores. Patterns in the abundance, composition and size-fractionation of EPS and non-exopolymeric carbohydrates were observed. These results are discussed in the context of environmental forcing on sea ice communities and potential implications for the cycling of carbon in Arctic marine systems. (Abstract ID 12815)

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THE ECOLOGY OF MICROBIAL COMMUNITIES ASSOCIATED WITH THE GIANT KELP MACROSCYSTIS PYRIFERA

Kelp forests are characterized by high biodiversity and productivity, and the cycling of kelp-produced carbon is a vital process in this ecosystem (Mann 1982, 2000). Although bacteria are assumed to play a major role in kelp forest carbon cycling, knowledge of the composition and diversity of these bacterial communities is lacking. Bacterial biofilms on the surface of Macrocystis pyrifera were sampled at the Hopkins Marine Life Refuge in Monterey Bay, CA, before and after the onset of spring upwelling. The population distribution of the biofilm and adjacent seawater bacterial communities were studied using 454-tag pyrosequencing (16S RNA). Our results suggest that M. pyrifera harbors species-specific microbial biofilms that respond to changes in the environment. We identified several kelp-specific taxa that might play an important role in M. pyrifera. This study reports on the first in-depth assessment of the diversity and phylogenetic profile of the bacterial communities associated with M. pyrifera. (Abstract ID 10696)

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THE NANOOS NORTHWEST ENHANCED MOORED OBSERVATORY: A NOVEL THREE-TIERED APPROACH TO OBSERVATIONS ON THE WASHINGTON COAST

Since July 2010, the University of Washington has maintained a real-time system on the previously under-sampled outer Washington coast that integrates three separate sampling platforms, each with unique and complementary sampling capabilities, to resolve a broad range of complex processes on the Washington shelf. The core of the system is a heavily instrumented surface mooring (Cha Ba) that records and telemeters meteorological data, pCO2 data and a suite of physical and bio/geochemical variables measured throughout the water column. To complement the rapidly-sampled, discrete-depth measurements on Cha Ba, a nearby sub-surface mooring, which relays data to shore via Cha Ba, employs a McLane Moored Profiler recording hourly measurements of T, S, DOX, and (for the first time) nitrate over most of the water column at finer vertical scales (~0.5 m). Lastly, cross-shelf spatial data are collected with a Seaglider, which runs transects between the two moorings and a waypoint 190 km offshore. With little historical data from this region, data collected are beginning to outline the range of processes and expected variability. We describe the system and some initial results. (Abstract ID 12849)

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SENSITIVITY TESTS ON SEABED SEDIMENT ERODIBILITY OF THE TEXAS-LOUISIANA CONTINENTAL SHELF

Sediment resuspension and transport are controlled by hydrodynamic conditions and seabed erodibility, and have important implications to coastal processes and benthic ecosystems. A sediment transport model for the Texas-Louisiana continental shelf was developed to test the sensitivity of seabed sediment erodibility under various oceanographic conditions. The Regional Ocean Modeling System (ROMS) model includes winds, river discharge, waves derived from a Simulating WAVes Nearshore (SWAN) model, and spatially-variable (both horizontal and vertical) sea bed conditions. Freshwater and sediment discharge measurements from the Mississippi and Atchafalaya rivers are incorporated in the model. Multiple sediment tracer experiments are used to perform the sensitivity tests of settling velocities and critical shear stress of sediment on the Texas-Louisiana shelf during fair-weather and storm conditions. Sea floor sediment erosion/deposition and sediment fluxes are calculated during multiple storm events. Measured field sediment erodibility data from a Gusty Erosion Microcosm System are being applied into the sea bed model to represent more realistic sediment dynamics and to reveal the possible sediment impact on the formation of hypoxic events in the northern Gulf of Mexico. (Abstract ID 11965)

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DISSOLVED ALUMINIUM IN THE WEST-ATLANTIC OCEAN FROM GREENLAND TO THE FALKLAND ISLANDS / MALVINAS

Among other parameters, the distribution of dissolved Aluminium (Al) was determined along the GEOTRACES Atlantic Meridional section of the Netherlands. The transect was completed in three cruises with a total of 55 full water column depth stations. The concentrations of Al in general have an inverse relationship with concentrations of major nutrients and correspond remarkably well with major water masses along the transects. The young North Atlantic Deep Water (NADW) has low concentrations of silicate (Si) and low to intermediate concentrations of Al. Contrarily older water from the south such as Antarctic Intermediate Water (AAIW) and Antarctic Bottom Water (AABW) have high Si concentrations and are depleted in Al. The lower NADW appears to become enriched in Al during its southward transport along the bottom until it is underlain by AABW, thus losing contact with the sea floor. This sedimentary source appears to cause the high Al in NADW. During advection of NADW and AABW, Al seems to be scavenged and within the sub-arctic gyre there is evidence for co-dissolution of Al and Si from diatom frustules. (Abstract ID 9728)

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A 13C LABELLING STUDY OF CARBON FLUXES IN ARCTIC PLANKTON COMMUNITIES UNDER ELEVATED CO2 LEVELS

The effect of CO2 on carbon fluxes in Arctic plankton communities was investigated during the 2010 EPOCA mesocosm study in Ny Ålesund, Svalbard. Nine mesocosms were set up with initial pCO2 levels ranging from 180 to 1400 ppmv for 4 weeks. 13C labelled bicarbonate was added to quantify gross carbon fixation (by isotope dilution) and to follow the transfer of carbon from dissolved inorganic carbon into total particulate organic carbon, zooplankton, settling particles, and via the use of polar lipid fatty acids (PLFA) as biomarkers into phytoplankton groups and heterotrophic bacteria. Phytoplankton PLFA showed enrichment within one day after label addition, but label incorporation in green algae and cryptophyte PLFA was much faster than that in diatom and dinoflagellate PLFA. Bacteria PLFA showed enrichment within 2 days, indicating a tight phytoplankton-bacteria coupling. Zooplankton gradually acquired 13C tracer during the experimental period. Sediment trap material became strongly enriched in 13C after about 3 weeks. Significant CO2 effects on algal and bacterial dynamics and particle settling became only apparent after nutrient addition. (Abstract ID 9601)
efforts to explain this observed variability have suggested that it is caused by changes in the
gradient of atmospheric radiocarbon was subject to substantial temporal variability. Previous
Measurements of radiocarbon in tree rings over the last 1000 years indicate that the latitudinal
GRADIENTS IN ATMOSPHERIC RADIOCARBON
THE INFLUENCE OF SOUTHERN OCEAN DYNAMICS ON LATITUDINAL
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SEASONAL VARIABILITY OF THE DEEP CHLOROPHYLL MAXIMUM DYNAMICS IN THE PACIFIC SUB-TROPICAL GYRES
The Deep Chlorophyll Maximum (DCM) is a typical feature of the central zones of the oceans. The mechanisms responsible for its formation, maintenance and possibly destruction are still a matter of debate, partly the consequence of a lack in highly resolved time series. A better understanding of the DCM dynamics and its driving force is required for a better understanding of its role in the control of new production not only because of its spatial significance (~60 % of the global ocean) but also because its location, which is out of reach of satellite detection, corresponds to the base of the productive layer where “new” nutrients are absorbed by phytoplankton. In this study we present bio-optical flow time series in the South Pacific (DCM – 170 m) and North Pacific (DCM – 110 m) gyres. We analyze the conditions and driving forces of its formation, displacement, biomass intensity, and destruction over an annual cycle. We show similar mechanisms in both areas and expect to generalize or validate these findings at other sites, thanks to the future dissemination of Bio-optical floats. (Abstract ID 10284)

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OBSERVATIONS OF HYDROTHERMAL VENT MODIFIED CIRCULATION OVER ROUGH TOPOGRAPHY WITH THE NEPTUNE CANADA CABLED OBSERVATORY
Moorings and Radioecho Sounder

The Endeavour Segment of the Juan de Fuca ridge has vigorous hydrothermal venting in its 10-km-long, 1-km-wide rift valley. Studies in the confines of the valley, the estimated 1500Bq/m³ of hydrothermal heat flux has significant control over the along-axis circulation. Above the ridge complex, the ambient deep-sea circulation is strongly affected by the ridge topography, and the temperature and salinity forcing (i.e. the NEPTUNE Canada cabled undersea network of the Ocean Networks Canada Seafloor Observatory completed deployment of two of its proposed four regional circulation moorings (RCM) at the Endeavour spreading centre in September 2011. The two northern moorings are 700m apart spanning the rift valley and situated ~3km north of the main Endeavour field (MEF) and south of the Salty Dsoq and Sasquatch vent fields. Each carry four CTD/Current meter pairs at 3, 50, 125 and 200mab to resolve the complex hydrothermally modified flow within the valley and an upward-looking ADCP at 250mab to examine topographically modified flow above the ridge. Here we present the first observations from the two cabled moorings. (Abstract ID 11472)

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THE INFLUENCE OF SOUTHERN OCEAN DYNAMICS ON LATITUDINAL GRADIENTS IN ATMOSPHERIC RADIOCARBON

Measurements of radiocarbon in tree rings over the last 1000 years indicate that the latitudinal gradient of atmospheric radiocarbon was subject to substantial temporal variability. Previous efforts to explain this observed variability have suggested that it is caused by changes in the frequency of ENSO in the tropics, but recent idealized model perturbation studies have suggested that the latitudinal gradient in natural radiocarbon may also be highly sensitive to wind driven changes in air-sea fluxes from the Southern Ocean. We use atmospheric and oceanic model simulations to evaluate the relative importance of variability in Southern Ocean air-sea radiocarbon fluxes, tropical air-sea fluxes and atmospheric transport in controlling latitudinal gradients of atmospheric radiocarbon. The results from this suite of simulations suggest that this variability is primarily driven by changes in wind stress over the Southern Ocean, with atmospheric transport playing a secondary role. This work suggests that latitudinal gradients in atmospheric radiocarbon may serve as a proxy for changes in Southern Ocean winds and is likely to be highly sensitive to recent changes in the Southern Ocean carbon sink. (Abstract ID 10715)

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GRAIN SIZE DISTRIBUTION AND SEDIMENT FLUX STRUCTURE IN A RIVER PROFILE, MEASURED WITH A LISSLT-SL INSTRUMENT
Riverine sediment transport data are obtained using a LI3ST-SL laser diffraction instrument, measuring velocity, optical transmission, depth, temperature, and sediment particle size distribution (PSD) isokinetically. The PSD sums to suspended sediment concentration (SSC). Transmission is nearly constant in the top 3.5m of the 4m deep river, suggesting a constant SSC profile. The PSD profile, however, reveals a well-mixed wash load, to which the transmissimeter responds, and a coarse grain mode increasing in size and concentration towards the riverbed, which is not seen by the transmissimeter. Beginning immediately below the surface, data shows a gradual increase towards the bed in sediment flux and the concentration of coarse grains. Near the bed, the sediment flux and concentration of coarse grains are, respectively, factors 3 and 2 higher than at the surface. The particle size concentration profiles follows Rouse, and provides consistent estimates of the friction velocity. SSC statistics display skewness due to the minimum concentration imposed by washload. The mass mean sediment diameter increases by a factor 5 from surface to bottom. The apparent insensitivity of the transmissimeter is explained by a factor 2.5 increase in Sauter Mean Diameter from top to near-bottom. Finally, it is seen that a mean velocity and SSC estimate at half-depth is within experimental error of column-mean values. However, PSD at half-depth is not representative of the column mean PSD. (Abstract ID 9540)

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FLORIDA STRAIT TRANSPORT VARIABILITY DRIVEN BY INTERNAL OCEAN DYNAMICS
It is demonstrated that most of the observed monthly to decadal variability in estimates of the Florida Strait (FS) transport can be attributed to internal ocean dynamics, and not to variability in the atmosphere forcing. We found a clear relationship between eddy shedding of the Loop Current in the Gulf of Mexico and minima in the FS transport, both in observations and in meso-scale eddy-permitting ocean model simulations. Differences (and changes) between eddy shedding period and seasonal cycle lead to an interannual to decadal beat frequency, which dominates the variability of the FS transport in the model simulations in comparison to atmospheric forcing variability. Model simulations without eddy shedding produce significantly less variability in FS transport. Simulations without interannual variability in the surface forcing show almost as large (or even larger) interannual FS transport changes as without forcing variability. It is thus argued that the eddy shedding process leads to most of the observed interannual changes in FS transport, which have been previously interpreted as atmospherically forced variability. (Abstract ID 11380)

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SOUTH ATLANTIC SUBTROPICAL MODE WATERS REVISITED
The properties of Subtropical Mode Waters (STMW) in the South Atlantic Ocean are analyzed using Argo profiles and high density XBT section AX18 data in austral winter from 2002 to 2011. Previous works have identified three STMW in the South Atlantic subtropical front region. Our dataset shows only two mode waters: a warmer salty type with potential temperature between 14.1°C and salinities between 33.25-35.7 and a colder fresh STMW with potential temperature between 12.1°C and salinities between 35.1-35.4. The warmer type is found west of 20°W and its thickness reach 300 m approximately. The colder type is formed in the eastern basin of South Atlantic (east of 25°W) with variable thickness. Warmer layers, with temperatures between 16.1°C characterized as mode waters in previous works, are found only in seasonal thermocline, suggesting that these water types may entrain in the mixed layer in subsequent winters, thus forming the upper part of the permanent thermocline. Considering the geographical distribution and thickness, we suggest that the 14-16°C STMW...
is the South Atlantic counterpart of the well-known North Atlantic Eighteen Degree Mode Water. (Abstract ID 11680)
SALINITY

Modern Antarctic Bottom Water (AABW) properties and formation rate are heavily influenced by ice-ocean processes on the Antarctic continental shelves. At the Last Glacial Maximum (LGM), AABW was colder and saltier, and the salinity contrast between northern and southern source deep water was reversed with respect to the contrast today. We examine to what extent colder temperatures, through their effect on ice formation and melting, set the LGM bottom water salinity and ocean salinity stratification. Computational sensitivity experiments using the MIT gcm ice shelf cavity - sea ice - ocean model are performed using a Weddell Sea domain as a representative case study for bottom water formation originating from Antarctic continental shelves. Ocean temperatures at the domain open boundaries are systematically varied to determine Weddell Sea water mass property sensitivity to a range of cooler conditions. Our results show that reduced ocean temperature has a significant effect on Weddell Sea continental shelf and bottom water salinity, and that temperature has a first order role in determining the salinity of Antarctic Bottom Water, as well as the salinity stratification of the ocean. (Abstract ID 12584)

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APPLICATION OF THE IMPLICIT PARTICLE FILTER TO A MODEL OF NEARSHORE CIRCULATION

We present results of the application of the implicit particle filter to a shallow water model of nearshore circulation, along with gridded observations of the two horizontal velocity components. This is a highly nonlinear model with approximately 30,000 state variables. The implicit particle filter differs from most proposed particle filters in that the trajectory of each particle is informed by observations. In its simplest form, the implicit particle filter reduces to the method of optimal importance sampling. Our results show that the problem of sample impoverishment that plagues many other particle filter methods does not arise here. The system runs efficiently on a single workstation with at least 50 particles, and good results are obtained with as few as 10 particles. (Abstract ID 12499)

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MEASURING THE EVOLUTION OF A DINOFLAGELLATE BLOOM USING AIRCRAFT BASED HYPERSPECTRAL IMAGERY

Aircraft-based hyperspectral remote sensing flights were conducted over Monterey Bay with a Compact Airborne Spectrographic Imager (CASI) during October 2010 in conjunction with the BIOSPACE field program. Special efforts were made to map and monitor a persistent and expansive dinoflagellate bloom in the northeastern region of the Bay. The increased information available in hyperspectral data permits an expanded investigation of the optically complex waters of the coastal ocean. Aircraft altitudes and flight speeds resulted in pixel sizes of between 0.75 and 1.5 meters and covered the spectral range between 377 and 1055 nm. After radiometric calibration, geolocation, and atmospheric correction, spectra from the aircraft imagery were compared with a large database of pre-calculated spectra of known inherent optical properties to determine the water column constituents (chlorophyll, chlorophoric dissolved organic matter, and suspended sediments) of each pixel using the Naval Research Labs Coastal Waters Spectral Toolkit (CWST). Results were compared with concurrently collected ship-based inherent optical property and remote sensing reflectance measurements for validation. Changes in the bloom's structure and optical characteristics over the 10 days of the deployment are described. (Abstract ID 10653)

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PHYTOPLANKTON ASSIMILATION NUMBERS ARE NOT GROWTH RATE DEPENDENT.

The assumption that assimilation number reflects phytoplankton physiology has been long-held in biological oceanography and is thought to be influenced by light and nutrient availability. We monitored 6 indices of photosynthetic activity in steady-state Dunaliella tertiolecta and Thalassiosira weissflogii cultures over a range of nitrate-limited growth rates (μ), including photosynthetic efficiency of PSI (Fv/Fm), C2-bass and net production, 20 min and 24 h carbon absorption, and carbon- and μ-based net primary production NPP. Across all growth rates, chlorophyll normalized gross and net production were constant (assimilation numbers do not vary with growth rate), but short term 14C P vs 1 incubations did not measure net or gross carbon fixation. The oft stated oceanographer question of “what is 14C measuring?” can be answered. Our data demonstrate that it depends on the carbon allocation to a transient carbon pool, a flux that is growth rate dependent, and not dependent on internal carbon recycling. Our work to date supports the use of 24hr 14C incubations as the best estimate of NPP and demonstrate that short term 14C incubations do not reliably measure gross carbon fixation. (Abstract ID 12400)
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POST-LGM FLUX AND FATE OF FLUVIAL SEDIMENTS IN THE GULF OF PAPUA

The modern Gulf of Papua (GoP) clinoform receives most of its sediments from the mountainous Purari, Kikori, Turama and Vaidala rivers that discharge onto the eastern part of the clinoform; these sediments are subsequently transported southwardwestward over the clinoform by counterclockwise currents. Although the Fly River is the largest river discharging into the GoP, it presently accounts for only about 1/3 of the clinoform’s surface sediments. Prior to ~47 ka BP less Fly’s sediment appears to have reached the GoP much of it presumably deposited on the river’s extensive floodplain in response to post-LGM sea-level rise. Holocene accumulation on the clinoform and adjacent mangrove forests accounts for only 50% of the present-day river input; assuming that off-shelf transport has been minimal throughout the Holocene, recent sediment fluxes presumably have been influenced by climate change and/or human alteration of the landscape. Alternatively – or in addition to - on-land storage, particularly on the floodplain, may be greater than previously assumed. (Abstract ID 11277)

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NITRATE UTILIZATION BY PHYTOPLANKTON AND BACTERIAL COMMUNITIES IN THE CHUKCHI SEA

The changing Arctic ecosystem is expected to have major impacts on the region’s marine carbon and nutrient biogeochemistry. Particularly interesting is how changes in organic nutrient inventories will alter competition between phytoplankton and heterotrophic bacteria for mineral nutrients, and how this will impact future Arctic productivity. During the Summer 2011 ICESCAPE expedition to the Chukchi Sea we followed multiple NO3 enrichment bioassays over several days with the goal of describing and quantifying current competition between the phytoplankton and bacterial communities. The addition of NO3 stimulated phytoplankton productivity and biomass in 5 of 6 experiments. The timing of the increases were different between the diatom dominated shelf communities and the picoeukaryote dominated communities northeast of the shelf waters. In contrast, bacterial production and abundance responses to NO3 amendment were variable with positive responses in only a few experiments. Additionally, 15N03 uptake measurements were performed on the whole water and ~2μm fractions and will be addressed with respect to community composition. The impacts of changes in Arctic nutrient biogeochemistry on the nature of competition between phytoplankton and bacteria will be discussed. (Abstract ID 12324)

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SEVERE AND PERSISTENT EFFECTS OF DISTURBANCE ON LARVAL SUPPLY AT VENTS: PATTERNS IN THE PLANKTON AFTER THE 2006 ERUPTION ON THE EAST PACIFIC RISE

In order to predict how benthic communities will respond to disturbance, it is necessary to understand how disturbance affects the planktonic larval supply available to recolonize the area. Deep-sea hydrothermal vent fauna along the East Pacific Rise (EPR) experience frequent local extinctions due to tectonic and magmatic events, but the effects on larval supply of longer-term disturbances, such as a polymetallic sulfide mining operation, are unknown. We had been monitoring larval supply at ’9507 on the EPR prior to the 2006 eruption and were able to perform long-term larval surveys during the 2007 and 2010 cruises. In this study, we evaluated the impact of the 2006 eruption on larval recruitment to the EPR. We found that larval supply was severely disturbed for several years following the eruption, but recovery was already underway by the 2010 cruise.
resumes collection shortly afterward. We found that many species that were common before the eruption became significantly rarer, whereas a few species increased in abundance. Overall species richness remained high some months afterward, then decreased sharply and had not returned to pre-eruption levels nearly two years later. These results suggest that recovery from long-term disturbance may not follow the rapid trajectory reported from some previous eruptions, particularly if the post-disturbance environment does not provide a favorable habitat for colonization. (Abstract ID 10346)

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Dissolved cobalt distributions in the (sub-) tropical Atlantic Ocean as part of the UK GEOTRACES A06 cruise

Co is an essential micronutrient for critical biological processes. It is an absolute requirement for the photosynthetic cyanobacteria Prochlorococcus and Synechococcus. Given that Prochlorococcus is thought to be the most abundant marine autotroph, and thus accounts for a significant proportion of global photosynthesis, the importance of Co in marine systems is evident. Despite this, knowledge of its distribution and cycling is limited. The 2011 UK GEOTRACES A06 transect of the Atlantic Ocean (10°S-17°N) and an east-west transect (12°N) increased our understanding of Co in this region. This is a region of high Saharan dust inputs and an oxygen minimum zone, moreover entrainment from lateral shelf transport could potentially be significant. Water column profiles were collected from 24 depths, ranging from 20 m to a maximum depth of 5600 m. Samples were determined for total dissolved Co using an established ICP method following UV irradiation. Co concentrations ranged dramatically from a potentially limiting ~5 pM in the surface waters of the North Atlantic gyre to a high of 135 pM observed in the subsurface shelf waters of the oxygen minimum zone. (Abstract ID 11202)

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Assessment and propagation of uncertainties in input terms through an ocean-colour-based model of primary productivity

Uncertainties in input terms were propagated through one of the most widely used net primary productivity (NPP) models via a Monte Carlo method. The study was based on monthly averaged global remote sensing observations from 2005. We found that the typical distribution of uncertainty around the model output was lognormal-like. The nominal NPP values in individual grid cells were typically overestimated by 6%, relative to the means of the associated uncertainty distributions. The random component of uncertainty in NPP, expressed as the coefficient of variation, was 108% on average. The positive systematic errors accumulated to an overestimate of 2.5 Pg C in the annual global NPP of 46.1 Pg C. The input quantity that contributed most to the systematic uncertainty in NPP was the parameter representing irradiance-dependent vertical changes in chlorophyll-normalized photosynthetic rates. On the other hand, the largest contributor to the random uncertainty in NPP was the term describing the physiological state of phytoplankton. Thus, reductions in the respective uncertainties in these two input terms could improve the accuracy of the NPP model by 1% on average. (Abstract ID 11385)

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Decadal-scale dissolved oxygen changes in the three mid-latitude marginal seas

Along with the recent ocean warming, detectable changes in dissolved oxygen concentrations have been observed in intermediate and deep waters in the various ocean basins during the recent decades. Changes in solubility, ventilation, circulation, and biological productivity may contribute to the changes. Although smaller in size, some marginal seas may serve as a good proxy for the larger scale ocean changes. We analyze the oxygen data from the Mediterranean Sea (MS), the East/Japan Sea (EJS), and the Gulf of Mexico (GoM) during the 1960-1999 period to better understand the decadal-scale oxygen variability in these seas. Dissolved oxygen of the deep waters in these seas is replenished either by local deep water formation or by deep water inflow from the open ocean. We compare temperature, salinity, bottom density, and oxygen distributions, which are merged for individual decades, at several sub-regions for each sea. The oxygen content in deep waters (1000-2500 m) has increased, decreased, and changed insignificantly in MS, EJS, and GoM, respectively during the last several decades, indicating different processes might be dominantly affect the changes in different marginal seas. (Abstract ID 12755)

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LARGE EDDY SIMULATION OF OCEAN RESPONSE TO A TYPHOON IN THE EAST CHINA SEA

A large eddy simulation (LES) model is used to examine an ocean response to a typhoon in the East China Sea. Wind stresses and wave fields at the right of the route where the typhoon Komppasu passes are applied for surface forcing, and temperature and salinity structures observed before the typhoon is used as an initial ocean condition. The LES model shows that turbulent intensity increases and surface mixed layer deepens during the typhoon as expected. In contrast to the vertical component of the turbulent intensity which is high in the middle of the mixed layer, its horizontal component is high very near the surface. Besides near the surface, the downwind direction component of the turbulent intensity is high near the bottom of the surface mixed layer while the crosswind direction component is low. With the comparison experiment to examine the effect of wind direction change, it is found that the change of wind direction influences the velocity field not only in the mixed layer but also below the thermocline. (Abstract ID 11033)

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The role of iron ligands in controlling southern ocean Fe cycling and primary productivity: a modeling study

Iron is the nutrient limiting primary productivity in the Southern Ocean, with much of dissolved iron (dFe) bound to organic ligands or colloids. A Southern Ocean Fe model was developed and coupled with a one dimensional ROMS model to understand the role of organic ligands in controlling Fe cycling and productivity. The model resolves the classical food web and microbial loop, including three nutrient types (N, Si, Fe) and two ligand types produced by iron-stressed bacteria and remineralization of dissolved organic matter. Numerical simulations gave results generally agreeing with observed in situ nutrients, chlorophyll and zooplankton biomass. Further analysis suggests that Fe cycling can be categorized into fast euphotic zone cycling dominated by photo-reactions and ligand binding and slow subsurface cycling with most dFe biologically complexed. The removal flux of dFe from euphotic zone is determined by the relative strength of photo-reduction, organic binding, biological uptake and scavenging. Also, direct uptake of Fe by phytoplankton significantly increases productivity and allows a longer bloom, supporting high secondary production in the Antarctic Peninsula, consistent with satellite and field observations. (Abstract ID 11226)

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Ozone acidification indirectly effects microzooplankton grazers via PCO2-induced alterations to prey state

Rising ocean pCO2 can directly affect phytoplankton physiology, biochemistry, and morphology. These direct phytoplankton responses to elevated CO2 may alter rates of ingestion and growth of their primary consumers, the microzooplankton, because of their acuity to changes in prey state. Thus, elevated pCO2 may indirectly affect microzooplankton ecology, which in turn may alter rates of energy transfer across, and nutrient cycling within, plankton communities. We ran experiments exploring how elevated pCO2 (395, 750, and 1000 ppmv) affects calcifying and non-calcifying E. huxleyi cultured under 750 and 1000 ppmv pCO2 at higher rates than cells grown under ambient pCO2 over short time scales, yet growth rates of both microzooplankton species were lower on E. huxleyi cultured under 750 and 1000 ppmv pCO2 than under ambient pCO2. Our results imply reduced food web efficiency in a high pCO2 ocean resulting from alterations in planktonic predator and prey interactions. (Abstract ID 9911)

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VARIABILITY OF THE SEA-SURFACE TEMPERATURE: AN OVERVIEW

The temperature of the sea surface (SST) is a deceptively simple concept that in reality exhibits a complex behavior with a wide range of temporal and spatial variability. We are able to measure
the SST on spatial scales from sub-millimeter to the dimensions of ocean basins; variability exists at all scales. Ocean currents and eddies are depicted at the larger scales, revealing the underlying turbulent nature of the upper ocean, and at the microscale the SST responds to both ocean and atmosphere and helps control, and is controlled by, the ocean-atmosphere heat, momentum and gas fluxes. Better knowledge of the causes and effects of SST variations will provide enhanced knowledge of the coupling of the ocean and atmosphere; this has a wide range of applications including improved weather- and ocean-forecasting and a better understanding of the role of the oceans in the climate system. The presentation will provide a brief overview of the characteristics of SST variability, based primarily on measurements taken in situ and remote sensors. (Abstract ID 10680)

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DETECTING DECADAL CLIMATE PHASE REVERSAL IN NEAR PAST: IMPLICATIONS OF RECENT NORTH PACIFIC CLIMATE VARIABILITY
Decadal climate variability, in which air-sea interaction in the mid-latitudes especially those over the western boundary currents may play a role, strongly influences a wide range of aspects of the ocean and climate over land. Therefore, understanding of the current or near past decadal climate status as correct as possible is of great scientific and socio-economic importance. However, to isolate decadal variability from observed data near the end of record is not a simple task. In this study, we develop a new method for objective evaluation of uncertainty in decadal climate variability around the end of the record with special attention to recent phase reversals on decadal timescales. A performance test of this method indicates that a decadal phase reversal associated with so-called major climate regime shifts, such as those in the 1940s and 1970s, can be detected after two-three years from its occurrence. Implications of the application of this method to the recent North Pacific climate conditions will be discussed. (Abstract ID 11266)

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THE INTERACTION BETWEEN THE BRAZIL CURRENT AND TOPOGRAPHY FROM A QUASI-GEOSTROPHIC MODEL
Mesoscale structures in the Brazil Current seem to be associated with features in the coastline. Some observational evidences suggest they are recurrent. In the present work we aim to investigate the role of topography on the formation of these features in two scenarios. The first is off the eastern Brazilian coast (nearly 19°S), where anticyclones fit between banks and seamounts. In the second scenario, a change in coastline direction in the southeastern coast seems to play a role in generating eddies and occasional dips (nearly 23°S). The approach utilized here was idealized numerical modeling: we examined the evolution of the potential vorticity field of a coastal jet in a quasi-geostrophic 1-layer model. The idealized jet satisfies the Rayleigh necessary condition for instability, but the growth rates are small. The change in coast orientation provides perturbations exciting the instabilities of the jet. The relative width of the jet vs. rate of change in the coast orientation determines whether the jet will separate from the coast and form eddies. Depending on this relation, we obtained patterns closely resembling the observations. (Abstract ID 11196)

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ECOSYSTEM CHANGE ALONG SOUTHERN COASTLINES OF ARGENTINA AND CHILE; STABLE ISOTOPE ANALYSES OVER THOUSANDS OF YEARS USING ARCHAEOLOGICAL REMAINS
The archaeological records of the coastlines of southern Argentina and Chile are well preserved and provide data critical to understanding the effects of climate change on humans and the marine ecosystems they relied upon. Using 270 bird and sea mammal samples from archaeological sites spanning 5000 years in both regions, preliminary investigations of stable isotopes of carbon and nitrogen trace changes through time in marine ecosystems. Species investigated include southern sea lion (Otaria flavescens), southern fur seal (Arctocephalus australis), common oyster (Phalacrocorax spp.), penguin (Aptenodytes patagonica and Eudyptes chrysolophus) and gull (Larus dominicanus). These data are correlated with existing archaeological and paleoecological data to investigate the effects of ecosystem disruptions on human adaptive strategies, the long-term dynamics of marine ecosystems, and marine responses to global and regional climatic events. (Abstract ID 9465)

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INTERANNUAL AND STORM-RELATED EVOLUTION OF NEARSHORE MORPHOLOGY AND ITS RELATIONSHIP TO SHORELINE BEHAVIOR
We present a time series of three-dimensional geophysical data collected over a two-year period contrasting two nearshore regions, one with shore-parallel bars and homogenous sediments and another with shore-oligoc bars and heterogeneous sediments. High-resolution shoreline behavior data are compared to geophysical observations including swath bathymetry, backscatter and high-resolution seismic reflection data. Observed nearshore behavior is highly spatially variable, even between sites with similar nearshore bar morphology. Nearshore sediment thickness and bar morphology are related to the magnitude of interannual nearshore variability and the cross-shore extent of morphologic variability, respectively. Additionally, interannual nearshore and shoreline evolution is more dynamic in regions with shore-oligoc bars than in regions with shore-parallel bars, which is likely related to high variability in cross-shore profile slope over small longshore distances. Observations for specific storm periods suggest that extratropical storms and spatial variation in seafloor sediment act to preserve shore-oligoc bars and troughs, whereas tropical storms tend to diminish the morphology. Analyses of datasets like this one provide unprecedented insight to the complexity and interconnectedness of nearshore and shoreline morphological evolution. (Abstract ID 11373)

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BIO-OPTICAL INVERSION MODEL FOR RETRIEVING PHYCOCYANIN CONCENTRATION IN CYANOBACTERIA DOMINATED WATERS
We present a novel technique to monitor cyanobacterial harmful algal bloom (CHAB) using hyperspectral remote sensing reflectance, Rrs (λ) and products. We have modified a multi-band quasi analytical algorithm to retrieve phytoplankton absorption coefficients, aab (λ) and data collected from several highly turbid and hypereutrophic aquaculture ponds. A novel technique was developed to further decompose the aab (λ) and obtain phyocyanin absorption coefficient at 620 nm, a620. (An empirical relationship was established between a620 and measured phyocyanin concentrations. Model calibration showed strong relationship between a620 and phyocyanin pigment concentration (R²=0.94). Validation of the model in a separate data set produced a root mean squared error of 167 mg m-3 (phyocyanin range: 26-1012 mg m-3). Band architecture of the model allows for the potential of CHAB hyperspectral sensors such as the Hyperspectral Imager for the Coastal Ocean (HICO) and Hyperion, and multispectral sensor such as Medium Resolution Imaging Spectrometer (MERIS) to monitor CHAB in opticaly complex waters. (Abstract ID 10401)

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EVALUATING THE IMPACTS OF SPATIALLY-VARYING IRON-BINDING LIGAND CONCENTRATIONS ON DISSOLVED IRON DISTRIBUTIONS IN THE GLOBAL OCEAN
This study incorporates a spatially-varying distribution of iron-binding ligand concentrations into an ocean general circulation model simulating the marine iron cycle. The distribution of apparent oxygen utilization is used as a proxy for humic substances that have recently been hypothesized to account for the bulk of iron-binding ligands in seawater. Compared to two control cases using the conventional approach with homogeneous ligand distributions, an experiment incorporating the spatially-varying ligand distribution exhibits substantial improvement in simulating the global dissolved iron distribution as revealed in available field data. The better model-data skill results largely because the spatially-varying ligand distribution results in a more reasonable basin-scale variation in the residence time of iron at high concentrations. Our model results, in conjunction with evidence from recent field studies, suggest that humic substances are playing an important role in the iron cycle in the ocean. (Abstract ID 10705)

2012 Ocean Sciences Meeting
OCEAN AROUND FUKUSHIMA
TRANSPORT SIMULATIONS OF THE RADIONUCLIDE FROM THE SHELF TO OPEN
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During the summers of 2010 and 2011 we participated in the NASA-sponsored ICESCAPE cruises to the Chuuk and Beaufort Seas where we completed a total of 70 profiled UV-visible radioradiometer stations with supporting analyses of chlorophyll and absorption by particles, detritus and soluble material (ap, ad, as). Data were collected for coastal shelves and deeper waters that were partially ice-covered. ICESCAPE data were compared to our California Current bio-optical data which have a similar total range in observed chlorophyll. Absorption of soluble and detrital material for ICESCAPE were much higher per unit of total absorption and per unit of chlorophyll compared to CalCOFI. There was also very significant regional scale variability in relative ratios of the absorption components, with particularly high ap/(ap+as) in coastal waters near river inflow. Since ocean color reflectance is strongly affected by the absorption coefficients, the strong contributions of ad and as at 443 nm lead to large over-estimates of chlorophyll up to 3x using standard NASA algorithms. Implications for regional satellite estimates of chlorophyll and primary productivity will be discussed. (Abstract ID 9799)

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RAINBAND IN THE EAST CHINA SEA SUSTAINED BY THE WARM SEA Surface TEMPERATURE OF THE KUROSHIO
A narrow rainband emerged to the west of the Okinawa Islands in the evening of 19 May, 2010 and persisted for more than a half day. It was separated clearly from the Baiu/Meiya front to the north. The collocation with the Kuroshio axis suggested warm sea surface temperature (SST) of the Kuroshio contributed to the organization of convective precipitation systems. To confirm this hypothesis, we conducted a set of numerical experiments using a regional atmospheric model. The control run where satellite-measured high-resolution SST was prescribed successfully reproduced the observed rainband structure. The reproduction, however, failed in another experiment where the SST fields had been artificially smoothed to eliminate the band of SST maxima along the Kuroshio axis. These results clearly demonstrate that the high SST along the Kuroshio was of critical importance in organizing the rainband. This study thus presents an obvious example supporting recent discoveries that the mid-latitude western boundary currents can influence the overlying atmosphere. Additional experiment using the flattened Taiwan showed that the orography played some but less important role than the SST in this case. (Abstract ID 10866)

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AN EFFECTIVE RADIUS OF THE SEA SURFACE ENTHALPY FLUX FOR THE MAINTENANCE OF A TROPICAL CYCLONE
The present study found that there is a radius within which the sea surface flux for moist enthalpy plays a vital role in determining the intensity of a tropical cyclone. From the results of the numerical experiments using an axisymmetric nonhydrostatic model, it was shown that when the sea surface fluxes are modified within the radius the tropical cyclone intensity suddenly changes on a short time scale. As long as the surface enthalpy flux diminishes outside this radius the tropical cyclone maintains its intensity. From the results of numerical experiments using an axisymmetric nonhydrostatic model, it was shown that when the sea surface fluxes are modified within the radius the tropical cyclone intensity suddenly changes on a short time scale. As long as the surface enthalpy flux diminishes outside this radius the tropical cyclone maintains its intensity. 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rapid and sustained expansion of OMZs, the gradation of biological responses, and the spatial oceanographic processes that maintained oxygenation across the coastal basin feature through the deglaciation. (Abstract ID 10496)

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ACTION OF NONLINEAR INTERNAL WAVES AT THE NAMIBIAN SHELF

The sediment distribution on the Namibian shelf depicts accumulation of carbon rich sediments in three, belt like patterns parallel to the bathymetry. The location of critical slope angles for internal M2 tide coincide with the gaps between the accumulation areas, most probably caused by enhanced sediment resuspension. Surface expressions of nonlinear internal waves are a common feature in satellite images of the Namibian shelf. Observations of temperature time series, near bottom currents and TKE dissipation rate are presented, which reveal the occurrence of highly nonlinear internal waves and enhanced levels of turbulent kinetic energy. The power spectrum of horizontal current velocities in the internal wave range N(1) is dominated by the M2 tide, diurnally forced motions and near inertial waves. Temperature time series show intermittent wave packages with wave periods between 0.7 to 1.2h. It is hypothesized that the nonlinear waves are generated by breaking events of M2 internal tide at the shelf edge. This region is characterized by thick, well mixed bottom layers with high SPM concentration and enhanced levels of TKE dissipation rate throughout the water column. (Abstract ID 9468)

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SUB-MESOSCALE INSTABILITIES ON THE RIM OF A MESOSCALE EDDY

Sub-mesoscale flows are subject of interest because they represent a dynamical regime where the rigorous bounds of geostrophy are being relaxed. This allows for the occurrence of a forward energy cascade and enhanced vertical exchanges that are precluded by larger scale geostrophic dynamics. As an example of sub-mesoscale flow, we will investigate a mesoscale eddy in the Cape Hatteras area that is unstable to sub-mesoscale perturbations along its rim. The eddy that is studied bears a striking resemblance to an unstable eddy that was observed in area in the Summer of 2011 with the M2OS-TERRA satellite. Using a numerical solution of ROMS (the Regional Ocean Modeling System) we will discuss the characteristics of the evolution of the sub-mesoscale unstable mode and its implication for horizontal and vertical mixing of tracers, and dissipation of kinetic energy. ROMS allows for the seamless offline nesting of multiple domains with increasing levels of grid resolution. This makes it possible to resolve both mesoscale eddy and straining field as well as the evolution of very small scales using very high numerical resolution. (Abstract ID 12225)

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CONSTRaining CO2 budgets in the CONTinental SHELF SEAS of alaska: NEW INSIGHTS FROM MOorings and ocean time-series

The Pacific-Arctic region plays an important and likely increasing role in the global climate system with complex and poorly understood interactions and feedbacks among sea ice, the ocean and atmosphere, the cryosphere-hydrological cycle, and ocean circulation, leading to significant impacts on the global balance of atmospheric carbon dioxide (CO). Here, we use data from recent ocean observations and moorings to constrain the sources and sinks of CO in the coastal oceans surrounding Alaska. These novel datasets show that the northern Gulf of Alaska, the Bering Sea, and the Western Arctic Ocean are all moderate to strong sinks for atmospheric CO, throughout the spring and summer in response to biological drawdown in the surface ocean. However, this sink is mitigated by the intrusion of riverine and glacial runoff along the coast that has high pCO, as well as seasonal ice-melt that can dilute total alkalinity and also cause an increase in surface water pCO. In winter, coastal upwelling and the remineralization of organic matter can lead to the outgassing of CO, particularly in the in-bay and estuaries along the coast. (Abstract ID 9486)

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TESTING AIR-SEA EXCHANGE PARAMETERIZATIONS THAT INCORPORATE CHEMICAL AND PHYSICAL PROCESSES OPERATING ON SMALL SPATIAL AND TEMPORAL SCALES

Air-sea flux parameterizations are important controls in biogeochemical cycling and are thus critical components in global climate models. As the number and resolution of air-sea flux field measurements increase, more insight into the dynamics and variables that control the flux of the various molecules across the atmosphere-ocean boundary is gained. The air-sea flux of carbon dioxide, di-methyl sulphide and other gases has been modeled through several investigations, primarily as a function of wind speed. These models are compared against the change in gas flux, measured by direct eddy covariance during recent field studies conducted in the Southern Ocean, with coincident changes in wind speed, and concentration changes in air and water, to lend further insights into the chemical properties that give rise to differences in the air-sea exchange coefficients of various gaseous species. (Abstract ID 10642)

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MEASUREMENTS OF TURBULENCE AND SCALAR FLUCTUATIONS ACROSS A SEAGRASS PATCH EDGE USING PIV AND PLIF

Seagrass communities provide diverse ecosystem services, including habitat complexity, carbon sequestration, and flow baffling which promotes sedimentation and nutrient uptake in coastal waters. A better understanding of hydrodynamics and transport of dissolved and particulate species in seagrass ecosystems can improve modeling and efforts toward their restoration. Here we study flow in a model seagrass canopy in the UNC-Chapel Hill Fluids Lab, consisting of 800 species in seagrass ecosystems can improve modeling and efforts toward their restoration. Here we study flow in a model seagrass canopy in the UNC-Chapel Hill Fluids Lab, consisting of 800 flexible blades covering 4 m of an 18 m long recirculating flume, and extending 30 cm across the 75 cm channel width. We study the dynamics at the canopy edge, measuring vertical and horizontal flows with stereooscopic Particle Image Velocimetry (PIV), with particular focus on turbulence spectra and coherent structures. We also use Planar Laser-Induced Fluorescence (PLIF) to quantify the concentration spectra of a passive dye source as a function of position relative to the edge. In particular, we ask what effect the proximity of an organism to a patch edge has on the turbulence level and the strength, variability, and intermittency of chemical signals it experiences. (Abstract ID 12780)

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REGIONAL AND SEASONAL DIFFERENCES IN THE IMPACT OF MESOSCALE OCEAN EDDIES ON SATELLITE ESTIMATES OF SURFACE CHLOROPHYLL AND PRIMARY PRODUCTION

The movement of individual mesoscale ocean eddies can be tracked through time using automated methods applied to weekly gridded sea surface height estimates derived from merged satellite altimetry products. We have combined tracked eddy information location,
movement, diameter, amplitude and nonlinearity) with satellite-derived observations of surface chlorophyll concentration, sea surface temperature and vector winds to study the impact of mesoscale eddies on satellite estimates of chlorophyll and net primary production. The study has been applied to thousands of individually tracked eddies that formed in subtropical ocean regions between 1998 and 2009. Results confirm our basic understanding of a positive relationship between vigorous cyclonic eddy spin-up and the enhancement of surface chlorophyll concentration and associated enhancement of net primary production. Observations also suggest that there are secondary effects associated with eddy-wind interactions and with seasonal changes in winter convection and subsequent spring-summer stratification. (Abstract ID 11284)

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WAVES, STOKES DRIFT AND WAVE-DRIVEN FLOW OVER A CORAL REEF
We will discuss observations of wave-driven flow over a large reef on the north shore of Moorea, FP. Typical of many Pacific reefs, the Moorea reef has a steep fore-reef upon which incident waves break and pass over a very shallow reef crest into a lagoon filled with coral structures of different scales. Our observations show that the overall flow inshore of the reef crest, but offshore of the surfzone, is largely in the form of Stokes drift (wave transport), whereas inshore of the break, the transport is entirely carried by the Eulerian mean flow. While the setup that drives the inshore flow nicely obeys standard radiation stress theory (in contrast to previous results at this site), the effective drag coefficient in the lagoon appears to be flow dependent. Unique ADCP-based observations of the velocity field near the edge of the surfzone show that despite the strong nonlinearity of shoaling waves, mean properties like Stokes drift and radiation stress can be directly calculated from the rms wave height. (Abstract ID 12246)
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LATERAL DISPERSION IN THE THERMOCLINE ON THE INNER SHELF OF NORTHERN MONTEREY BAY
We examine lateral mixing dynamics within the thermocline on the inner shelf (~20m depth) using a continuously released Rhodamine WT dye plume. An autonomous underwater vehicle (REMUS AUV) made measurements of the plume in the form of consecutive transects at increasing distances downstream from the dye source in a "mow-the-lawn" pattern. The growth of the plume around its centerline suggests a scale-dependent lateral dispersion process, which we quantify in terms of a spatially changing lateral dispersion coefficient. High-resolution ADCP measurements of a complex velocity field were used to generate a modeled plume to compare against the field measurements. Analysis of the model dye field reveals the importance of vertical shears in horizontal velocities for driving shear flow dispersion processes in the lateral direction. We discuss the role of internal waves as a mechanism for generating some of the observed small-scale vertical variability of the horizontal velocity field and associated lateral dispersion. (Abstract ID 11492)
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STRONG REGULATION OF THE OCEANIC OXYGEN CONTENT BY MARINE PRODUCTIVITY: LESSONS FROM THE PAST
Taking the experience of the Oceanic Anoxic Events (OAEs), we illustrate how marine productivity can strongly regulate the oxygen content in the ocean along with the marine nitrogen cycle. OAEs are extreme climate events of the Cretaceous, characterized with warm temperature and widespread deposition of organic-carbon-rich sediments, indicating large perturbations of the global carbon and the marine oxygen cycles during OAEs. Using an Earth System model (GENE), we reconstruct the spread of oxygen minimum zones observed during the OAE of the late Cretaceous (93 Ma), and investigate the controlling mechanisms. We find that marine productivity with increasing nutrients is much more efficient at removing oxygen from the water column, than changing ocean physics (including ocean circulation and oxygen dissolution) with warmer temperature. Our reconstruction suggests that at least 50% of the ocean volume became anoxic during the event as a result of a three-fold increase in productivity. Preliminary results also suggest that the efficiency of marine productivity at removing oceanic anoxic might relate to how anoxic interwines with nitrogen fixation, nitrification and remineralization of organic matter. (Abstract ID 11097)
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THE DEEPWATER HORIZON OIL SPILL AND PELAGIC FOODWEBS IN THE NORTHERN GULF OF MEXICO: WHAT DO ELEMENTS AND ISOTOPES TELL US ABOUT OIL, PLUMES, AND ZOOPLANKTON?
The Deepwater Horizon (DWH) released some five million barrels of oil in offshore waters of the Gulf of Mexico. During cruises to the region shortly after the flow of oil was halted (OC468, 21 Aug-16 Sep 2010) and about 10 months later (EN496, 2-27 July 2011), we collected samples of suspended particles and zooplankton for elemental and isotopic analysis. In 2010, we encountered multiple subsurface features with low beam transmittance, distinct spectral fluorescence signatures, and high particle concentrations. These features occurred between about 150 and 1400m depth in all directions around the DWH wellhead. Although these layers appear spatially linked to the DWH oil spill, they did not consistently show high concentrations of methane or unusually low 8°C. At the same time, many of our zooplankton had an unusual brown to black coloration. These features were absent during our repeat visit in 2011. We will discuss the hydrographic context of our samples and their elemental and isotopic composition, which provide an index to the biogeochemical impact of the spill on pelagic foodwebs in the Northern Gulf of Mexico. (Abstract ID 11288)

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THE GULF OF MEXICO PILOT PREDICTION PROJECT (GOMEX-PPP)
Eight data-assimilative numerical circulation models are being evaluated for use in an operational ocean prediction system. The models are forced by operational weather forecasts, river runoff, etc. Only operational observations (e.g., satellite-derived sea surface heights and temperature, coastal sea levels, and telemetering ADCPs) are assimilated. Non-operational observations are used in assessment systems. The system aims to predict attributes of the Loop Current and the eddies it sheds in the open Gulf, the shelf circulation, and the interactions of the open Gulf and shelf circulations. These interactions can impact Lagrangian transports of contaminants, etc. The skill assessment metrics must address these varied aims. The project commenced in 2010 coincidentally with the Deepwater Horizon accident. Each model has a native space-time grid and domain; hence, the model outputs were mapped to a common grid and domain to facilitate comparisons. The experimental plan has three components: Step 1, a retrospective nowcast for 2010; Step 2, a retrospective 3-month forecast for 2010; and Step 3, a real-time 3-month forecast for 14 weeks in 2011. Salient results are summarized; details are given in associated presentations. (Abstract ID 12460)

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REGIONAL TESTBEDS: A NEW COLLABORATIVE PARADIGM
Regional testbeds offer a means for interfacing the R&D community and the operational and applications communities concerned with sustained advancement of regional, coastal, and estuarine circulation and ecological prediction systems in a mutually beneficial fashion. Regional testbeds offer a means for interfacing the R&D community and the operational and applications communities concerned with sustained advancement of regional, coastal, and estuarine circulation and ecological prediction systems in a mutually beneficial fashion. Regional testbeds offer a means for interfacing the R&D community and the operational and applications communities concerned with sustained advancement of regional, coastal, and estuarine circulation and ecological prediction systems in a mutually beneficial fashion. Regional testbeds offer a means for interfacing the R&D community and the operational and applications communities concerned with sustained advancement of regional, coastal, and estuarine circulation and ecological prediction systems in a mutually beneficial fashion. Regional testbeds offer a means for interfacing the R&D community and the operational and applications communities concerned with sustained advancement of regional, coastal, and estuarine circulation and ecological prediction systems in a mutually beneficial fashion. (Abstract ID 12513)

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PHYSIOLOGICAL AND BEHAVIORAL RESPONSES TO SOUND IN THE LONGFIN SQUID (LOLIGO PEALEI)

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While responses to sound have been described in many underwater vertebrate species (e.g., mammals and fish), considerably less attention has been paid to marine invertebrates. Among cephalopods, this is surprising because squid comprise a key component of the ocean’s biomass and play a central role in many marine ecosystems. Here we describe physiological and behavioral responses to sound in squid (Loligo pealeii). Physiological responses were measured using auditory evoked potentials. Hearing ranges and thresholds were established for both pressure and particle-motion components of a sound field. Physiological responses were generated between 20 and 500 Hz, with lowest thresholds between 100-200 Hz. Acceleration and sound pressure peaks also generated responses. Behavioral responses (jetting and body patterning changes) were initiated in a narrower frequency range (50-300 Hz) and at levels 15-20 dB higher then physiological thresholds. Results suggest squid likely “hear” similar to fish and that squid can sense acoustic stimuli from predators, prey, and ambient or anthropogenic sources. These novel findings are important for understanding controls on habitat ranges, prey selection and predator avoidance in a key marine invertebrate. (Abstract ID 10563)

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INTEGRATING PLANKTON FUNCTIONAL GROUPS INTO EARTH SYSTEM MODELS

Increasingly, plankton functional groups are being incorporated into the global-scale ocean models used in climate simulations. Ocean biota strongly impact carbon cycling and the air-sea carbon dioxide fluxes. Thus, it is important to understand the feedbacks between biological communities and activities, and climate, in order to understand marine carbon cycle perturbations under different climate states. The marine carbon cycle is intimately linked with the cycles of nitrogen, phosphorus, silicon, and iron. Key plankton functional groups play major roles in each of these biogeochemical cycles, and, thus need to be represented in coupled climate-biogeochemical models, also called Earth system models. Significant progress has been made in linking carbon with these biogeochemical cycles through various plankton functional groups, but many challenges remain. One difficulty is representing diverse organisms within a single functional group, with limited knowledge about many important organisms. There is limited observational data available for constraining phytoplankton community composition under the current climate regime. Computational constraints are also a factor restricting model spatial resolution and biological complexity. This talk will examine recent progress and strategies for future development. (Abstract ID 11889)

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Atoll topography and internal wave trains on uniform slope/shelf topography in a two-layer stratified fluid system. (Abstract ID 324)

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PHYSICAL AND BIOLOGICAL CONTROLS ON OXYGEN MINIMUM ZONES IN THE CESM/CCSM OCEAN MODEL

Oxygen minimum zones (OMZs) play a key role in the marine nitrogen cycle, as the location where much of the loss of fixed nitrogen and production of nitrous oxide occurs. OMZs form where ventilation processes that allow oxygen replenishment from the atmosphere are weak and the remineralization of sinking organic matter is sufficient to deplete oxygen to very low concentrations. Observational evidence suggests that the ocean’s core OMZs may be expanding in response to climate change. Model studies suggest that the ocean’s oxygen content will decline over the coming century due to increasing ocean temperatures and stratification. The coarse-resolution ocean models used in climate simulations typically do a poor job of reproducing the current distribution of OMZs. Recent improvements to one such model, the Community Earth System Model (CESM/CCSM) allow a much better representation of OMZs for the current era. This talk will focus on the physical and biological controls on OMZ distribution in the CESM model. (Abstract ID 12163)

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TOWARD EFFECTIVE CARBON CYCLE MODELING IN AN ESTUARY USING A ONE-DIMENSIONAL VERTICAL BIOPHYSICAL MODEL

A one-dimensional vertical mixing model coupled to an NPZD biological model has been developed for the Strait of Georgia, British Columbia. The physical model is a K-profile mixing
model with two-dimensional processes such as estuarine circulation parameterized and has been previously used to successfully hindcast the timing of the spring phytoplankton bloom. The current biological model includes multiple size classes of phytoplankton and zooplankton, a remineralization loop, and the nutrients nitrate, ammonia, and silica. Results through the full seasonal cycle will be compared to data collected as part of the STRATOGEM project. In addition to the models, this project will explore and incorporate carbon cycles to begin to investigate the factors contributing to acidification in the Strait. Comparison of the carbon model with recently available carbon observations in the Strait will be discussed. (Abstract ID 11743)

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IMPACT OF PHOTO-FLOCCULATION OF TERRESTRIAL DISOLVED ORGANIC MATTER AND IRON ON THE MARINE DOM POOL

DOM rich water samples (Great Dismal Swamp, Virginia) were 0.1-um filtered and UV-irradiated in a solar simulator for 30 days, during which particulate organic matter (POM) and particulate iron formed. Dissolved and particulate phases were analyzed by UV-visible spectroscopy, TOC/DOC, 13C-NMR, FT-IR, and AAS for iron. After 30 days, 7.1% of the DOC was converted to POC while 75% was remineralized—87% of the iron was removed from the dissolved phase after 30 days, but iron did not flocculate until an excess of DOM was removed by photo degradation and flocculation (~10 days); thus, during the initial 10 days, there were still sufficient organic ligands present to keep iron in solution. NMR and FT-IR spectra indicated that the photo-flocculated POM is more aliphatic than the photo-oxidized DOM. Photo-flocculated POM was also enriched in amide functionality, while carbohydrates were resistant to both photo degradation and flocculation. Abiotic photochemical flocculation removes a significant fraction of terrestrial DOM from the upper water column and is therefore a heretofore-ignored phenomenon that alters our understanding of DOM and POM cycling & transport in ocean margins including estuaries. (Abstract ID 10753)

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ELEVATED 15N/14N IN PARTICULATE ORGANIC MATTER, ZOOPLANKTON, AND DIATOM FRUSTULE-BOUND NITROGEN FROM THE ICE COVERED WATER COLUMN OF THE BERING SEA SHELF

A survey of δ15N of particulate organic matter (POM), zooplankton, and diatom frustule-bound N from material collected with 53 and 153 µm nets across the eastern Bering Shelf in late winter reveal a pattern of increasing δ15N eastward and northward, with POM δ15N reaching 9% higher than water column nitrate. POM δ15N of stations on the inner and middle shelves without significant phytoplankton growth, primarily under ice cover, is much higher than POM δ15N expected from phytoplankton consumption of water-column NO3. Photo-flocculated POM was also enriched in amide functionality, while carbohydrates were resistant to both photo degradation and flocculation. Abiotic photochemical flocculation removes a significant fraction of terrestrial DOM from the upper water column and is therefore a heretofore-ignored phenomenon that alters our understanding of DOM and POM cycling & transport in ocean margins including estuaries. (Abstract ID 10753)

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THE IMPACT OF SEA-ICE ON BOTTOM-UP AND TOP-DOWN CONTROLS OF CRUSTACEAN ZOOPLANKTON AND THE MEDIATION OF CARBON AND ENERGY FLOW IN THE EASTERN BERING SEA

Large crustacean zooplankton (LCZ) appear to be a biological choke-point for the flow of energy through the pelagic ecosystem in the eastern Bering Sea. A new synthesis program examines bottom-up and top-down controls of LCZ standing stocks, including climate, physics, primary production, micro-zooplankton production, and predation, and examines how secondary production is partitioned among top predators under varying climate scenarios. This study incorporates data from monitoring programs as well as multiple large-scale, comprehensive research programs during the past several decades, and provides an unprecedented opportunity to assess how this ecosystem responds to multi-year periods of cold and warm conditions. It is becoming evident that the presence or absence of sea-ice in spring is the single most important component determining the physical and biological structure of the shelf ecosystem, not only in spring, but through the summer. Associated with a warming climate are predictions of dramatic reductions in sea-ice extent and re-partitioning of carbon and energy flow within this ecosystem. (Abstract ID 12389)

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SIMULATIONS OF DEEP CURRENITS ALONG THE SISIGGEE ESCARPMENT USING A MULTI-MODEL NESTING APPROACH

The Sisigbee Escarpment in the northern Gulf of Mexico is a deep topographic feature where the seafloor drops 500 to 1000m with local slopes exceeding 20%. Historic observations have shown large magnitude (~ 100 cm/s) fluctuating currents, suggestive of topographically trapped waves, near the bottom over the escarpment. These currents have short cross-isobath length scales and are intensified in the lower water column. There is some evidence that the strongest of these events may be linked to the presence of the Loop Current or an eddy. Numerical simulation of these currents is complicated by the steep topography and need to resolve the vertical and horizontal flow structure. The model requirements are not only very small spatial scales and are intensified in the lower water column. There is some evidence that the strongest of these events may be linked to the presence of the Loop Current or an eddy. 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A NEW GLOBAL MARINE PROTECTED AREAS ATLAS AND ASSESSMENT

In the face of declining global marine biodiversity, marine protected areas (MPAs) are an essential tool for achieving ocean conservation goals. Many nations have set goals for territorial MPA coverage, and international bodies are working to establish high seas MPAs. Only about 1.6% of the world’s oceans, however, are in MPAs, and less than half of these are no-take reserves. Many ecosystems are currently unprotected and others are vastly underrepresented. Marine Conservation Institute has developed an interactive online atlas that assembles key information on global MPAs. Users can locate and learn about individual MPAs including their level of protection, biodiversity, size, management authorities, and a novel assessment of conservation effectiveness. Additionally, the atlas describes country- and regional-level progress towards implementing MPAs and allows users to answer unique questions about the distribution of MPAs from social, political, and ecological contexts. The MPA atlas benefits and engages various user groups, from students and educators looking for general information to managers and scientists needing up-to-date analyses. The atlas also provides valuable information for those involved with the creation of new conservation areas. (Abstract ID 12868)

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DIFFERENTIAL TRANSPORT ACROSS THE SURF ZONE OF REFLECTIVE AND DISSIPATIVE SHORES AS A DETERMINANT OF LARVAL SUPPLY

We determined whether differences in water exchange across the surf zone on dissipative and reflective shores regulates larval supply to intertidal populations. We surveyed zooplankton daily for one month relative to physical conditions inside and outside the surf zone at a dissipative and reflective beach near Monterey, California. Larvae of some species completed development nearshore while larvae of other species migrated offshore and back. Concentrations of zooplankton were much greater outside than inside the surfzone at the reflective beach, indicating that the surf zone may block onshore transport. Barnacle cyprids were an exception, suggesting that ontogenetic changes in larval behavior may facilitate penetration of the surf zone. In contrast, zooplankton were 1 to 2 orders of magnitude more concentrated inside the surf zone of the dissipative beach. Settlement of barnacles on rocks at both beaches was low, and settlement of sand crabs, Emerita analoga, was abundant only on the dissipative beach. Different hydrodynamics of surf zones at dissipative and reflective beaches together with larval behavior may play a major role in regulating larval supply along the West Coast. (Abstract ID 12850)

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REWORLING OF FLOOD DEPOSITS ON THE WAIPAOA RIVER CONTINENTAL SHELF NEW ZEALAND

Flood deposits on continental shelves carry terrestrial signatures, but are typically modified by the marine environment. After initial deposition, energetic waves and currents may rework and redistribute deposits so that short-term (days to weeks) deposition differs from long-term accumulation. The MARGINS Waipaoa shelf initiative investigated these processes by conducting a thirteen month field campaign and numerical modeling study. Here, sediment fluxes and fate during an eight-year recurrence interval flood and subsequent high wave event were analyzed by implementing a three-dimensional numerical hydrodynamic-wave-sediment transport model (Regional Ocean Modeling System-Simulating WAs Sinshore - Community Sediment Transport Modeling System) for the Waipaoa Shelf. This multi-layered seabed model parameterizes erosion and deposition, and accounts for seven non-cohesive sediment classes. Preliminary results indicate that initial deposits along the shallow inner shelf offshore of the river were reworked by energetic waves in the days to weeks after the flood. These waves resuspended sediment until it was transported to deeper areas, either off the shelf (25%) or to long-term shelf depositories. Model estimates of water column turbidity and deposit footprint will be compared to observations. (Abstract ID 12369)

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ON A TRIGGERING MECHANISM OF THE INDIAN OCEAN SUBTROPICAL DIPOLE

By use of an atmospheric general circulation model (AGCM) and a coupled general circulation model (CCGM), we have studied how the Indian Ocean subtropical dipole (IOSD) is excited. The IOSD is characterized by a northeast-southwest oriented dipole of sea surface temperature (SST) anomalies in the southern Indian Ocean, and is linked with variations in the Mascarene High. In an AGCM experiment forced by the climatological (monthly) SST in the southern Indian Ocean and the monthly (climatological) SST elsewhere, southward shift of the strengthening of the Mascarene High are seen (not seen) during the austral summer when the positive IOSD grows. This suggests that the IOSD is excited by a remote effect. In a CCGM experiment, in which the SST outside the southern Indian Ocean is nudged toward the climatological SST, the IOSD occurs with zonal wavenumber 3 or 4 pattern of sea level pressure anomalies in the mid-lattitudes but less frequently as expected. (Abstract ID 11034)

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IDENTIFYING AND ASSESSING CLIMATE DATA RECORDS DISTRIBUTED IN A NASA DATA CENTER

The Physical Oceanography Distributed Active Archive Center (PODAAC) is responsible for the stewardship and distribution of satellite remote sensing data in support of NASA's ocean and climate science programs. Eight ECVs are distributed at PODAAC: wind speed and direction, water vapor, sea-surface temperature, sea-surface salinity, sea level, sea state, surface current, and groundwater. While a very small portion of PODAAC's distributed ECVs includes CDRs directly funded by NOAA (e.g., AVHRR Pathfinder v5 Sea Surface Temperature), the vast majority are from NASA. Although some these data sets might meet all of the desired features of a CDR, many remain to be assessed for quality and uncertainty, while others lack useability due to either poor documentation and/or metadata. Here we present a series of case studies of identifying a NASA data set as complying with the basic NRC definitions of a Thematic or Fundamental CDR and highlight the key issues of data quality, uncertainty, and overall usefulness of the data in the aim for furthering the advancement of satellite data products as tools in understanding climate processes. (Abstract ID 10590)

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RADIAN DERIVED MIXING RATES AND TRACE ELEMENT FLUXES IN THE NORTH ATLANTIC OCEAN

The quartet of radioactive radium isotopes (223Ra, t1/2 = 11 d; 224Ra, t1/2 = 4 d; 226Ra, t1/2 = 1600 yr; 228Ra, t1/2 = 6 y) that exist in the marine environment occur in vanishingly small quantities, circa 10^-14 - 10^-23 moles L^-1. However, recent advances in sampling technology coupled with rapid ship-board analysis of the short-lived isotopes, has made it possible to simultaneously measure full ocean depth profiles of all four isotopes. Radium, conservative in seawater and a marker of seawater-lithosphere interaction, can be used to estimate mixing rates in a variety of ocean settings. For example 226Ra and 223Ra can provide information on larger-scales such as cross-basin and diapycnal mixing rates. Here we will present preliminary Ra data and associated mixing rates from two recent field campaigns that skirted the Eastern and Northwestern Atlantic margins. Furthermore, we will then demonstrate the usefulness of these Ra-derived mixing rates in compiling geochemical fluxes of other trace elements. (Abstract ID 11691)

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INTERPLAY BETWEEN THE ZONAL MOMENTUM BALANCE AND OVERTURNING IN THE SOUTHERN OCEAN

Understanding the response of the Southern Ocean overturning circulation to changes in wind stress is pivotal to projecting the future of the Southern Ocean CO₂ sink and developing theories of glacial-interglacial outgassing. Wind stress is thought to drive both the zonal
Antarctic Circumpolar Current (ACC) and the meridional overturning, yet high resolution models indicate that mesoscale eddies reduce the sensitivity of the circulations to wind stress changes. The mechanisms by which the eddy field limits the response of the circulation, and the link between the sensitivity of the ACC and the sensitivity of the overturning remain unclear. We apply a layer-wise momentum balance analysis in an isopycnal framework to a suite of simulations with resolution varying from coarse to 1/16° eddy resolving in an idealized domain. We find that the responses of the ACC and overturning circulation to wind stress perturbations, and the extent to which they are linked, depends upon both the eddy field and the timescale being considered. (Abstract ID 10043)

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AN ISSUE-DRIVEN OBSERVING SYSTEM PLAN FOR THE NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS (NERACOOS)

NERACOOS engaged in a multistage input process to develop an issue-driven observing system plan for the waters off the Canadian Maritime Provinces of Nova Scotia and New Brunswick to those waters off Connecticut. Planning built upon previous user needs assessments and included direct contributions from many regional stakeholders. Similar to the ten other IOOS regions, issues were gathered into five themes: marine operations; climate variability and change; ecosystems, fisheries and water quality; coastal hazards; and coastal and marine spatial planning. Multipurpose fixed platforms were central to the observing subsystem with an increased focus on nearshore and estuarine waters. Mobile platforms, including ships and autonomous vehicles, enabled more diverse data collection and greater spatial coverage. Remotely sensed information included that from satellites and high frequency radar for surface currents. The observing subsystem was closely tied to the modeling and analysis subsystem – the two forming the regional information system. The Northeast Coastal Ocean Forecast System provided the modeling foundation. Expanded capacity for data management and communication was necessary to ensure information delivery to those who use and manage the region’s coastal waters. (Abstract ID 11395)

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MARINE ORGANIC SUBSTRATES ENHANCE MICROBIAL DEGRADATION OF MACONDO (MC252) CRUDE OIL: EVIDENCE FROM STABLE ISOTOPES AND BIOMARKERS

The rates of aerobic degradation of Macondo (MC252) crude oil by naturally occurring microorganisms present in sandy beach environments were determined. In addition, the extent to which the rate of crude oil degradation was enhanced by supplying the microbial community with naturally occurring marine organic matter (OM) was determined. Replicated mesocosms consisted of four treatments: (i) controls (beach sand), no amendments, (ii) sand contaminated with crude oil (4000 mg/kg), (iii) sand with OM (400 mg/kg of fish tissue: Atlantic humpback), and (iv) sand with crude and OM. CO2 production was measured daily over a six-week period in all treatments and the carbon isotope ratio of respired CO2, δ13C-CO2 was used to measure the fraction of respired CO2 that was derived from respiration of the crude oil. The overall mineralization rate was 66% higher in the OM amended crude oil treatment compared to crude oil only additions. The lower n-C17/21pristine and n-C18/phytane ratios in crude plus OM treatment compared to the crude only indicated enhanced biodegradation. The 13C of respired CO2 in the crude with OM treatment indicated that crude oil was mostly metabolized to CO2. (Abstract ID 10412)

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FINAL RESULTS FROM THE 2008 GEOTRACES AEROSOL INTERCALIBRATION STUDY

Accurate aerosol trace element sampling is a vital component of ongoing GEOTRACES cruises. There are currently no standard sampling/analysis procedures for trace elements or other biogeochemically relevant atmospheric components, making it difficult to compare the marine aerosol data collected between sites and investigators. Here we report the results of an intercomparison of aerosol analysis conducted at the Rosenstiel School of Marine and Atmospheric Science, University of Miami in September 2008. From these data, we evaluated the precision and internal consistency of different methods employed by the international aerosol community. The intercalibration results demonstrate that aerosol dust can be collected and analyzed with precision and minimal contamination. Despite variations in the digestion and analytical methods used, bulk aerosol concentrations of Al, Fe, and V generally agreed within 20% of the average. Similar agreement was observed for soluble trace elements and major anions, but differing extraction methods resulted in variability of Fe solubility. It is our intent that the results of this intercalibration effort will assist the community in establishing reliable procedures for the collection and analysis of aerosol samples. (Abstract ID 10532)

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STRATEGIES FOR BROADENING PARTICIPATION IN THE MARYLAND SEA GRANT REU PROGRAM

Maryland Sea Grant strives to provide students from underrepresented groups in marine science opportunities to participate in its NSF-supported Research Experiences for Undergraduates (REU) program in estuarine science. While women dominate the applicant/accepted student pool, we are testing different strategies to increase the number of students from underrepresented groups in our program. We use such strategies as: 1) developing trust and partnerships with faculty at minority-serving institutions; 2) expanding our outreach in advertising our program; 3) recruiting potential applicants at professional meetings; 4) targeting minority serving institutions within and beyond our region; 5) encouraging our REU alumni to promote our REU program among their peers; and 6) improving our application process. These strategies contribute to improved diversity and composition of our student pool. To help sustain long-term outcomes, we are exploring ways to work directly with minority-serving institutions to build ‘bridging REU programs’ that can train prospective REU students and thus enlarge the pool of potential applicants to recruit. (Abstract ID 10619)

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IMPACT OF SENSOR NOISE ON THE ACCURACY OF BIOPHYSICAL PARAMETER ESTIMATION IN OPTICALLY COMPLEX WATERS USING SPACEBORNE SENSORS

It has been shown via satellite altimetry data that the inverse cascade associated with two-dimensional turbulence takes place in the ocean, albeit over a narrow range of length scales. While the theory behind the inverse cascade is in wavenumber space, many types of real data are collected at fixed positions in the ocean, leading to measurements in frequency space only. We study the signal of the inverse cascade as seen in single point time series, particularly in regions where a Taylor-like hypothesis does not apply. We run simulations of two-dimensional turbulence and develop a theory of the inverse cascade in frequency space. (Abstract ID 11512)
Errors in the estimated constituent concentrations in optically complex waters due solely to sensor noise in a spaceborne hyperspectral sensor can be higher than 80%. The large variation in the magnitude and spectral shape of the measured signal in coastal waters complicates the impact of signal-to-noise ratio (SNR) on the estimation accuracy. Due to water's low reflectivity, in the magnitude and spectral shape of the measured signal in coastal waters complicate the sensor noise in a spaceborne hyperspectral sensor can be higher than 80%. The large variation in the magnitude and spectral shape of the measured signal in coastal waters complicates the impact of signal-to-noise ratio (SNR) on the estimation accuracy.

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OPTICAL MICROFLUIDICS: OBSERVING ZOOPLANKTON BEHAVIOR IN THE PRESENCE OF MICROBUBBLES

Microbubbles are known to be generated in aquatic environments by a variety of processes including: water turbulence, temperature and pressure changes, and chemical dispersion. Their presence has been suggested to affect the behavior of microorganisms, primarily in swimming and feeding mechanics. In the past, it has been difficult for scientists and engineers to simulate micron-sized droplets; however, with the advancements in the technology of microfluidics, this is now possible. Microfluidics is the study of the fluid dynamics at the micro-level with applications ranging from biomedical engineering to environmental monitoring. Using microfluidic devices, we are able to produce monodispersed micro-droplets of predetermined size (5-100 microns) and frequency. The primary goal of our research is to observe the behavioral responses in zooplankton in the presence of fluid microbubbles of varying composition. Digital microscopic holography was used to record and view experiments since it allows multiple focal planes throughout the vessel. Our presentation focuses on the design of the apparatus and systems used to produce such results. (Abstract ID 12307)

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EFFECTS OF LARGE BOTTOM SLOPES ON SEDIMENT TRANSPORT AND BED LEVEL CHANGES IN HOLES IN THE SURFZONE

Observed bed-level changes in holes excavated in an energetic surf zone are compared with predictions of sediment transport models that include bottom slope effects. In most surfzone studies, bottom slopes are small (<5°), and the effect of slopes on sediment transport is ignored. In contrast, the 2-m-deep, 10-m-diameter man-made holes have sloping sides as steep as the angle of repose (~32°), and the effect of slopes on bed-level changes may be dominant. The bed level at the center of the holes was recorded continuously until the holes filled (2-6 days). The models are initiated with the observed starting bathymetry of the holes and are driven with observed waves and currents. The presence of bottom slopes causes a gravity-driven downslope component of transport that increases with the magnitude of the slope. Therefore, spatial variations in bottom slope in the holes imply spatial gradients in gravity-driven transport that lead to temporal changes in bed level. This suggests a diffusive-smoothing-type process that may be important for the evolution of steep bathymetric features. Funded by NSF/NSF, ONR, and CEN. (Abstract ID 9653)

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DOWNSLOPE FLOWS AND BERNOUILL: TOWARD A DIRECT MEASURE OF TOPOGRAPHIC FORM DRAG

Downslope windstorms (or severe downslope flows) in the atmosphere attract understandable attention because of the destruction that can result. These flows are most frequently associated with hydraulically-controlled flow over mountain ranges. Their occurrence in the ocean is not so well documented even though consequences to local habitats are significant. Here we investigate the dynamics of a downslope flow over a small bank on the continental shelf during a densely-instrumented field experiment featuring high-resolution seafloor pressure sensors. A Bernoulli function that includes interfacial and bottom stress is used for which all of the terms are directly measured. The demonstration balance of terms bodes well for direct measurement of topographic form drag using seafloor pressure sensors alone. (Abstract ID 9422)
and alkalinity on discrete water samples. Surface pCO2 was significantly below atmospheric on air-sea CO2 exchange. We measured surface water pCO2 underway along with total DIC part of the ASPIRE project (Dec-Jan 2010), our goal was to determine the impact of the polynya within the context of variable ice cover over the SeaWiFS (1998-2010) and MODIS phytoplankton bloom timing, magnitude, and changing optical properties are investigated. Lake Superior has undergone substantial physical changes over the last several decades. Satellite remote sensing offers one of the best spatial and temporal observational approaches to begin to understand how the observed physical changes are impacting biogeochemical parameters. Lake Superior's optical properties are highly influenced by colored dissolved organic matter (CDOM), which has previously hindered the retrieval of chlorophyll concentration through band-ratio algorithms. We have developed algorithms that make possible well-validated retrieval of chlorophyll concentration and the absorption due to CDOM. In this presentation, phytoplankton bloom timing, magnitude, and changing optical properties are investigated within the context of variable ice cover over the SeaWiFS (1998-2010) and MODIS (2002-present) missions. (Abstract ID 11642)

ADVANCES IN OCEANIC NONLINEAR INTERNAL WAVES: HIGHLIGHTS OF THE NEW MILLENNIUM

Significant advances in our understanding of the fundamental properties of the nonlinear internal waves found throughout Earth's oceans have been led not only by new and exciting observations in a variety of locations and topographies but also by numerical modeling and theory over the past decade. Much, though certainly not all, of this effort has been targeted from targeted programs. Highlights will be discussed with an emphasis on observations. (Abstract ID 9358)

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TRENDS IN SATELLITE-DERIVED chlorophyll CONCENTRATION AND OPTICAL PROPERTIES IN RELATION TO CHANGING ICE ON LAKE SUPERIOR

Lake Superior has undergone substantial physical changes over the last several decades. Satellite remote sensing offers one of the best spatial and temporal observational approaches to begin to understand how the observed physical changes are impacting biogeochemical parameters. Lake Superior's optical properties are highly influenced by colored dissolved organic matter (CDOM), which has previously hindered the retrieval of chlorophyll concentration through band-ratio algorithms. We have developed algorithms that make possible well-validated retrieval of chlorophyll concentration and the absorption due to CDOM. In this presentation, phytoplankton bloom timing, magnitude, and changing optical properties are investigated within the context of variable ice cover over the SeaWiFS (1998-2010) and MODIS (2002-present) missions. (Abstract ID 11642)

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WHAT HAPPENED TO THE WAKE OF TYPHOON FANAPI (2010)?

In September 2010, the NTO (Impact of Typhoons on the Ocean in the Pacific) research program conducted a detailed survey of the upper ocean response to a tropical cyclone. The wind and waves associated with the passage of Typhoon Fanapi over the Philippine Sea created a mixed layer over 80m deep, approximately 75km wide, and about 2.5°C cooler than surrounding waters. The formation, evolution, and destruction of this “cold wake” was documented by a vast array of oceanographic platforms, including 2 moorings, 7 EM-APLEX, 9 Seagliders, 36 drifters, 87 AXBTs, and 3 weeks of shipboard CTD. Within several days of formation, a warm cap developed on the surface of the wake, creating a sub-mesoscale thermoclast that was isolated from the atmosphere and hidden from remote sensing. The following days and weeks, the capped wake was split by topography, was stirred and strained by mesoscale eddies, and thinned vertically by mixing. Remnants of the remote were found to remain for more than 21 days later, suggesting that cold wakes from tropical cyclones may persist significantly longer than can be estimated by remote sensing alone. (Abstract ID 9541)

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ATMOSPHERIC CO2 UPTAKE BY A SUPER-PRODUCTIVE ANTARCTIC POLYNYA

The Amundsen Sea hosts the most productive (m²) polynya in the southern hemisphere. As part of the ASPIRE project (Dec-Jan 2010), our goal was to determine the impact of the polynya on air-sea CO2 exchange. We measured surface water pCO2 underway along with total DIC and alkalinity on discrete water samples. Surface pCO2 was significantly less than atmospheric conditions. The area with the lowest values (below 100 ppm) were associated with peak chlorophyll fluorescence, which reached values as high as 40 µg/l. Supersaturation was only observed in the SE region - near the expected influence of CDW, and when we were near or within the sea ice pack. If we calculate a rough gas exchange rate for this area, the carbon taken up by the polynya over a 90 day season is ~8 TgC, which compares well with estimates for the much larger Ross Sea polynya, and confirms the ASP region as a significant CO2 sink. Whether this sink is climate sensitive remains to be determined as we can't quantify the mechanisms responsible for the bloom. (Abstract ID 12213)

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SENSITIVITY OF OCEAN TIDES TO CLIMATE RELATED PROCESSES

Ocean tides are changing on secular and seasonal time scales with much larger magnitudes than we would expect from changes in the gravitational forcing. Numerical and analytical models are used to analyse the sensitivity of ocean tides to climate related processes. These processes are sea level change, retreat of the arctic ice cover, variability of atmospheric pressure and winds and changes in stratification. All these processes have an impact on the tidal amplitudes and phases. However, the effect of changing stratification conditions in shallow waters is the most effective one. As shown with analytical and numerical models, changes in stratification from well-mixed to stratified conditions can affect tidal transport by up to 10% and a change in the mixed layer depth of only 10 meters can have an effect of about 2%. (Abstract ID 11561)

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SOME IMPLICATIONS OF BOTTOM EKMAN LAYER DYNAMICS FOR CROSS SHELF EXCHANGE IN THE AMUNDSEN SEA

Seawater exchange across the Amundsen Sea continental shelf provides a shoreward flux of oceanic heat that contributes to sub-glacial melting at the interface between the ocean and the continental West Antarctic Ice Sheet. Instantaneous slope currents observed over the continental shelf slope were determined in 2009 in the eastern Amundsen, near 110°W, flow toward the center and appeared to be associated with the Antarctic Circumpolar Current. Slope currents observed farther west, near 130°W, were westward. At the eastern location, warm subsurface water from 850 m depth seaward of the slope flowed shoreward across the shelf break. This transport was consistent with the theory of arrested Ekman layers, whereby bottom Ekman transport forces denser water upslope until the resulting baroclinic pressure gradient balances the barotropic pressure gradient that is forcing the primary along-slope current. The western Amundsen shelf was dominated by water from 800 - 1000 m depth offshelf, similar to that flowing shoreward at the eastern site. We posit that bottom Ekman layer processes in the eastern Amundsen contribute to onshelf transport and presence of warm deep water in the western basin. (Abstract ID 9628)

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OCEANIC CLIMATE CHANGE OFF WESTERN GREENLAND: FACT OR FICTION?

A 2003 eddy-resolving survey of northern Baffin Bay reveals a 10-km wide warm and salty barotropic slope current of Atlantic waters off Greenland, a cold and fresh buoyancy-driven...
flow of Arctic waters off Baffin Island, and meso-scale eddies. The geostrophic Baffin Island Current advects sea ice from the Arctic and icbergs from Greenland southwestward. Integrating this baroclinic boundary current over a 100-m surface layer for 14 months, Petermann Ice Island PII-A moved from North-Greenland (August 2010, 81-N) to Newfoundland (October 2011, 50-N). Its average velocity agrees with those of the 2003 survey. Subsurface Baffin Bay waters warmed by 0.1°C decade from 1916-2003 according to hydrographic data while mooring records indicate warming twice as strong for the 2003-2009 period. The mooring data resolve tidal and seasonal variability without aliasing while the hydrographic record rarely resolves dynamical scales. Interannual variability of ice severity, temperature and freshwater flux off eastern America relates to the atmospheric North-Pacific Oscillation index. Swinging from large negative to positive from 1960 to 1990, it currently hovers near zero. Present conditions thus are near normal at decadal scales. (Abstract ID 11143)

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Spring spawning grounds of Atlantic tunas in the Northern Gulf of Mexico: Environmental constraints and response to climate change

Atlantic bluefin tuna (Thunnus thynnus) are found throughout the Atlantic Ocean, however spawning in the western North Atlantic is mostly restricted to the Gulf of Mexico. A spring spawning habitat model constructed using historical larval collections showed that larvae were primarily collected between early May and mid-June, within a defined temperature range. In contrast, spawning of tropical tunas such as yellowfin tuna (Thunnus albacares) and skipjack tuna (Katsuwonus pelamis) commenced in spring and continued through summer, without a strong upper temperature limit. Given their different thermal tolerances and spawning requirements, it is likely that bluefin tuna and tropical tunas will show different responses to the effects of climate change. To investigate this, we applied future predictions of water temperature sourced from a dynamically downscaled climate model for the Gulf of Mexico and Caribbean, projected under CO2 emission scenario SRES A1B, to spawning habitat models. Potential changes in spawning habitat for each species in the Gulf of Mexico were then quantified for the middle and end of the 21st century. While spring spawning grounds for bluefin tuna were predicted to increase slightly in March, and decrease through April, May and June, spawning grounds of tropical tunas were predicted to increase. This work has significant implications for the future management of highly migratory tunas in the western Atlantic Ocean. (Abstract ID 9333)

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Intercomparison of 1-D turbulence closure models with large eddy simulation applications to submesoscale processes

Submesoscale mixed layer eddies arise from surface frontal instabilities, characterized by Ok(1) Rossby number and O(1) Richardson number. We focus on the interaction between sub-grid turbulence and submesoscale processes. We first present a series of one-dimensional simulations forced by wind and surface buoyancy flux, including wind entrainment in a rotating ocean, convection induced deepening and diurnally varying mixed layer evolution, using second order closure schemes (k-e and k-9L) to parameterize vertical turbulent fluxes. Traditionally, turbulent fluxes depend on pressure-strain correlation term and dissipation rate, parameterized by different empirical sets of coefficients. However, the evolution of turbulent fluxes and kinetic energy should only be attributed to irreversible processes (Venayagamoorthy and Stretch 2010, VS10 hereafter). We intercompare the results of one-dimensional simulations including k-e model with the VS10 parameterization, other common second order closures, PWP (Price, Weller and Pinkel), PRT (Pollard, Rhines and Thomson) and KPP (K-profile parameterization), with Large Eddy Simulation results. Based on the one-dimensional simulations, we will couple the most suitable second order closure model with the three-dimensional Process Study Ocean Model (PSOM) under different forcing conditions to explore the sensitivity of submesoscale processes to subgrid mixing parameterizations. (Abstract ID 11842)

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Seasonal and interannual variability in primary productivity and nutrient uptake along the northeastern US continental margin

Primary productivity varies seasonally and interannually due to variations in top-down and bottom-up controls. We measured primary production, dinoflagellate (N2) fixation, and nutrient uptake during cruise transects spanning the slope and shelf break along the North American Coast between Cape Hatteras and Georges Bank. In addition to higher rates of primary productivity than what had been observed during the MARMAP study 25 years ago, we found substantial rates of N2 fixation over the study area including on Georges Bank, where N2 fixation had not been previously documented. N and P concentrations were usually measurable throughout the study period suggesting that these elements were not limiting for phytoplankton growth. In general, ammonium and urea uptake dominated the total measured N uptake but there was seasonal variability in the magnitude of N uptake and the proportion of N taken up as ammonium, urea, nitrate, nitrite and amino acids. (Abstract ID 11802)

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V wave forced motion of submersed single stem vegetation

We present a new analytical model for the wave-forced movement of submersed single stem vegetation and compare solutions against observed motion of sedge (Schoenoplectus americanus) from the Skagit salt marsh. Solutions for constant diameter and tapered stems are expanded using normal mode solutions to the Euler-Bernoulli problem for a cantilevered beam. Consistent with theory, mode zero motions dominated, and sedge motion led water motion, with the phase decreasing (from 90 to 0 degrees) with increasing wave frequency. After tuning of a single free parameter (Young’s modulus), the theory successfully predicted the transfer function between measured water and stem motion. Formulae predicting frequency-dependent wave dissipation by flexible vegetation are derived. The vegetation was found to act as a band pass filter with higher and lower frequencies being preferentially attenuated. For the moderately flexible stems observed, the model predicted total dissipation was about 30% of the dissipation for equivalent rigid stems. (Abstract ID 10022)

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Quantifying the offshore transport associated with a northern Benguela upwelling filament during October 2010

The mesoscale dynamics of a northern Benguela upwelling filament located at approximately 18.5°S was examined under the auspices of GENUS (Geochemistry and Ecology of the Namibian Upwelling System) in Oct 2010. The development of the filament was tracked using optimal interpolated SST satellite data and two transects were consequently sampled across the feature using a towed undulating CTD (ScanFish). Additional hydrographic, nutrient and biological parameters were investigated at several stations along each transect. Following 7 days of strong upwelling favorable winds, sampling coincided with a period of relative wind relaxation and the filament was presumably in a decaying state. The basic mesoscale structure of the investigated filament corresponded well to what had previously been described for filaments from other eastern boundary current systems. The offshore transport associated with the filament was found to be significantly greater than the integrated Ekman transport in the region. In addition, the high resolution dataset revealed a more complex mesoscale geostrophic flow field around the feature than had previously been described and there was evidence for strong counterbalancing onshore flow within the filament. (Abstract ID 9842)

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The CARIACO ocean time series program

The CARIACO program conducts monthly oceanographic cruises to the Cariaco Basin (10°30'N, 66°40'W, SE Caribbean Sea) since November 1995. This basin is connected with the Caribbean Sea in the upper 140 m and is well ventilated above this sill depth, but waters below ~250 m are anoxic. The time-series objective is to understand the relationship between
hydrography, community composition, primary production, microbial activity, terrigenous inputs, sediment fluxes, and element cycling in the water column, and how changes in these processes are preserved in seafloor sediments. The observations show major changes have occurred in the oceanography of the Basin since the mid-2000s, with primary productivity falling by 20-30% from >500 gC m-2 y-1 in the late 1990s. For the first time in the time series history, surface primary productivity was undetectable in June 2011. We discuss trends in several parameters including an apparent steady increase in N2 even during upwelling periods. An ecosystem shift has resulted from a decrease in the Trade Wind intensity and weaker coastal upwelling, including a sharp decrease in the abundance of sardine in the region. (Abstract ID 10982)

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OCEAN … WHAT OCEAN? THE NEAREST COAST IS 200 MILES AWAY! EFFECTIVE STRATEGIES FOR TEACHING LAND-LOCKED K-12 COMMUNITIES OCEAN STEWARDSHIP

A common misconception among students in land-locked K-12 communities is their actions do not impact the coastal ocean environment. Many K-12 communities have limited to no exposure of the oceans or even to educational resources about ocean environments. Combining previous involvement in an NSF GK-12 program, we started an initiative to incorporate K-12 educational outreach efforts in Texas A&M University College of Geosciences and Department of Oceanography research programs. The primary goals of our efforts are to promote ocean stewardship and educate local communities about coastal ocean hazards. Our activities focus on coastal hypoxia in the Gulf of Mexico, the focus of the large-scale research project Mechanisms Controlling Hypoxia (hypoxia.tamu.edu). Outreach materials we present include K-12 curriculum, community lectures, cruise blogs, and scientific training programs. We will share methodologies for creating these types of interactive activities, effectiveness and challenges of each, and successes within our local community. We also will show participant survey results from 2008 and 2009 and share tools and techniques for new institutions interested in incorporating coastal oceanographic outreach within their academic and local community. (Abstract ID 12020)

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THE IMPACT OF SOUTHERN OCEAN PHYSICS ON OCEAN CARBON STORAGE AND ATMOSPHERIC CO2

Recent advances suggest that the circulation of the Southern Ocean is a balance between low latitude wind forcing, globally integrated diapycnal mixing, and deep water formation (in both hemispheres). Eddy processes play an essential role, with modelling studies demonstrating that coarse resolution ocean models, with or without parameterised eddies, many of which are uncertain at best. Furthermore, the time required and cost of running a global eddy-resolving model to statistical equilibrium currently makes them impractical for use in earth system models. By constraining model geometry, we are able to use MITgcm at a range of resolutions. The resulting narrow sector model can be integrated to statistical equilibrium for many of these resolutions. By combining the simplified geometry with MITgcm’s biogeochemistry, we can then investigate ocean carbon storage as physical forcing is altered. A large number of experiments can thus be performed targeted at understanding not only the differences in physical response between resolution, but also how these different physical responses impact the modelled carbon cycle. (Abstract ID 10228)

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SELECTION FOR CO2 TOLERANCE IN MARINE FISHES

Experimental studies have demonstrated that changes in ocean chemistry associated with predicted future levels of CO2 can affect the reproduction, growth, development and behaviour of many marine species, with potentially devastating ecosystem consequences. However,
a critical unanswered question is the capacity of species to adapt to these changes in ocean chemistry. Selection of tolerant individuals over multiple generations could help some species adjust to the CO2 levels projected to occur by the end of this century. We used a unique field-based experiment to test for selection of CO2 tolerant individuals in a wild population of coral reef fishes. Juvenile fish exhibited variation in their response to elevated CO2 and this influenced their risk of mortality from predation. Individuals that were sensitive to elevated CO2 were more active and move further from shelter in natural coral reef habitat and, as a result, mortality from predation was significantly higher compared with individuals from the same treatment that were tolerant of elevated CO2, and control fish. This demonstrates that rapid selection of phenotypes tolerant to elevated CO2 can occur in nature. (Abstract ID 10033)

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THE ROLE OF ENVIRONMENTAL FACTORS ON PHYTOPLANKTON BLOOM INITIATION UNDER THE LANDFAST ICE NEAR RESOLUTE BAY, NUNAVUT

It is common practice in the scientific literature to assume phytoplankton production to be negligible when the ocean is ice-covered due to the strong light attenuation properties of snow, sea ice, and ice algae. However, observations of significant under-ice blooms have been reported. Using hydrographic data collected under a landfast ice cover in Resolute Passage, Nunavut, Canada between 1 May and 18 June 2010, we documented the commencement of a substantial under-ice phytoplankton bloom. Numerous factors played a role in bloom initiation: 1) termination of the ice algal bloom and melt pond formation increased transmitted light; 2) melt water stratified the upper 3 metres of the water column; and 3) tidal energy acted to both deepen and mix nutrients into the surface stratified layer. In this poster, we discuss these different processes in relation to under-ice bloom occurrence in Arctic waters. (Abstract ID 11300)

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A REVIEW OF CLIMATE INDICES OF THE TROPICAL ATLANTIC

Climate indices are often used to diagnose climate phenomena and their predictability. Several climate indices have been developed for the tropical Atlantic region. These indices span various timescales (from interannual to decadal) as well as various features such as: 1) indices that increased in response to Atlantic Ocean warming and are sensitive to changes in the large-scale circulation; 2) the PDO index; and 3) indices that are related to specific ocean processes. In this presentation, we will review these indices and discuss their potential applications in understanding and predicting future climate scenarios. (Abstract ID 12709)

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THE EARTH SYSTEM COG COLLABORATION ENVIRONMENT

Earth System CoG is a multi-institutional project that seeks to examine the organizational characteristics of community science and infrastructure projects and to recommend structures and processes for their efficient governance and operation. The CoG team is developing a web-based collaborative environment as a way to put some of these findings into practice. This environment targets projects that are involved with the generation, management, access, and analysis of scientific data. It combines interfaces and services for federated data search, discovery, and download, with elements of social networking and interaction such as news, bookmarking, and dynamic web site editing. CoG enables its projects to be linked into networks, with tools for sharing knowledge bases across those networks. Initial pilots using the CoG environment include model intercomparison projects, infrastructure development projects, and a project to build a community around local impacts of climate change. Future plans include incorporation of metadata, visualization, analysis, and other services. Visit CoG at: http://esrl.noaa.gov/cog/ (Abstract ID 9608)

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OBSERVING THE INFLUENCE OF ALGAL BLOOMS ON THE BACTERIAL COMMUNITY STRUCTURE WITHIN IN A FRESHWATER COMMUNITY LAKE

The presence of algal blooms in freshwater lakes may be attributed to the growing pollution of ecological systems due to excessive human activity. The aim of this study was to record and compare the bacterial community within and away from an algal mat. We hypothesized that greater numbers and diversity of bacteria species would be present within the algal mat. In August 2010, two water samples from the mat and mat-free areas of Lake Eberta, a recreational lake in Tallahassee, Florida were collected and processed. Samples were then plated for heterotrophic bacteria count, pathogenic bacteria, and Delekovich and like...
organisms (BALOs). To identify the individual species present in the lake, DNA was extracted and amplified with 16S rDNA gene universal primers with polymerase chain reaction and was sequenced. Denaturing gradient gel electrophoresis (DGGE) was performed to indicate differences in the bacterial community structure within and away from the algal mat. There were minor differences in the number of species present within and away from the algal mat, however the species composition differed significantly between the algal mat and non-matted areas. (Abstract ID 10541)

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AIRBORNE LIDAR DATA ASSESSMENT OF WALLOWS ISLAND, VIRGINIA

The Virginia eastern shore & Delmarva Peninsula are ideal test locations for developing adaptive conservation approaches & strategies for analyzing the effect of sea level rise on coastal ecology & municipal establishment. This work will use remote sensing LIDAR data collected by the NASA Wallows Flight Facility to develop various digital models of the elevation (terrain & bare-earth) of Wallows and the surrounding areas. The digital model developed are used to map current distributions of important coastal habitats, create beach profiles, & detail areas likely to experience the greatest impact from sea level rise. The goal of this study is to understand the effects of sea level rise particularly for migratory birds & their habitats. (Abstract ID 19992)

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MONSOONS AND AIR-SEA INTERACTIONS AT INTRASEASONAL-TO-DECADAL TIME-SCALES

The Indian Ocean is well known for its reversing Southwest and Northeast Monsoons, offering the seasonal cycle as the uniformitarian principle for regional climate. Within this dominant seasonal cycle, there are intricate air-sea interacions and monsoon variabilities at diurnal to intraseasonal to interannual and longer time-scales. The nearly-monomonic warming over the last several decades, has made this an indicator ocean for upper ocean response to climate change. The mean and low variability of the SSTS continue to bedevil the quantification of its role in regional climate variability. But it is now evident that SST variability at intraseasonal and interannual to decadal time-scales is critical for the coupled air-sea interactions. The net annual heat input from the atmosphere and the IIT seem to combine with the direct pipeline from the Southern Ocean to produce multi-decadal secular variability in the tropics that affect the onset and withdrawal of the monsoons even as the seasonal mean may remain unchanged.

The relatively deep thermocline is accompanied by regional variabilities in freshwater forcing and barrier layers with eddies that produce air-sea interactions at subseasonal to basin scales which are modulated by the intrinsic coupled climate mode and external forcings. Observing systems must consider all these scales. The most salient of these processes and feedbacks will be discussed. (Abstract ID 9625)

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A MULTI-SCALE THREE-DIMENSIONAL VARIATIONAL DATA ASSIMILATION SCHEME (MS-3DVAR) IN THE KUROSHIO EXTENSION

A MS-3DVAR method for use with the Naval Coastal Ocean Model (NCOM) is being examined in the region of the Kuroshio extension. The advantage of a multi-scale approach to data assimilation is the ability to resolve the multiple spatial scales present in regional ocean models. This method relies on the specification of large and small horizontal correlation length scales and their associated background error variances. Using empirical orthogonal functions (EOF) the variances associated with pre-specified length scales can be determined. An additional benefit of the MS-3DVAR technique is the ability to assimilate coarse and dense collections of observations. The benefits are examined in this region where small scale eddies are generated by the wake of several small islands within the western boundary current. In this area, dense observations are needed to constrain these small scale features. Additionally a twin data assimilation experiment comparing the MS-3DVAR and a traditional 3DVAR will show the advantages of a multi-scale approach to assimilation. (Abstract ID 10593)

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FRESHWATER PATHWAYS IN THE ARCTIC AND SUB-POLAR NORTH ATLANTIC

Significant fluxes of low salinity water pass from the Pacific Ocean into the Arctic Ocean, and after mixing with other freshwater sources in the Arctic, are transported into the North Atlantic. These pathways and the associated fluxes can have a significant impact on physical, chemical and biological ocean properties and potentially can impact aspects of the large scale circulation and climate. Specific details on how Pacific Waters travels from Bering Strait to the Canadian Arctic Archipelago are uncertain. As well, the fate of the freshwater (of Pacific and other origin) that passes through the Canadian Arctic Archipelago is uncertain. In particular how does this freshwater leave the boundary current system and where is it taken up into the Atlantic Ocean. We examine these questions using several eddy-permitting regional configurations of the NEMO coupled ocean/sea-ice numerical model. As well as examining hydrographic properties and fluxes, we use the lagrangian float thatione to examine the freshwater pathways and their variability. (Abstract ID 12365)

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MODELING A NORWEGIAN FJORD WITH HIGH RESOLUTION WIND FORCING

The Regional Ocean Modeling System (ROMS) is applied to the fjord system of Sirdal and Nordfjord in northern Norway (67.5°N) with 200 m horizontal resolution. These are two separate fjords with a joint opening towards Vertfjorden, and consist of several smaller fjord branches. Both fjords have deep basins (~754m), sills near the mouth (~225m) and are surrounded by steep mountains. The complex topography requires high resolution atmospheric forcing to sufficiently resolve the spatial variability, therefore the Weather Research and Forecasting model (WRF) was run with 1 km horizontal resolution to provide atmospheric forcing to the ocean model. The high resolution wind forcing reveals large spatial variability between the fjord branches, and that the prevailing wind directions follow the fjord axis. The ocean surface responds quickly to changes in the wind field, which hold the potential to mix down the low-saline surface layer. Some fjord branches show larger retention of passive particles than others, these differences can partly be explained by dominant wind direction at the mouth of fjord arms. (Abstract ID 10390)

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NEAR 13-DAY BAROTROPIC OCEAN RESPONSE TO THE ATMOSPHERIC FORCING IN THE NORTHWESTERN PACIFIC

Ocean bottom pressure measurements from an array of 43 pressure-recording inverted echo sounders, which were part of the Kuroshio Extension System Study (KESS), reveal fluctuations of about 13-day period in the Northwestern Pacific. The fluctuation is characterized by “common mode” which shows coherent in-phase oscillations with a relatively large amplitude in the northeastern part of the observational domain. It also shows energetic fluctuations in the winter season during the 2-year observational period. Regression analysis with wind stress curl field reveals a significant correlation between them, which suggests that the near-13-day barotropic ocean response observed from the bottom pressure array is driven by the large-scale atmospheric forcing in the Northwestern Pacific. This finding is confirmed by a daily wind forced barotropic ocean model that produces similar near 13-day sea level fluctuations. (Abstract ID 10801)

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DEPENDENCY OF MICROWAVE BACKSCATTERING FROM OCEAN SURFACE ON OCEAN WINDS USING AIRBORNE DUAL-FREQUENCY POLARIMETRIC SYNTHETIC APERTURE RADAR

The normalized radar cross section (NRCS) of ocean surface in the L- and X-bands is measured from three directions of illumination by an airborne dual-frequency synthetic aperture radar (SAR), and the dependency of the NRCS and the polarization ratio on the relative wind direction is analyzed. In the X-band, the dependencies of the NRCSs in the parallel polarizations show different features each other. The NRCS in the X-band HH polarization has difference between the up- and down-wind conditions, though that in the L-band is not apparent. The results suggest the possibility of ocean wind measurement using the polarimetric
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SAR in the X-band. (Abstract ID 11262)

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Fronts are known to play a vital role in watermass formation and circulation model. Preliminary results seem to support the hypothesis that a higher level of energy in near-inertial frequency motions leads to an enhancement of the forward cascade of turbulence leads to an increase of kinetic energy in near-inertial range, but to a decrease in both the low frequency and total kinetic energy. (Abstract ID 11436)

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ELEVATED TURBULENT DISSIPATION IN THE KUROSHIO FRONT THERMOCLINE

Fronts are known to play a vital role in watermass formation and subduction, and biological production. Moreover, recent studies have suggested that fronts are sites of elevated energy dissipation through forced and uninforced frontal instabilities. In the frontal mixed layer, several field studies showed that potential vorticity (PV) can be negative through atmospheric forcing, leading to Symmetric Instability (SI) and associated 3D turbulence. In contrast, under the mixed layer, previous microstructure surveys in mid 70’s to 80’s did not find enhanced dissipation near the Gulf Stream Front. In this study, a series of microstructure surveys were conducted in the Kuroshio Front, in 2008, 2009, and 2011 to re-examine whether the turbulent dissipation is elevated under the main Kuroshio current. Our direct measurements in the mixed layer on the southern flank of the Kuroshio Front suggest that turbulent dissipation rates are one order of magnitude larger than those based on the law of the wall. The estimated PV in the mixed layer is found to be negative, suggesting onset of SI consistent with recent studies. More importantly, under the mixed layer, a number of microstructure profiles directly under the main Kuroshio stream show pronounced turbulent dissipation rates (10^{-6}-10^{-4} Wkg^{-1}), which are 10-1000 times greater than typical thermocline values. These results suggest that the Kuroshio Front, from top to toes, is a site of elevated turbulent dissipation. (Abstract ID 10813)

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SPATIAL DISTRIBUTION OF RADIOACTIVITY OF CS-134 AND CS-137 IN SEAWATERS FROM COASTAL AREA OFF THE FUKUSHIMA IN JAPAN TOWARDS NORTHEASTERN PACI

Nuclear accident at the Fukushima Daiichi Nuclear Power Plant (NPP) was occurred after the 2011 Tohoku Earthquake and Tsunami. Large amount of radionuclides have also been released into the ocean area. The short and long term dispersion of radioactive cesium (Cs) in the sea has been simulated by several models and assess the impact of radioactive pollution on living species. Therefore, it is important to understand dispersion of Cs-134 and Cs-137 in seawaters from coastal to pelagic ocean on the basis of monitoring research. The aim of this study is to describe spatial distribution of radioactivity of Cs-134 and Cs-137 in western Pacific Ocean, which ranges from 30˚N to 46˚N, and from 141˚W to 165˚W. The 15-20L of seawater samples were collected at surface and/or down to 100 m depth during the cruises of Mirai (MR11-5), Hakuho-Maru (KH-11-7) and Tansui-Maru (KT-11-22 and KT-11-27) in 2011. The Cs-134 and Cs-137 were separated by coprecipitation with AMP and measured by gamma-ray spectrometry using low BKG Ge detector at LLRL and Ogoya URL of Kanazawa University for 1-2days. The radioactivity of Cs-134 and Cs-137 was about 1 Becquerel for the coastal seawater samples from Onahama (36˚56’N, 140˚54’W) and almost three orders higher than those before the Fukushima accident. In this presentation, we will show you the preliminary results for spatial variation of these radionuclides in western Pacific Ocean. (Abstract ID 10878)

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MODELLING OF REMOTE SENSING REFLECTANCE AND DIFFUSE ATTENUATION COEFFICIENT IN THE SOUTHEASTERN BERING SEA

Bio-optical properties were investigated and parameterized in the southeastern Bering Sea during July 2008. Lower specific phytoplankton absorption was observed relative to middle and lower layers. Results were indicated in pigment composition and/or package effect. The absorption budget revealed that colored dissolved organic matter (CDOM) absorption (\(a_{CDOM}(\lambda)\)) was the dominant (greater than 50% at all depths) light absorbing coefficient at all wavelengths examined except at 676 nm. Modeling of remote-sensing reflectance (\(R(\lambda)\)) and diffuse attenuation coefficient (\(K_{d}(\lambda)\)) from inherent optical properties revealed the strong influence of \(a_{CDOM}(\lambda)\) on R(\(\lambda\)) and \(K_{d}(\lambda)\). Good optical closure was achieved between modeled and radiometer measured \(R(\lambda)\) and \(K_{d}(\lambda)\) with average percent difference of less than 15% and 10% respectively, except at red wavelengths. The \(a_{CDOM}(\lambda)\) caused the blue to green \(R(\lambda)\) ratios to decrease by a factor of 2 and accounted for >50% of \(K_{d}(\lambda)\) which was vertically variable. These results have important implications to bio-optical models and algorithms in the southeastern Bering Sea. (Abstract ID 11894)

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LONG-TERM SALINITY CHANGE IN THE DELAWARE ESTUARY

Salinity is the most important variable for characterizing an estuary and thus an understanding of salinity change is a prerequisite for understanding other long-term estuarine changes. Here, a long-term record of salinity in the Delaware Estuary (northeastern United States) is constructed from several data sources and analyzed for long-term trends. The initial focus is on the upper estuary, near Reedy Island, where the United States Geological Survey (USGS) has maintained an automated conductivity sensor since the early 1960s. These data are supplemented with data digitized manually from reports of the U.S. Army Corps of Engineers. The Delaware Geological Survey, and the USGS. The earliest measurements digitized are from the 1950s. Salinity variability due to streamflow and tides is estimated using statistical methods, and the residual salinity change is found. At Reedy Island, this residual salinity has increased from about 2 in the 1930s to about 4 in recent decades. Possible explanations for the increase, including dredging and sea-level rise, will be discussed. (Abstract ID 12363)

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LONG-TERM MODULATIONS IN THE DECADAL CLIMATE VARIABILITY OVER THE NORTH PACIFIC: OBSERVATIONS AND A COUPLED MODEL SIMULATION

Observations for the post-war period suggest that local decadal climate variability over the wintertime North Pacific may have undergone notable modulations. A 20-year segmented EOF analysis of 3-year running-mean anomalies of the North Pacific SST reveals that the subarctic oceanic frontal zone was the primary center of action of the extratropical decadal SST variability until the 1980s. The SST variability there has exhibited correlation with the decadal variability of the surface Aleutian Low and a PNA-like pattern aloft but with no significant simultaneous correlation with the tropical SST variability. Though extracted in the second EOF, however, this extratropical ocean-atmosphere variability has lost its predominance in the 1990s and 2000s. Instead, the primary center of action has shifted to the subtropical oceanic frontal zone, where the decadal SST variability that accompanies the variability of the subtropical anticyclone is strongly anti-correlated with the tropical SST variability that has enhanced since the 1980s. A 20-year CGCM integration is found to simulate similar long-term modulations both in the decadal variability over the extratropical North Pacific SST and in the associated atmospheric variability. (Abstract ID 10807)

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DEEP OVERFLOW THROUGH THE KERAMA GAP CONNECTING THE EAST CHINA SEA AND THE PHILIPPINE SEA

The East China Sea includes the Okinawa Trough (in part deeper than 2000 m) between the continental slope and the Ryukyu Islands. In the Okinawa Trough, thermocline waters are exchanged with those of the Philippine Sea via the Kuroshio, while the deep waters below the thermocline can be exchanged only through the Kerama Gap with a sill depth of 1100 m. This study reveals temporal and spatial velocity-structures below the thermocline over the Kerama Gap, cross-section mainly using data from moored current-meters during 2006-2011 and supplemented with outputs from a data-assimilated daily model provided by the Naval Research Laboratory. The temporal mean velocity field reveals a steady deep flow (>10 cm/s) into the Okinawa Trough, which is clearly intensified on the northern slope of the Kerama Gap. The model outputs suggest that the deep flow is a branch of the Ryukyu Current, which is a deep current flowing northeastward along the eastern slope of the Ryukyu Islands. Most strong variations of the deep flow in the Kerama Gap are ascribed to unstable motions of the Ryukyu Current. (Abstract ID 10846)

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WINTER MIXED LAYER DEVELOPMENT BY SUBTROPICAL WATER INTRUSION OVER SUBARCTIC WATER AND ASSOCIATED IRON SUPPLY

The development of winter mixed layer (ML) is often approximated to be a vertically one dimensional process and thus slowly varying in space. However, high-resolution observations of XCTDs and sea surface iron concentration (SSFe) found winter ML and SSFe vary simultaneously in sub-meso to meso scales in the western subarctic Pacific. Deep ML and high SSFe occur when ML consists of the mixture of subtropical water (STW) and subarctic water (SAW), whereas the opposite occurs when ML contains only STW or SAW. We estimated ML depth as a function of STW supply and surface heat flux from heat and salt budgets. When a moderate amount of saline, warm STW runs on fresh, cold SAW, the associated salt supply enables, together with surface cooling, the ML to develop further than the case of pure SAW or STW. Iron-rich, subarctic SAW is then mixed up to the surface. SSFe controls primary production in the western subarctic Pacific. The present results provide a strong support for the significance of iron supply by oceanic transport from the Hokkots Sea through the subarctic layer. (Abstract ID 12718)

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TRACERS IN COLD-CORE EDDIES DETACHED FROM THE KUROSHIO EXTENSION

Cold-core eddies in eddy-resolving OGCMs are investigated by using passive tracers and Lagrange particles. The cold-core eddies detach from the Kuroshio Extension accompanying waters originated from the north of the Kuroshio Extension throughout the water columns. Thus, the origin of high nutrient waters that crops up in the cold water eddies is not deep waters south of the Kuroshio Extension but the ones north of the Kuroshio Extension, at least near the formation area of the eddies. Even though the cold-core eddies have cycloic circulation throughout the water columns during their westward movements, the temporal variation of tracers in the eddies differ from the waters below and above the thermocline. Above the thermocline, the cold water eddies is surrounded by high PV waters, which originated from the Kuroshio Extension Jet. The high PV waters prevent the interior waters from interacting with the exterior waters. Below the thermocline, due to the lack of such PV barriers, the waters mix with surrounding water through many filament structures. (Abstract ID 10462)

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CONTRIBUTION OF CORAL-DERIVED ORGANIC MATTERS AND POM AS CARBON SOURCES FOR REEF-ZOOPLANKTON COMMUNITIES

In coral-reef ecosystems, high zooplankton production must be achieved by additional carbon sources onto phytoplankton because planktonic primary production is limited by oligotrophic environment. Here we investigated carbon stable isotope of zooplankton and their possible food sources to understand the carbon pathway among lower trophic levels. As possible carbon sources, we analyzed the isotope signatures of seawater POM and coral-derived organic matters such as mucus. Samples were collected at a reef area of Bidor Island, Malaysia in 2009 and 2010. The isotopic values of zooplankton taxa ranged from −15.0‰ to −22.4‰, and coral-mucus indicated the enriched value of −15.3‰, while POM was −23.8‰. The estimated contribution of coral mucus to zooplankton groups varied from 2.4 to 10.7%. The values were obviously higher for the carnivore such as amphipods (76.1%) and isopods (71.7%) than the whole herbivore (13.0%) and omnivore (23.7%). These results revealed that reef-zooplankton communities are sustained not only by phytoplankton but also substantial contribution of coral-derived organic matters. (Abstract ID 11667)

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CHANGES IN DISSOLVED OXYGEN CONTENT OBSERVED IN THE EASTERN PACIFIC DURING THE TRANSITION FROM 2009-2010 EL NIÑO TO 2010-2011 LA NIÑA

Significant oxygen decrease associated with the transition from 2009-2010 El Nino to 2010-2011 La Nina was observed from five years of moored observations in the continental shelf off southern California. Only less than half of the seasonal anomaly is related to the isopycnal movement. The additional oxygen decrease beyond that is strongly correlated with decreased chlorophyll concentration and strengthened poleward flows by the California Undercurrent. The combined actions of these three processes created the oxygen decrease as large and as long as the normal seasonal minimum during the upwelling period in spring, but later in the year. This is compared with observations on larger scales, e.g., changes in biological activity and transport by the California Current during the transition. Data comes from two subsurface moorings, five PIES, and satellite altimetry in the Eastern Pacific. With a different timing of a La Nina, we hypothesize that the seasonal oxygen minimum and the La Nina anomaly should overlap to potentially create hypoxic events of previously not observed magnitudes. (Abstract ID 11617)

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MOMENTUM TRANSFER AT THE AIR-WATER INTERFACE IN EXTREMELY HIGH WIND CONDITIONS

Momentum transfer across the wind driven air-water interface is experimentally investigated using a wind-wave tank in extremely high wind speed conditions. The velocity fluctuation in air with dispersed droplets is measured by a phase Doppler anemometer, and friction velocity, surface roughness, wind speed at 10 m height and drag coefficient are calculated by an eddy correlation method. The water level fluctuation is measured by a resistance type wave height meter. The results show that the local equilibrium law and Charnock’s formula are not applicable to high wind-speed conditions because of wave breaking. Instead of such conventional laws, we derived a new relationship between wind wave shape and surface roughness in the whole wind speed region. This new relationship suggests that the drag coefficient has a constant value in the high wind speed region and it can be also estimated from the water level fluctuation. (Abstract ID 10972)

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VARIATION OF THE DRAG COEFFICIENT INVESTIGATED USING TOWER-BASED LONG PERIOD MEASUREMENTS

The drag coefficient C_D is generally expressed as functions only of wind speed U. However, there exists considerable disagreement among the observed values of C_D. The data periods were from 1 Jan. 2005 to 31 Dec. 2009. The directional wave spectra were then observed and separated into three different groups: the following and cross swell
cases, and pure wind-wave case. In high wind speed region, the plots of cross and following swell cases are same as pure wind-wave case on the $C_r - U_{sw}$ diagram. In the following swell case, $C_r$ value is slightly smaller. In cross swell case, when difference of direction between wind and wave is larger than 70 degree, $C_r$ has large values. However, $C_r$ has same value with the following swell case, when smaller than 70 degree. The data set also shows variation in wind speed regions higher than 20 m/s. (Abstract ID 9483)

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DYNAMICS CONTROLLING THE DISTRIBUTION OF ENHANCED MIXING IN THE OCEAN

The ultimate fate of atmospheric and tidal energy is turbulent dissipation. It plays a prominent role in setting large-scale stratification, diffusing momentum, and controlling nutrient-availability. Our goal is to understand the dynamics that control the geographic distribution of mixing by following the flow of energy from large scales and internal waves through to its ultimate dissipation. In this tutorial, we review observations of enhanced turbulent mixing to elucidate the processes that govern it. As we move forward with the next generation of numerical/climate models, a priority for our community should be the identification of processes that can be effectively parameterized, versus those that need to be explicitly resolved. (Abstract ID 9606)

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ANATOMY OF TURBULENCE IN A BREAKING INTERNAL TIDE

Luzon Strait generates some of the largest amplitude internal tides in the world. At the ridges where they are generated, internal tides become unstable and break in a violent process that produces 300-m tall overturns. During the summer of 2011, 5 closely-spaced moorings were deployed across a ridge crest to examine the detailed dynamics of mixing events within these breaking internal tidal waves. Here we use these observations to construct an anatomy of turbulence and high-frequency fine-scale waves that emerge during the breaking process. (Abstract ID 11576)

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WAVE-CURRENT INTERACTION AND BOTTOM TOPOGRAPHICAL INFLUENCE ON TURBULENCE IN THE COASTAL OCEAN BOTTOM BOUNDARY LAYER

Particle image velocimetry (PIV) measurements focused on the mean flow and turbulence statistics in the inner part of the coastal ocean bottom boundary layer. Simultaneous 2D velocity distributions were obtained in 28x28 cm planes aligned with the current and the dominant wave direction in close proximity to the seabed. Datasets spanning the entire tidal cycle were obtained at 6 Hz, under varying velocity and relative wave-current orientations. A novel image processing technique was implemented to eliminate laser reflections, enabling velocity calculations in the wave boundary layer, down to 2-3mm off the bottom. Collocated ADV measurements facilitated calculations of Reynolds stress profiles by filtering out the wave-induced motions. A pencil beam sonar was used to characterize the seabed roughness, and hence correlate it with the PIV data. These scans indicated that the sandy bottom was primarily composed of 2 cm high ripples with wavelengths of 20-30 cm. The PIV data resolves the interaction of currents and waves with these roughness elements. The images also show that bio-turbation seemed to have significant impact on the local sediment re-suspension. Acknowledgements: Sponsored by NSF (Abstract ID 11491)

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DYNAMIC TOPOGRAPHY OF THE BERING SEA AND TRANSPORT ESTIMATES THROUGH THE MAJOR ALEUTIAN PASS

A new mean dynamic topography (MDT) for the Bering Sea was derived by 4-D data assimilation of historical oceanographic and atmospheric data into a high-resolution ocean model and compared with several MDTs available for the region. The new MDT is in a better agreement with independent velocity observations by Argo drifters and moorings. The MDT estimates derived from the latest Gravity Recovery and Climate Experiment (GRACE) geoid model have more in common with the obtained MDT than with the MDTs based on earlier versions of the geoid. The corresponding sea surface height (SSH) errors are estimated by inverting the Hessian matrix in the subspace spanned by the leading modes of SSH variability observed from satellites. Sea Surface Height (SSH) anomalies observed by satellites in 1992-2010 were combined with monthly temperature and salinity climatologies to estimate circulation in the southern Bering Sea. The magnitudes of the currents are consistent with independent observations by surface drifters and Argo floats parked at 1000m. Analysis of the SSH observations reveals 1-3 Sv inter-annual transport variations of the major currents with typical intra-annual variability of 3-7 Sv. On seasonal scales, the Alaska Stream transport is well correlated with the Kamchatka (0.81), Near Strait (0.53), and Bering Slope (0.37) currents, supporting the concept that the deep Bering Sea basin is ventilated by the waters carried by the Alaska Stream south of the Aleutian Arc. (Abstract ID 12222)

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QUANTIFYING NET TRANSPORT OF RIVER NUTRIENTS AND ORGANIC CARBON TO THE COLUMBIA RIVER ESTUARY USING IN SITU SENSORS

The Columbia River is a dominant geographic and ecological feature of the Pacific Northwest and a significant freshwater input to the California Current ecosystem. Over the last century humans have altered the seasonal pattern in river discharge through the construction of an international network of hydroelectric dams. A likely consequence to river biogeochemistry was the decrease in turbidity and alleviation of light limitation for phytoplankton, which may have altered the flux of nutrients and organic matter to the coastal zone. To determine the contemporary state of the river we investigated the role of pelagic primary production on biogeochemical fluxes during a two year study at a sampling location in the Lower Columbia River using in situ autonomous sensors. Throughout fall and winter, chlorophyll was low and biogeochemical parameters including nitrate, CDOM, and turbidity increased during episodic storm events, snowmelt, and hydroelectric management activities. During summer, increases in chlorophyll, dissolved oxygen, and nitrate utilization demonstrated that pelagic productivity was a controlling factor for inorganic nutrient and organic carbon flux to the estuary and coastal zone. (Abstract ID 10639)

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OCEAN OPTICS SUMMER COURSE 2011: WHAT TWENTY STUDENTS LEARNED ABOUT CALIBRATION AND VALIDATION IN THREE WEEKS

A generation of viable data records from satellite-borne ocean color instruments requires complementary field data for the calibration and validation of the instruments and their data products. Production of decade-long “climate data records” from these remotely-sensed time-series requires very high quality measurements of bio-optical and biogeochemical parameters collected following well-verified calibration, deployment, and data processing protocols. To this end, NASA recently funded a graduate-level course titled “Calibration and Validation for Ocean Color Remote Sensing” Students were immersed in measurement theory and instrument concepts in the classroom, and they applied laboratory theory to instrument operation and data collection in the field. Comprehensive laboratory sessions combined application of the theory and hands-on experience with the instruments. The course impressed upon the students the importance of quality data collection, data processing, applying the appropriate corrections to the data, accounting for uncertainties, and quality control. This poster describes the fundamental step-by-step process that should be implemented from data collection to data submission, using instruments operated during the course as examples, and demonstrates that this program is essential to the next generation of bio-optical oceanographers. (Abstract ID 10047)

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location-specific features are presented here, with reference to their generalized data product available from OOI's Integrated Observatory Network data portal. Over 700 instruments are expected to complement the OOI arrays at the time of commissioning, with additional space for Principle Investigators to deploy instruments (arranged through a separate NSF proposal process). Fixed instruments will be located at the air-sea interface, at the seafloor and throughout the water column. In addition, up to 45 mobile assets will be deployed within the OOI at any one time. These include gliders, AUV's, surface piercing profilers, and wire-following profilers. This presentation is intended to be viewed in conjunction with any of the other OOI posters at this meeting session that provide information on OOI data products, sampling strategy, etc. (Abstract ID 11651)

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ANALYSIS OF CAPTURE METHODS USED TO CONTROL THE POPULATION OF LIONFISH (PTERIOS spp) IN PUERTO RICO
This document serves as a reference for the management of Indo-Pacific lionfish (Pterios spp.) in Puerto Rico. We will present a background of the invasion and the mechanisms used to control the specie in different coastal environments (mangroves, sea grass beds and coral reefs) of the island. The tools described were used by commercial fisherman, sportmen and the general public in order to minimize any detrimental effect on our fish and invertebrate populations and its impact on ecological and economic issues in Puerto Rico. The goals and objectives of this paper are to analyze the capture methods used in Puerto Rico to control this specie. The discussion examines the methodology and tools used to control (trap), Lionfish (Pterios spp.). Due to the lack of a best practices document for the management of the specie, this will serve as basis for the drafting of future management plans and rapid response in the Caribbean. We hope that the review of existing fishing gear, a comparison of methods and cost-effectiveness analysis will allow us to design future measures that could be more efficient. (Abstract ID 1031)

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COMPARATIVE METAPROTEOMIC CHARACTERIZATION OF MARINE PARTICULATE PROTEINS IN PRODUCTIVE SHELF WATERS AND OLIGOTROPHIC OFFSHORE WATERS.

The traditional approach to evaluating proteinaceous marine particulate organic matter (POM) is to conduct acid hydrolysis and measure amino acids. However, this is a brute force approach in which valuable information about protein structures, sources, cellular localization and degradation are lost. Here we used a shotgun proteomic approach to understand the nature of proteins associated with POM. 700-1200 L of seawater were filtered (75-1500m) in the productive waters of the Western Margin (WM), the oligotrophic waters of the North Pacific (NP) and in the Sargasso Sea (SS). Proteins were extracted from GFF filters, tryptically digested and the peptides analyzed by shotgun proteomic. MS/MS spectra were searched using SEQUEST++ against a database derived from NCBI WJM samples were primarily composed of diatoms, dinoflagellates, chlorophytes, oomycte, crustacean, bacterial and cyanobacterial proteins, whereas NP and SS were dominated by heterotrophic and cyanobacterial proteins signatures. Proteins involved in photosynthesis were the most abundant in the euphotic zone whereas membrane biogenesis, energy production, AA transport and metabolism proteins were abundant in the meso- and bathypelagical zone. Interestingly, the proteins desaturase and serine protease were found throughout the water column of SS, suggesting that these collagenolytic protease might play an important role in the degradation of marine particulate organic matter in these waters. (Abstract ID 10725)

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IMPACT OF WAVE ENERGY ARRAYS ON BEACH PROCESSES

Before wave energy converter (WEC) arrays can be used to generate electricity at large scale, their environmental impacts need to be understood. Here, we examine the impact of large-scale WEC array operation on sand bars. Sand bars have an important role in natural coastal defence since they protect coastlines from the impact of storm waves. Since the wave climate between a WEC array and the coast will likely be modified by large-scale energy extraction, this could disrupt the natural processes which maintain sand bars, and therefore affect flood risk. We address this aim through application of a 1D cross-shore wave and sediment transport model UNBEST-TC. The model is used to understand seasonal variations in a bar system in southwest Wales (UK), a location exposed to the North Atlantic, and so an attractive region in which to exploit the wave energy resource. Wave energy is subsequently extracted at the model boundary for a range of WEC array operating modes, and morphodynamic impacts examined. For our case study, WEC device operation leads to enhanced sand formation over seasonal timescales. Since reduced water depth over the bar leads to enhanced depth-induced wave breaking, WEC array operation could provide enhanced coastal protection from storm waves. (Abstract ID 9867)

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FROM METABOLOMICS TO NATURAL PLANKTON FOOD WEBS INTERACTIONS. CONCLUSIONS FROM A CROSS-DISCIPLINARY IN SITU MESOCOSM EXPERIMENT.

In April 2008 a cross-disciplinary group of 24 scientists from 7 countries conducted a mesocosm experiment using 7x11 m3 in situ enclosures with natural seawater on the Norwegian west coast. A controlled gradient of increasingly mono-specific blooms of the diatom Skeletonema marinoi was created, and used to investigate chemical signaling, metabolomics, food quality, copepod reproduction and plankton development. We summarize intriguing results spanning from comprehensive studies of in situ metabolomics to food web dynamics using a suite of novel and classical approaches. With the advent of new in situ targeted analytical approaches, we argue that mesocosms are excellent tools to study complex food web interactions including chemical signaling and net nutritional effects on the plankton ecosystem. (Abstract ID 12573)

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CDOM AS A DEEP OCEAN PROXY FOR OXYGEN AND AOU

Chromophoric dissolved organic matter (CDOM) the optically active fraction of DOC, is ubiquitous in the global ocean, and can be detected by absorption or fluorescence measurements as well as by ocean color remote sensing. A global-scale survey of CDOM from sections of the U.S. CO2 CLIVAR Repeat Hydrography Project has revealed consistent relationships between light absorption signatures and AOU below the thermocline in much of the ocean. Fluorescence-based measurements provide analogous results with the additional possibility of high spatial or temporal resolution measurements from various platforms. Prospects for the assessment of dissolved oxygen or AOU from CDOM absorption and fluorescence measurements will be discussed. (Abstract ID 991)

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THE INFLUENCE OF RIPPLE GEOMETRY ON SEABED ROUGHNESS AND VERTICAL SUSPENDED SEDIMENT CONCENTRATION PROFILES

Bottom bedforms such as ripples affect the physical roughness experienced by the flow thereby significantly influencing boundary layer and sediment resuspension processes. This influence has been found to vary as a function of relative angle between ripples and mean flow. This study examines the temporal and spatial evolution (including directionality) of ripples and their effect on the vertical suspended sediment concentration profile. The ripple evolution and directionality is described through a 2-D time dependent ripple model which allows for the bed to be in disequilibrium with the prevailing flow by accounting for bed response time and as such does not assume that waves are always aligned with the waves. As application of this model depends on the equilibrium geometry being known, a new equilibrium predictor is presented based on the majority of available published information enriched with data from three different field sites along the south eastern coast of the United States. Finally, a
detailed analysis of the influence of bedform geometry on the vertical suspended sediment concentrations and associated bedform roughness is examined. (Abstract ID 9877)

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A MULTI-PLATFORM APPROACH TO INVESTIGATE SUBMESOSCALE STRUCTURES IN A COASTAL REGION AND THEIR IMPACTS IN REGULATING CROSS-SHELF EXCHANGES

The interactions between ageostrophic processes and large scale dynamics in the western part of the Gulf of Lion (NW Mediterranean) play a fundamental role in regulating water exchanges between the continental shelf and the open sea. The dominant regimes emerging from these interactions were successfully characterized during the Lagrangian Transport Experiment (LATEX, 2008-2010) thanks to a multi-platform approach which included in-situ observations, satellite measurements and numerical model simulations. During the LATEX10 campaign (September 1-24, 2010), in-situ Lagrangian Coherent Structures reconstructed from drifter trajectories allowed to identify an alongshore corridor through which coastal waters escaped the Gulf. Satellite imagery indicated that the offshore boundary of the corridor was associated with a strong frontal region. Glider profiles allowed to reconstruct the vertical structure of the front, and ship-based ADCP current estimates to estimate the associated horizontal fluxes. Realistic numerical simulations showed that this regime alternates with periods during which the circulation is dominated by coastal anticyclones (also observed in previous campaigns). Model results, along with a regional satellite altimetry product, allowed to characterize the influence of the two regimes in regulating cross-shelf exchanges. (Abstract ID 10211)

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THE ERROR-SUBSPACE TRANSFORM KALMAN FILTER

Ensemble square-root Kalman filters are currently the most computationally efficient ensemble-based Kalman filter methods. In particular, the Ensemble Transform Kalman Filter (ETKF) is known to provide a minimum ensemble transformation in a very efficient way. In order to further improve the computational efficiency, the Error-Subspace Transform Kalman Filter (ESTKF) was developed. The ESTKF solves the optimization problem of the Kalman filter in the error-subspace that is represented by the ensemble. As the ETKF, the ESTKF provides the minimum ensemble transformation, but at a slightly lower cost. We discuss the ESTKF and its localized counter part the LESTKF using numerical experiments with the parallel data assimilation framework PDAF and models of different complexity. (Abstract ID 9418)

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A FASTER VARIATIONAL NON-CONVEX DATA ASSIMILATION SOLVER USING MULTIGRID METHODS. EXPERIMENTS ON A HIGH RESOLUTION SHALLOW WATER MODEL

For the past thirty years, earth observation instruments and numerical models have improved greatly and now provide a large amount of accurate, yet heterogeneous, information on geophysical fluid dynamics and structures. Optimization methods, also called variational data assimilation, are capable of merging information from different sources in a consistent way to better forecast oceanic flows. Unfortunately, it can be difficult to apply these powerful methods on always more complex information due to the limited availability of sufficiently powerful calculators. Multigrid methods accelerate iterative methods by solving for the error on low resolution grids and we extend their application on the variational data assimilation process in order to limit computational cost. We define two multigrid algorithms and their convergence properties: The first is based on the Full Approximation Scheme (FAS), a non-linear multigrid algorithm, while the second is the Gauss-Newton Multigrid (GN-MG), which is applied to the incremental variational method. We present the comparison of multigrids and classic solvers made on a high resolution Shallow-water model with preconditioning. (Abstract ID 11534)

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NEW FRONTIERS IN THE CHEMICAL ECOLOGY OF PROCELLARIIFORM SEABIRDS

Our laboratory studies the chemical ecology of procellariiform seabirds, the order typified by albatrosses and petrels. We have worked extensively on how birds use signal molecules in the marine environment for foraging and navigation. We have also shown that some species use odors to recognize each other and their nest site, and this behavior is particularly pronounced in burrow-nesting species. We have recently demonstrated that Leach’s storm-petrel (Oceanodroma leucorhoa) chicks can identify nest-specific odors, and that chicks can learn to identify both personal and experimental odors before they leave the nest. We are exploring the chemical basis for these behaviors using a combination of forensic methodologies developed for human personal scent characterization for law enforcement, and behavioral bioassays that have been developed in our field laboratory. We are currently extending these methods to characterize the personal odor signature of individual birds relative to genetic markers. (Abstract ID 10379)

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We investigated the proteome of T. pseudonana under limiting (62% mu-max) and replete Fe BY CELL SURFACE BIOTINYLATION COUPLED WITH MASS SPECTROMETRY

We investigated the proteome of T. pseudonana under limiting (62% mu-max) and replete Fe by better understand the repertoire of transporters that may be involved in Fe uptake. Briefly,
cells surfaces were labeled with a biotinylation reagent to isolate proteins on a neutravidin resin. After elution, extracts were subjected to SDS-PAGE, in-gel tryptic digestion, separation via Dionex U-3000 nano LC system, and Thermo LTQ-Orbitrap-Velos mass spectrometry. We obtained at least two-fold greater abundances of several known membrane bound proteins under low Fe. These included two paralogous iron (III) permeases (also transcriptionally regulated, Kurtka et al. 2007), an oxidoreductase of unknown function, and two ABC transporter proteins. These preliminary trials also revealed some carryover of intracellular proteins. Several of these were highly expressed under low iron, including iron stress induced protein. There was also a two fold down-regulation of several proteins involved in carbon metabolism, photorespiration and the urea cycle (Allen et al. 2011). These observations are consistent with a decreased CO2 demand relative to flux, as expected with a depressed growth rate. Since cell surface proteins are a small fraction of the proteome, spillover of intracellular proteins may the efficient identification of some cell surface proteins. We are currently optimizing conditions to obtain a more thorough cell surface proteome. (Abstract ID 12872)


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On behalf of the SOOS community, …

THE SOUTHERN OCEAN OBSERVING SYSTEM: TOWARDS IMPLEMENTATION

The Southern Ocean provides the principal connection between the Earth’s ocean basins and the global overturning circulation. Changes in the Southern Ocean therefore have global ramifications. Recent research has demonstrated that the Southern Ocean is changing. The region is warming rapidly, salinity changes have been observed in both the upper and abyssal ocean the uptake of carbon has caused basin-wide ocean acidification; and ecosystems are reacting to changes in the physical and chemical environment. These results, and their implications, demonstrate the need for sustained Southern Ocean observations. The Southern Ocean Observing System (SOOS) has been established to develop a multidisciplinary observing system. It will address the following key challenges: 1) Global heat and freshwater balance, 2) Stability of the overturning circulation, 3) Future of the Antarctic Ice Sheet and its consequences, 4) Ocean uptake of carbon dioxide, 5) Future of Antarctic sea ice, and 6) Impacts of global change on Southern Ocean ecosystems. This presentation will outline the SOOS strategy and provide details on plans towards implementation of the SOOS. (Abstract ID 10774)

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NANOOS: SERVING THE PACIFIC NORTHWEST

The Northwest Association of Networked Ocean Observing Systems (NANOOS) is the Integrated Ocean Observing System (IOOS) Regional Association (RA) for the U.S. Pacific Northwest. NANOOS members are evenly distributed between academic, governmental, industry, and non-profit organizations, which designate a representative to the NANOOS Governing Council. User-driven since its inception in 2003, the NANOOS Regional Ocean observing system responds to a variety of scientific and societal needs across its regional coastal ocean, estuaries, and shorelines. Regional priorities have been solicited and reaffirmed through active engagement with users and stakeholders. These include: Maritime Operations, Regional Fisheries, Ecosystem Assessment, Coastal Hazards, and Climate. To scope the NANOOS build-out plan, guiding strategies were to leverage integration of existing assets and be strategic in filling gaps. Coordination with OOI and other major observing efforts is important and explicit in this activity. NANOOS has joined the other west coast RAs in planning coast-wide integration of data and products relevant to issues such as ocean acidification, harmful algal blooms, and tsunami response. The IOOS system, of which NANOOS is a component, provides an effective national means to leverage, link, and conduct such integration, which is necessary for effective use and management of limited marine resources. (Abstract ID 10996)

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BEACH SAND MICROBIAL COMMUNITY VARIATION AS AN INDICATOR OF ECOSYSTEM DISTURBANCE

Microbes might provide sensitive measures of aquatic ecosystem disturbance. The blowout of the Macondo reservoir provided an important opportunity to examine this hypothesis. Following the blowout, 454 pyrosequencing of the 16S rRNA gene provided detailed assessments of community structure changes over a six-month period among seven beaches from Bay St. Louis, MS to St. George Island, FL. The bacterial community composition of surface sands suggested structuring by local environmental conditions, where individual beaches had unique community signatures that persisted over time, while also exhibiting decreased community similarity as sample distance increased from 1 m to 100 m. Large bacterial community composition differences between beaches located to the east (AL & FL) and to the west (MS) of Mobile Bay provided evidence of regional effects. Superimposed upon these beach community-distance and -time relationships were bacterial community composition changes related to beach oiling. Oiled beaches underwent significant shifts in community diversity, composition, and variability. At the end of the six-months, after measurable petroleum hydrocarbons had disappeared, increased variability among samples over time indicates persistent impacts at some of the studied beaches. (Abstract ID 12156)

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CHANGING FRESHWATER SOURCES TO THE CANADIAN BASIN: 1989 TO 2005

The upper layers of the Canadian Basin constitute a large reservoir of freshwater and buoyancy that derives from river runoff, sea-ice meltwater, and relatively fresh North Pacific waters. The size of the reservoir and fluxes of buoyancy to the sub-Arctic region vary with large-scale wind-stress patterns in the Northern latitudes. We use salinity, oxygen isotopes and nutrient concentrations to study the varying contribution from freshwater components in a series of Arctic Ocean cruises between 1989 and 2005. We put these temporal changes in the context of the time-mean Arctic-wide distribution of water-mass tracers based on 30 years of modern research cruises there. We also link the component shifts to basic indices of Arctic atmospheric variability. Finally, we compare different methods for performing the decomposition, based on different combinations of tracers. We address uncertainties in end-member definition that have led to conflicts between water mass estimates by different research groups, and show that the these methods can reconciled, at least in the Chukchi Sea region, through a careful treatment of biological processing and mixing over the Arctic shelf seas. (Abstract ID 12203)

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THE LAMONT DOHERTY SECONDARY SCHOOL FIELD RESEARCH PROGRAM

For Black, Latin American and Native American students, the largest leak in the STEM pipeline occurs between high school and college. For 6 years The Lamont-Doherty Secondary School Field Research Program has engaged high school students and teachers from NYC in field or laboratory research projects. Our partners are non-competitive entry neighborhood-based public schools. They are predominantly Title I/Title III populations and over 75% Black and Latino. Our student participants have been over 90% from under-represented minorities and approximately 50% young women. The results have been very positive. All of our graduates attend college. Enrollment in after-school science clubs is dramatically up. Approximately a dozen students have presented posters at professional science meetings. Two of our girls won the team competition at the NYC Science and Engineering Fair. A semi-formal network of collaborating scientists, technicians and teachers has formed around the field work. We present the Program as a potential model for intervention by research institutions and departments that can (a) improve college attendance, (b) improve STEM recruitment and (c) invigorate teaching in the Program as a potential model for intervention by research institutions and departments. (Abstract ID 12237)

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FACTORS DRIVING PHYTOPLANKTON BLOOMS ALONG THE CENTRAL AND SOUTHERN CALIFORNIA COAST

Integrated dataset of satellite remotely-sensed ocean color (SeaWiFS, 1997–2007) and sea surface temperature combined with modeled freshwater discharge was used to analyze the factors associated with phytoplankton blooms in the central California and Southern California Bight (SCB) coastal zones. Blooms were assessed using the offshore extension of zones of high
CHL: a novel analytical method that excludes terrestrial interference. Offshore CHL extensions showed a significant positive trend during 1997–2007, with maxima in 2000–2001 and 2005–2006 that coincided with higher than normal frequency of upwelling events. Upwelling was found to be a major driving factor; although the standard upwelling index was decoupled from the frequencies of both upwelling events and phytoplankton blooms. Areas of longer residence time associated with natural boundaries had more extensive and persistent blooms. The influence of stormwater discharge appeared to be limited to areas in close proximity to major river mouths. These locations, identified as bloom “hot spots,” were also co-located with ocean outfalls of Publicly Owned Treatment Works (POTW) discharge and, in some cases, longer residence time of coastal waters. (Abstract ID 10537)

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COMPARISON OF HYDROCARBON BIODEGRADABILITY IN ALCANIVORAX STRAINS ISOLATED FROM TEMPERATE AND TROPICAL SEAWATER

Alcanivorax is known to be an oil-degrading bacterium and have been isolated from various areas of the sea. In this study, the abilities of two bacterial strains belonging to the genus Alcanivorax to utilize normal- and branched-alkanes as sole carbon sources were examined. Alcanivorax borkumensis strain ST-T1 (Sytsma et al. 2001) and Alcanivorax sp. 2A75 (Teramoto et al. 2009), which were previously isolated from Japan Sea and Java Sea, respectively, were obtained from NBRC culture collection. The optimal growth temperatures of strains ST-T1 and 2A75 on the headspace degradation were 35ºC and 25ºC, respectively. Degradation rates of hexadecane and pristane (2,6,10,14-Tetramethylpentadecane) by the strains were then analyzed by gas chromatography during a 21-day incubation at 25ºC and 35ºC. As a result, each of the strains utilized both normal- and branched-alkanes, however the substrate preferences were different between the strains. These results suggested that the combinational use of the strains ST-T1 and 2A75 may contribute for more efficient hydrocarbon degradation than the uses of single strain. (Abstract ID 11106)

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GENERALIZED INVERSION OF SATELLITE AND IN-SITU OBSERVATIONS IN THE MONTEREY BAY USING THE NAVY COASTAL-OCEAN MODEL (NCOM)

A 4DVAR data assimilation system was recently developed for the Navy coastal ocean model (NCOM). It was first tested using a combination of real surface data (temperature and sea surface height) and synthetic subsurface data (temperature and salinity) produced by the modular ocean data assimilation system (MODAS). Here a full range of real surface and subsurface data is considered following encouraging results from the preliminary test. The data include sea surface temperature (SST) and sea surface height (SSH) from satellite, as well as subsurface data from moored buoys and gliders from the ACSN II field experiment in the Monterey Bay. It is shown that the weak constraint assimilation system is able to fit both the assimilated and non-assimilated data through the water column and over the entire assimilation window. In addition, the retrieved forcing errors are consistent with previous studies that attempted to correct the model forcing empirically in order to fit the data. (Abstract ID 10595)

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MICRODIVERSITY STUDIES REVEAL A HIGH-TEMPERATURE ADAPTED CLUSTER OF SAR11 IN WATERS OF THE RED SEA

The Red Sea is an extremely oligotrophic marine ecosystem that is characterized by high surface water salinity, solar irradiation and temperature (winter: 24%; summer: 35°C), a permanent water column stratification having 22°C from 200 m to the bottom, and negligible freshwater inputs. Despite these unique traits that set it apart from other marine environments, the microbiology of this ecosystem is understood. Our recent large-scale survey of bacterial 16S rRNA genes indicated that the diversity of pelagic bacterioplankton is similar to those in other tropical seas, with the predominance of SAR11 (56%) and Prochlorococcus (20%) taxa. Temperature was the best predictor of species richness across its north-central axis. Internal transcribed spacer (ITS) region sequences of water column samples further document the existence of four distinct SAR11 phylotypes that are dominated by Surface 2 (30%) clade, which is restricted to surface waters. Another unclassified cluster (30%) occurs throughout the column, and is strictly affiliated with sequences from other high-temperature marine environments. Sequences of both clusters have also been independently obtained from single cells and high-throughput cultures from the Red Sea surface waters. (Abstract ID 9897)

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PROGRESS AND ASSESSMENT OF THE ARCTIC AND SUB-POLAR NORTH ATLANTIC STATE ESTIMATE

The Arctic Ocean and sub-polar North Atlantic are home to processes of great importance to the global climate system. These processes include the modulation of heat, moisture, and momentum fluxes between the atmosphere and ocean by sea ice, the ice albedo feedback which regulates the radiative budget, deep water formation in the Greenland and Labrador Seas which affect deep ocean circulation and energy transport, and a coupling between ocean heat and marine terminating glacier melt rates around the marginal Greenland ice sheet. To advance our understanding in this region, we aim to produce a 20-yr (1992-present) eddy-permitting Arctic and sub-polar North Atlantic state estimate (ASTE) for climate studies using the techniques developed within the framework of the EECO consortium. Data constraints include meteorological and oceanographic profiles from Sea-Ango floats, ice-tethered profilers, a modern climatology, and moored arrays; sea ice concentration, thickness, and velocity; and atmospheric state from several reanalyses. The ASTE domain covers the entire Arctic and the North Atlantic Ocean north of 5 degrees and has a horizontal grid spanning of 7-12 km with 50 vertical levels. The dynamical consistency of the state estimate will (a) permit closed budget calculations of time-varying tracers such as heat and freshwater and (b) serve as baseline for future sensitivity experiments and as a starting point for observationally-constrained very high resolution nested regional simulations. (Abstract ID 12267)

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OBSERVATIONS OF DIURNAL RESTRATIFICATION WITH WIND, WAVES, AND LANGMUIR CIRCULATIONS

Diurnal restratification and nocturnal convection events in the surface mixed layer were observed in conjunction with periods of strong wind and waves during Surface Waves Processes Program (SWAPP, 1990). Wind, waves, and Langmuir circulations play key roles to trap heat and momentum in the surface mixed layer that otherwise would be radiated back to the atmosphere during nocturnal convections. In abrupt diminutions of the wind strength, mixing remains enhanced by surface waves and Langmuir circulations that do not decay simultaneously. Rapid-profiling CTD data, surface sonic scattering, and fluxes from SWAPP measured on FLIP are used to examine the amount of trapped heat in the surface mixed layer due to each process: wind, waves, and Langmuir circulations. (Abstract ID 12730)

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ASSESSING TRIPLE OXYGEN ISOTOPES IN A GLOBAL MODEL

The triple oxygen isotopic (TOI) composition of dissolved oxygen (18O, 17O, 16O) has now been widely applied as a tracer of gross photosynthetic oxygen productivity (GOP) in the mixed layer. To get from a measured 18O excess (δ18O) to an estimated GOP rate, however, requires assumptions be made about the physical dynamics of the upper ocean. Equations commonly used to calculate GOP assume a steady-state mixed layer, with no vertical or lateral fluxes. We evaluate the TOI system in an earth system model (Community Climate System Model 3.0). Systematic biases due to non-steady-state dynamics and physical transport are evaluated based on seasonality and regional biophysical domains. (Abstract ID 12073)

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TIDAL CONTROL OF BENTHIC NITRATE REMOVAL IN A MESOTIDAL ESTUARY

Nitrate removal is an anaerobic process that occurs almost exclusively within suboxic sediments in estuarine environments. Consequently, sediment resuspension by tidal currents...
could affect nitrate removal through physical disruption of the sediment matrix if theoxic conditions are altered. Evidence of this possible link between biogeochemical cycling and estuarine physics is presented from two observational datasets from Elkhorn Slough, California: 1) a short-term intensive study focused in a tidal creek and 2) a long-term observational set in the main channel of the estuary. (Abstract ID 11882)

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MESOSCALE FRONTS IN THE CALIFORNIA CURRENT SYSTEM AND THEIR RELATION TO THE DISTRIBUTION OF SMALL PELAGIC FISH LARVAE

Physical mesoscale characteristics play an important role in the life cycles and distribution of sardine and anchovy, the most abundant pelagic fish species in the California Current System. We explore the spatial and temporal relationship between mesoscale fronts and the distribution of ichthyoplankton collected in bongo nets in the spring time CalCOFI surveys. We used information over the years 1997 to 2010 for the area between 19° - 43° N and 109° - 133° W. A method for automatic fronts detection based on an improved version of the Cayula-Cornillon algorithm for upwelling regions was implemented, using daily satellite images at 1 km resolution of sea surface temperature, computed from AVHRR (1997-2002) and MODIS data (2003-2010). We quantified and compared the abundance and size distributions of sardine and anchovy larvae inside and outside of the upwelling front and its distance to the front, using a euclidean distance map created considering the shape of the front. We also studied the enriched production in both zones and tested the effects on larval survival, using satellite images of chlorophyll from SeaWiFS and MODIS data. (Abstract ID 11490)

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WESTERN MEDITERRANEAN SEA SURFACE TEMPERATURES DURING THE LAST TWO MILLENNIA: A BIOMARKER APPROACH

Two temperature proxies, one based on isoprenoidal membrane lipids of marine Thaumarchaeota (the TEX15, –tetrather index of tetraethers consisting of 86 carbon atoms) and the other on alkenones produced by haptophytes (the Uk’ estuarine physics is presented from two observational datasets from Elkhorn Slough, California: 1) a short-term intensive study focused in a tidal creek and 2) a long-term observational set in the main channel of the estuary. (Abstract ID 11882)

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HOW DYNAMIC IS “REFRACTORY” DOM? - A GEO-METABOLIC APPROACH

Refractory dissolved organic matter (DOM) accounts for most of the global oceanic organic carbon inventory. Processes leading to its formation and factors determining its stability are still largely unknown. We hypothesize that refractory DOM carries a universal molecular signature. Characterizing spatial and temporal variability in this universal signature is a key to understanding dynamics of refractory DOM. We present results from a long-term study of the DOM geo-metabolome in the open North Sea. Geo-metabolomics considers the entity of DOM as a population of compounds, each characterized by a specific function and reactivity in the cycling of energy and elements. Ten-thousands of molecular formulae were identified in DOM by ultrahigh resolution mass spectrometry analysis (FT-ICR-MS, Fourier-Transform Ion Cyclotron Resonance Mass Spectrometry). The DOM pool in the North Sea was influenced by a complex interplay of processes that produced, transformed and degraded dissolved molecules. We identified a stable fraction in North Sea DOM with a molecular composition similar to deep ocean DOM. Molecular-level changes in this stable fraction provide novel information on dynamics and interactions of refractory DOM. (Abstract ID 9466)

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THE ROLE OF TOPOGRAPHY IN DISSIPATION OF GEOSTROPHIC EDDIES IN THE SOUTHERN OCEAN

High-resolution simulations of the wind- and buoyancy-forced eddying flow with rough bottom topography are used to investigate energy pathways and dissipation mechanisms in the ocean. Simulations explicitly resolve processes of energy transfer from balanced to unbalanced motions such as frontogenesis and submesoscale instabilities in the upper ocean and low-level nonlinear flows and radiating topographic internal waves at rough topography in the deep ocean. Results from the control simulation, with parameters characteristic of the Southern Ocean, show that flow-topography interactions effectively catalyze dissipation of balanced flows by direct generation of internal waves and other small-scale motions, accounting for about two-thirds of the total energy dissipation. The rest of the energy dissipation takes place mostly at the upper ocean and is quite frontogenesis and submesoscale instability processes. Energy dissipation by the unresolved bottom boundary layer, parameterized here with quadratic bottom drag, is small compared to the dissipation by resolved motions. A series of experiments is performed to examine sensitivity of the energy dissipation to variations in topographic roughness and other problem parameters. (Abstract ID 9727)

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TRENDS IN COMMUNITY STRUCTURE OF ZOOPLANKTON AND MICRONEKTON FROM WATERS NEARBY FUKUSHIMA AND THEIR RELATION TO BIOACCUMULATED CESIUM RADIONUCLIDES

The release of artificial radionuclides into the ocean from the Fukushima Daiichi nuclear plant is the largest accidental release into the ocean in history. Of particular interest is the bioaccumulation of long-lived radionuclides in marine food chains. Despite their importance, information on radionuclide bioaccumulation in zooplankton and micronekton in the western Pacific is limited, and in particular there is sparse information on the relationship between radionuclide uptake and the composition of these animal communities. A US-Japan collaborative cruise in June 2011 enabled us to collect zooplankton and micronekton samples between 141°E (~30 km away from the plant) and 147°E. Both 134Cs and 137Cs were detectable in various zooplankton taxa mixed together and micronekton at most sampled stations. 137Cs concentrations exceeded recent background levels by 2 to 3 orders of magnitude, however this record, which indicates a low influence of riverine derived soil organic matter into the basin and a predominant marine provenance for the sedimentary organic matter. (Abstract ID 10797)

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DIAGNOSIS OF WATER-MASS TRANSFORMATION AND FORMATION RATES IN A HIGH-RESOLUTION GCM OF THE NORTH PACIFIC

Relation between thermodynamic and kinematic methods to access water-mass formation is studied by applying both methods to the STMW and CMW formation region using long-term outputs of a high-resolution GCM of the North Pacific under climatological normal year forcings. Water-mass transformation and net formation rates are also compared. The diagnosis of the thermodynamic relation indicates that the air-sea transformation largely explains the diapycnal flux. The difference of these, which gives the non-advective effect, is relatively small compared with previous estimates. It is mostly explained by explicit and implicit vertical
diffusions. The diagnosis of the kinematic relation indicates that the annual subduction rate can be calculated from the convergence of the diapycnal flux with the lateral flux at the horizontal boundaries of the analysis region. The comparison of the air-sea formation rate, the net formation rate, and the subduction rate implies that the air-sea transformation rate is a good indicator of the subduction rate in STMW but not in CMW. The effects of the non-advective flux is relatively small in the formation of STMW, on the other hand, it is not negligible in the formation of CMW. (Abstract ID 10938)

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ARCTIC OCEAN CIRCULATION AND EDDIES CHARACTERIZING NUTRIENT AND PHYTOPLANKTON DISTRIBUTIONS IN THE CANADA BASIN

In recent years, the Arctic has rapidly lost its summer sea ice cover. As a result, the wind can drive the ocean circulation more efficiently. The enhanced ocean circulation changes nutrient distributions, and therefore, could impact ecosystem characteristics in the Arctic Ocean. For example, the accumulation of freshwater in the Canada Basin produces a density gradient between the Chukchi Sea shelf and the basin, resulting in the formation of strong westward flow over the shelf slope. This strong westward flow prevents the spread of nutrient-rich shelf water towards the central Canada Basin. This blocking of nutrient-rich water may inhibit phytoplankton growth in the Canada Basin. On the other hand, warm-core eddies which contain high-ammonium shelf water can supply ammonium to the euphotic zone in the southwestern Canada Basin and may increase biomass of phytoplankton there. The role of warm-core eddies in supplying nutrients to the euphotic zone and controlling phytoplankton distributions seems to be more important than previously because the recent deepening of the nutrient in the Canada Basin has decreased the nutrient supply to the euphotic zone. (Abstract ID 12545)

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EVIDENCE OF EXTENSIVE WIDESPREAD OF HYDROTHERMAL DISSOLVED IRON IN THE INDIAN OCEAN

The large-scale investigation of dissolved iron (Fe) took place through the Japanese-GEOTRACES study and here we report the results of basin-scale full-depth section profile in the Indian Ocean, from the Arabian Sea to the Southern Ocean. The data clearly provide the first observational evidence that the hydrothermal source influenced the Fe distribution more than expected. The hydrothermal Fe spread at the deep layer, over 3000 km, and the large part of the dissolved Fe from the hydrothermal source was real soluble fraction rather than the colloidal fraction. In the intermediate water in the north Arabian Sea, another dissolved Fe rich water mass existed where Fe was enriched by remineralization processes from settling particles and preserved into the oxygen minimum zone (OMZ). The basin-scale section profile indicates that there are several sources supplying dissolved Fe, such as the hydrothermal source and the terrestrial Fe input with persistent condition in the OMZ, between northern-subtropical section, though little Fe sources existed in the open Southern Ocean. (Abstract ID 9567)

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EPOCA/EUR-OCEANS DATA COMPILATION ON THE BIOLOGICAL RESPONSE TO OCEAN ACIDIFICATION: DESCRIPTION AND APPLICATIONS

EPOCA (European Project on Ocean Acidification) and EUR-OCEANS (European Network of Excellence for Ocean Ecosystems Analysis) have supported a compilation of experimental and observational data on the effects of ocean acidification on marine organisms, such as phytoplankton, zooplankton, corals, mollusks, echinoderms, and communities. Such compilation effort was needed because few papers do not provide the data and details on the carbonate chemistry. Additionally, variables are often reported in different units, calculated using different sets of constants and on different pH scales. This situation hampered data comparisons. The compilation includes organisms and communities originating from most worlds oceans and seas, dating back to 1986. Since 2008, data from a total of 398 papers were identified as relevant, and 186 data sets were made publicly available at PANGAEA - the Publishing Network for Geoscientific & Environmental Data. The data from this effort have proved useful for meta-analyses as well as for other comparative studies. This data compilation is regularly updated as an ongoing mission of EPOCA and is available through its data portal (http://www.epoca-project.eu/index.php/data/data-sets.html). (Abstract ID 9720)

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MILLIMANIA: S2S DISCOVERIES AROUND THE WORLD BY AND WITH JOHN MILLIMAN

The dominant types (siliclastic, carbonate) and sources (rivers, glaciers) of marine sediment have been investigated by John Milliman through his career. Repeatedly, he has delineated perspectives that have redirected and driven research into the linkages between land and ocean dispersal of sediments. I have been fortunate to have benefited from and participated in a range of these studies from diverse locations. At the mouth of the Amazon, John first recognized that, despite massive sediment supply, broad areas were not actively accreting. He led the first collaborative studies with Chinese coastal geologists, which defined sedimentary processes at the mouth of the Changjiang. Subsequently, he proved that the central Yellow Sea was dominated by a tongue of sediment emanating from the Huanghe. His groundbreaking studies with colleagues proved the integrated significance of sediment discharge from small mountainous rivers, and led to a series of studies. In southeast Alaska, he studied the impacts of catastrophic jokulhlaups. In New Guinea, he examined the complex sedimentation patterns from coalescing of multiple river dispersal systems. And in Taiwan, he demonstrated the existence of hyperpycnal flows. (Abstract ID 12088)

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BACKWATER HYDRAULICS AND SEDIMENT TRANSPORT IN COASTAL FLUVIAL SYSTEMS: OBSERVATION AND MODELING FROM THE MISSISSIPPI RIVER

Where rivers enter the coastal zone, gradually varying flow conditions develop. This section of the river is commonly referred to as the backwater segment. For lowland rivers, backwater extends hundreds of kilometers upstream of the outlet. Reach-average boundary shear stress varies temporally and spatially in this segment, influencing the timing and magnitude of sediment transport. We describe backwater influences in the lower 600 km of the Mississippi River. For example, adjustments in boundary shear stress lead to channel bed aggradation during moderate water discharge in the upper backwater segment. 300-600 km above the outlet. This region coincides with the node of five major avulsions during the past 5000 years due to preferential sediment deposition. Further downstream (200 km above the river outlet) diminished boundary shear stress stagnates bed material transport during low water discharge. During high water discharge, hydraulic drawdown increases boundary shear stress by a factor of ten, and bed-material transport increases one-hundred fold. Transport of fine sediments dominates in the lower reaches, so that as much as 70% of the sand flux occurs by way of suspension transport. Enhanced stress limits alluvial cover, exposing and eroding underlying substrate. Hydrodynamics limit the mobility of sand transport in the coastal Mississippi River, and render the system a unique filter in terms of sand conveyance to the ocean receiving basin. (Abstract ID 12587)

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ESTIMATION OF BAROCLINIC TIDE ENERGY AVAILABLE FOR DEEP OCEAN MIXING BASED ON THREE-DIMENSIONAL GLOBAL NUMERICAL SIMULATIONS

In this study, the global distributions of the major semiannual M2 and S2 and diurnal K1 and O1 internal tide energy are investigated using a hydrostatic sigma-coordinate numerical model. To examine the model sensitivity, a series of numerical simulations is conducted using various horizontal grid spacings of 1/15 to 1/5. For each simulation, the model topography is constructed by averaging the bathymetric data from ETOP02 within each model grid cell. The results of the simulation show that generation of energetic internal tide energy is restricted to representative prominent topographic features. In particular, nearly half of the diurnal internal tide energy is excited along the western boundary of the North Pacific. The sensitivity experiments show that the conversion rate from the surface to internal tides is very sensitive to the horizontal grid spacing as well as the resolution of the bottom topography. It is found that the conversion rate integrated over the global ocean is increased exponentially as the grid spacing is reduced. By extrapolating the calculated results, the global conversion rate in the limit of zero grid spacing is estimated to be 110GW. The amount of internal tide energy dissipated in the deep ocean is estimated to be 60GW, which is consistent with the energy required for deep water mixing to sustain the thermohaline circulation estimated by Webb and Sugimoto (2001). (Abstract ID 10173)

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of the current field, have significant vertical shear and are distributed over the entire water
deeper than 20 m). In shallower water, wind-driven currents account for a much larger portion
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SPATIAL AND TEMPORAL STRUCTURES IN WIND-FORCED, NEARSHORE TRANSPORT PATTERNS IN THE CENTRAL SOUTHERN CALIFORNIA BIGHT

It is thought that low-frequency wind-stress doesn’t drive currents in the Southern California Bight. However in 2001, measurements of winds and coastal currents in San Pedro Bay, the shelf located south of Los Angeles CA, suggested that winds were a significant forcing mechanism for alongshelf currents in approximately 15 m water depths. A more extensive field program in the summer of 2006 examined the structure of wind forcing over the entire shelf, with emphasis placed on measuring wind-driven responses in near-surface and shallow-water currents. Preliminary results indicate that wind stress only forces a small portion of currents that flow within 10 m of the sea surface over the mid and outer portions of the shelf (sea bed deeper than 20 m). In shallower water, wind-driven currents account for a much larger portion of the current field, have significant vertical shear and are distributed over the entire water column. Both components of wind stress force alongshelf transport and cross-shelf exchange in these shallow, near-shore regions. The spatial and temporal structures in this response are presently being examined. (Abstract ID 10503)

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LATITUDINAL AND VERTICAL DISTRIBUTION OF SYNECHOCoccus LINEAGES BELONGING TO SUB-CLUSTER 5.1 IN THE WESTERN NORTH PACIFIC OCEAN

Synechococcus are ubiquitously distributed throughout the world’s oceans. However, their abundances are much lower than Prochlorococcus in oligotrophic open oceans. Thus, Synechococcus diversity has not been studied in detail for oligotrophic open oceans. In this study, high-throughput phylogenetics using a primer specific to Synechococcus 5.1 sub-cluster was applied to investigate Synechococcus diversity in detail for the western North Pacific Ocean. Despite of low abundances, very diverse Synechococcus clades appeared. Clade II was a predominant Synechococcus. However, diverse clades in sub-cluster 5.1 excluding clades V, VI and WP2c were appeared. Among them, clades WP5C and WP5G were occasionally more abundant than clades II. Especially, clades WP5C and WP5G were found significantly at lower euphotic depths at about 75 m or less. On the other hand, clade WP5G distributed relatively high fraction at depth less than 100 m. Further, a number of sequences not affiliated with the previously designed clades were exhibited in lower euphotic depth, suggesting a possibility of existence of unidentified and light-adapted Synechococcus. (Abstract ID 10194)

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CONNECTIVITY OF LABRADOR SEA WATER BETWEEN THE EASTERN AND WESTERN NORTH ATLANTIC BASINS

Measurements of a recent Labrador Sea Water (LSW) freshening event in the Rockall Trough west of Ireland are presented. This freshening peaked in 2009 and most likely represents the arrival in the eastern basin of the North Atlantic of LSW formed through winter convection in the Labrador Sea ca. 2000. Sections occupied in Rockall Trough since 2004 are augmented by a recent transatlantic XBT/XCTD section running between the Rockall Trough and the Labrador Sea in early 2011. This section will also be put in the context of other observations from the AR7 and OVIDE sections including float and remote measurements. Heat storage anomalies are assessed along the transatlantic section and are compared with climatologies derived from all hydrographic and Argo float data available. Data from this section allow an investigation of the eastward spreading of LSW and the progressive shoaling of mixed layer depth within the thermocline from Ireland to Canada. The paper emphasizes the strong connection in intermediate and deep water masses between the eastern and western basins of the North Atlantic. (Abstract ID 12216)

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INTRINSIC AND WIND-DRIVEN INTERANNUAL VARIABILITY IN THE KUROSHIO EXTENSION IN AN EDDY-RESOLVING OGCM

Western boundary currents (WBCs) have been shown to have intrinsic variability due to oceanic nonlinear dynamics not only in idealized models but also in realistic OGCMs. While wind variability is considered to induce interannual variability in WBCs, the intrinsic variability is also expected to be involved, rendering uncertainty to the wind-forced interannual variability. Given importance to the extratropical air-sea interaction of huge heat transport and sea surface temperature frontal zones associated with WBCs, it is important to improve our understanding of interannual variability in WBCs including its uncertainty. Focusing on the Kuroshio Extension (KE), we explore this based on a four-member ensemble hindcast experiment from different initial conditions using an OGCM with 0.1° horizontal resolutions. The results suggest that intrinsic variability in KE speed estimated from the differences among the ensemble members has amplitude similar to or larger than the wind-driven interannual variability estimated from the ensemble mean. This means that interannual variability in KE speed has significant uncertainty. However, the uncertainty is significantly reduced when we consider the most dominant mode of the interannual variability in the KE region. (Abstract ID 10782)

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THE INFLUENCE OF OCEANIC OPTICAL TURBULANCES ON THE PROPAGATION OF LIGHT

Optical turbulences, which consist of structures with varying optical index result in a temporally and spatially varying disturbance of light propagation, severely degrade the performance of optical communication and imaging systems [1]. Efforts were undertaken to measure such turbulences along the east coast of Florida as well as in the Bahamas during a two week research expedition in July 2011. The relative movement of light dots projected by a diffractive optical element into a regular matrix was recorded by a high speed camera mounted 10m away from the light source within a telescoping rigid underwater sensor structure (TRUSS). Together with a set of instruments to measure the inherent optical properties of the test site, the TRUSS was lowered on a cable in order to profile the vertical optical turbulence structure. Good correlation was found between the distortion of the dot pattern and the temperature gradient in the thermocline layer. Efforts to separate the effects of particulate scatter and turbulent scatter are also described. [1] Proc. SPIE 8030, 803009 (2011) ”Impact of optical turbulence on underwater imaging” (Abstract ID 10275)

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ISOTOPIC INSIGHTS INTO TROPHIC SUCCESSION IN A DEVELOPING SALT MARSH

Restored trophic functioning is one measure of successful habitat restoration, although food
web interactions per se are seldom main objectives. We studied the recovery of the benthic food web after salt marsh restoration in Mission Bay, California (1996-2004). Macrofaunal community structure and composition in Spartina foliosa habitats of adjacent young (created) and mature (natural) marshes varied mainly due to shifts in abundance of insect larvae (macrozoal feeders) and oligochaetes (detritivores). Trophic succession was studied using two stable isotope approaches: high resolution 13C and 15N measurements, and analyzing isotopic labeling in macroalgae, bacteria, S. foliosa, and cyanobacteria revealed direct links (or absence thereof) between basal food sources and specific consumer groups, providing information on context-specific trophic interactions. Natural stable isotope ratios in food web components (primary producers and invertebrate consumers) reflected potential divergence in trophic structure between created and natural marshes, and changes along food web development. In addition, we explored relationships between functional redundancy, trophic diversity, and salt marsh function in bivariate isotopic-space along salt marsh successional development. (Abstract ID 12503)

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DISTRIBUTION OF DISSOLVED BISMUTH IN THE WESTERN NORTH PACIFIC

The number of studies on bismuth in the ocean is very limited. In this study, recent data on Bi is presented. Vertical profiles of dissolved Bi were obtained at stations of TR7 (35°N), TR11 (40°N), 13 (45°N) and 15 (50°N) along the 165°E transect and TR6 (47°N, 160°E) in the western North Pacific in July 2011. There was a south to north decrease in the concentration of Bi above 500 m. Both TR7 and 11 showed maxima at depths of 20 m and 200 m. The concentration of Bi at the 200 m maximum at TR7 was 1100 fM, being highest among any Bi data reported in the open ocean. Upper water concentrations at TR13, 15 and 16 ranged from 200 to 430 fM. The three stations showed a maximum at a depth of 600 m, which coincided with or was close to the oxygen minimum layer. Below this, Bi monotonically decreased toward lowest values of 23 to 43 fM near the seafloor. (Abstract ID 10156)

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SPATIAL PARTITIONING BETWEEN ZOOPLANKTON SPECIES IN NORTH NORWEGIAN FJORDS

When assessing interactions between zooplankton and their surroundings it is common to operate with average distributions, leading to erroneous estimates of grazing and predation. Environmental preferences and competition between similar species may lead to habitat partitioning along the depth axis, exposing populations to different predation pressure, and supplying predators with varying quality of food. We used an autonomous VPR to study patterns of zooplankton depth distributions and environmental data in several high latitude fjords at different seasons. We especially sought to detect depth aggregation and spatial partitioning of Calanus spp, different small copepod species and other zooplankton, and relate this to water column stability, temperature, food availability, presence of invertebrate predator and type of site. Although hydrographic parameters set the framework for zooplankton occurrence in the water column, biological factors seem to affect habitat choice strongly. Seasonal development and succession of species, as well as migratory behavior naturally influence the observed patterns. We attempt to find general rules for depth preferences and aggregation patterns in diverse fjord locations that can be used for predictive modeling. (Abstract ID 11969)

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DIETARY RESPONSE OF BENTHIC DEPOSIT-FEEDERS TO FRESH ALGAE SETTLING FROM AN ICE-EDGE SPRING BLOOM IN THE NORTHERN BERING SEA

Decreased annual sea ice cover due to climate warming is expected to lead to decreased organic matter inputs to the benthos through changes in the character of ice-associated spring blooms. Deposit-feeders may rely heavily on fresh algae deposited during the spring bloom for growth and reproduction. To determine the extent to which 5 abundant deposit-feeders in the study area (3 clams, a polychaete, and an ophiuroid) use fresh algae, we examined diets using stable isotope, fatty acid, and gut content analyses before and after the spring bloom in May-June 2007. Gut contents and stable isotopes reveal differential reliance on fresh algae among species. Also, predominance of penaeid diatoms in deposit-feeder guts before the bloom indicate that these ice-associated algae may be important sources of food in the early spring before ice retreat. Taken together these findings suggest the potential for substantial climate change impacts on benthic deposit-feeders. Results from this study will help facilitate forecasts of future changes in high-latitude marine benthic communities. (Abstract ID 11935)

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TRANSPORT AND EXCHANGE OF BLUE CRAB (CALLINECTES SAPIDUS) LARVAE IN THE MIDDLE ATLANTIC BIGHT

Blue crab larvae (Callinectes sapidus) are spawned at the mouths of Chesapeake and Delaware Bays and recruit back to the estuaries after a month in the coastal ocean. The objectives of this research were to investigate the influence of physical variability on the transport and ingress of blue crab larvae and to quantify larval exchange between Chesapeake and Delaware Bays. A coupled circulation (MACROM) and particle tracking (LTRANS) model was used to simulate the transport, behavior, and ingress of blue crab larvae during the years 2005 and 2006. Results indicate that there were marked differences in transport success between years. In 2005, 88% of particles successfully returned to the estuaries, whereas transport success in 2006 was an order of magnitude lower (0.7%). Although no particles were transported from the Chesapeake to the Delaware Bay in either year; 0.23% and 0.07% of particles were transported from the Delaware to the Chesapeake in 2005 and 2006, respectively. Physical process that produced the differences in transport success and larval exchange will be discussed. (Abstract ID 12663)

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RECENT STRONG INTERANNUAL VARIATION DISRUPTED PYCNOCLINE AND ABBYSSAL SALINITY TRENDS AT STATION ALOHA

Long-term freshening observed in the main pycnocline (25-26 σρ) at Station ALOHA reversed from 2008-10. The annual average salinity increased by nearly 0.2, reaching the 1992 record maximum for this density range. A larger salinity increase occurred in the upper pycnocline (24.2-25.2 σρ), where during winter 2008-9 dissolved inorganic carbon abruptly dropped, both absolutely and relative to salinity and alkalinity. Intrusion of anomalous water masses more likely explains the change than biological drawdown of carbon, as nutrient and chlorophyll levels appeared unaffected. Average salinity between 1.15-1.25°C (3500 m) increased by 0.035 from 1988 to 2006, and then decreased by nearly this amount between 2007 and 2009. From mid-2010 through mid-2011, salinity increased again in the mid-pycnocline and decreased in the upper pycnocline. Climate forcing included a strong La Nina in 2007-2009, the 2009-10 El Nino and the very strong 2010-2011 La Nina. These events generate first-baroclinic mode Rossby waves in the eastern Pacific that propagate westward past Hawaii. Along-isopycnal advection associated with these waves might explain the anomalous conditions. (Abstract ID 12577)

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MODELING THE DISTRIBUTION OF POC AND DOC FROM DISCRETE AND ATOONOMOUS UNDERWAY MEASUREMENTS COLLECTED SEASONALLY IN THE NORTHEASTERN US CONTINENTAL MARGIN

In order to refine Ocean Color measurements in the coastal region, extensive spatial and seasonal in situ data are required. However, it is expensive and time consuming to collect and process a sufficient number of discrete samples from a given region during a research cruise. One way to extend the data set is to make underway measurements using a flow through seawater system. Fluorometric CDOM (FDOM), Fluorometric Chlorophyll (FC-Chlow), and beam attenuation at 660nm were measured continuously in flow through as part of the field efforts for the project titled Impacts of Climate Variability on Primary Production and Carbon Distributions in the Mid-Atlantic Bight and Gulf of Maine (GIBEC). To help refine and quality control the data, every fifty minutes a valve automatically diverted the flow into a 0.2 micron capsule filter. These filtered moments provided baseline absorption measurements to account for fouling or instrumental background noise that was later subtracted from the attenuation measurements. Six research cruises were carried out on the R/V Delaware Two since Aug of 2008. Seventeen field relationships identified between Particulate Organic Carbon (POC) and beam attenuation, FDOM and Chromophoric Dissolved Organic Matter (CDOM), and CDOM and Dissolved Organic Carbon (DOC) were used to model POC, CDOM, and DOC throughout the study region and compared to Satellite products. (Abstract ID 11859)

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Tidal rivers (reaches with tidal fluctuations but no salinity intrusion) have historically been under-studied, even though they play a major role in the transport of water and sediment between fluvial and estuarine environments. The Amazon tidal river extends 800 km upstream from the Atlantic Ocean, and previous studies suggest that perhaps one-third of the total Amazon sediment load may be trapped in this low-gradient reach. Potential trapping environments include freshwater estuaries at the confluence of the Amazon and two of its large tributaries (the Tapajos and Xingu Rivers), floodplain lakes, and immobile tidal channels that connect to the main stem of the Amazon and incise its floodplain. Results from water-column profiling and ADCP transects collected during a pilot study reveal complex hydrodynamics and sediment dynamics of the two confluences with large tributaries. Fixed, 12-hour instrument deployments in small tidal channels allow us to determine the role of these channels in the tidal-scale sediment budget of the floodplain. These preliminary results provide insight to the many untested processes active in tidal rivers worldwide. (Abstract ID 10660)

Marine sediments contain the largest reservoir of organic matter. To elucidate the source of this organic matter, sedimentary proteins can be extracted and sequenced to provide potential source and functional information which may be used to reveal degradation and preservation mechanisms responsible for the deposition of carbon and nitrogen to marine sediments. Our efforts focused on linking proteomics with geochemical cycling to identify and track proteins through the degradation process. After establishing the expression profile of Thalassiosira pseudonana, our studies utilized standard shotgun proteomic techniques to track T. pseudonana proteins during a laboratory-based microbial degradation experiment which ultimately provided information on specific protein characteristics that enhanced preservation. By applying a purification method for particles and sediments from mixed communities, we tracked proteins as they precipitated to the ocean floor. We found that although bacteria dominate marine systems in both numbers and diversity, their relative contribution to the preserved proteinic pool is insignificant. These findings are the first to suggest that changes in the upper water column ecosystem will dramatically affect the preserved organic C and N in the sediments. (Abstract ID 12376)

Neutral surfaces are defined so that a water parcel that is displaced adiabatically along such a surface always has the same density as the surrounding water. Since such a displacement doesn't change the density field or the potential energy, it is generally assumed that it doesn't produce a restoring buoyancy force. However, it is here shown that, because of the nonlinear character of the equation of state (in particular the thermobaric effect), such a neutral displacement is accompanied by a conversion between internal and potential energy, and an equal transformation between potential and kinetic energy. While there is thus no net change of potential energy, the kinetic energy does change, implying that there is in fact a restoring force, and that isopycnal mixing (i.e. mixing along neutral surfaces) in general requires an external energy source. (Abstract ID 11111)

Mineral exploitation at deep-sea hydrothermal vents is poised to become a reality. Detailed knowledge of the biogeography, larval ecology, and occurrence of rare taxa at active and inactive vents is essential to foresee the potential impacts of mining, but our current understanding of vent biogeographic provinces, defined by differences in assemblage composition (e.g. Bachrathy et al., 2009; Vrijenhoek, 2010), is incomplete. Here we present faunal composition data from recent explorations of hydrothermal vent fields on the East Scotia Ridge, Mid-Cayman Spreading Centre, northern Mid-Atlantic Ridge, and Southwest Indian Ridge, which contribute to a preliminary analysis of the role of life-history on the distribution patterns of vent taxa. Our results address four regional “gaps” in the current picture of vent biogeography, revealing new species and novel assemblages. We anticipate that future analyses will enable us to assess how life-history biology may inform sustainable management of vent resources, and whether a taxon-specific approach is required to understand fully global patterns of vent biogeography. (Abstract ID 11159)
are also reported at stations where this species does not occur -- for example in parts of the Pacific Ocean. Ongoing analyses will investigate the role of environmental parameters such as light, nutrients and temperature in determining coccolithophore distributions, with a focus on interspecific variability. (Abstract ID 11609)

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CIRCULATION, MIXING AND THE VARIABILITY IN DO IN LONG ISLAND SOUND

Moored buoy observations of the evolution of the near bottom dissolved oxygen concentration in western Long Island Sound over the last decade have shown that the summertime trend towards hypoxic levels is intermittently reversed by periods of ventilation that last for 3-5 days. These intervals co-occur with periods of wind from northeast. It has been postulated that ventilation was a consequence of the modulation of the rate of re-stratification by the fresh water exchange flow through the East River. We report direct observation of the rate of re-stratification using moored salinity and temperature sensors, bottom mounted ADCPs, and an HF RADAR surface current mapping system. Measurements are consistent with the wind modulated straining hypothesis. Analysis of 50 years of wind observations at Ambrose Light, NY, suggests that there are decadal-scale variations in the frequency of occurrence of summer winds from the northeast. It is, therefore, likely that the decadal-scale variations in the extent and duration of hypoxia in western Long Island Sound can be explained by inter-annual wind variations. (Abstract ID 12005)

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SQUID ROCKET SCIENCE

Squid not only swim, they can also fly like rockets, accelerating through the air by forcefully expelling water out of their mantles. Using available lab and field data from three squid species, S. henotatus pteropus, Dosidicus gigas and Loligo opalescens, including 17 remarkable photographs of flying S. pteropus off the coast of Brazil, we compare the cost of transport in both water and air. The mantle volume of a flying S. pteropus (0.06m$^3$) is also calculated and methods of maximizing power output through funnel and mantle constriction are discussed. Additionally we found that fin flaps develop at approximately the same size range as flight behaviors in these squids, consistent with previous hypotheses that flaps could function as ailerons whilst aloft. Squid acceleration in air increases that in water several fold, so accelerometer data could easily record flight times. This extreme mode of transport may be more common than previously thought and potentially employed to reduce migration costs in addition to predation avoidance. Clearly squid flight, the role of fin flaps and funnel, and the energetic benefits need more investigation. (Abstract ID 11604)

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THE PHILIPPINES-TAIWAN OSCILLATION: MONSOON-LIKE INTERANNUAL OSCILLATION OF THE SUBTROPICAL-TROPICAL WESTERN PACIFIC WIND SYSTEM AND ITS IMPACT ON THE OCEAN

Tide-gauge and satellite data reveal an interannual oscillation of the ocean's thermoclines east of the Philippines and Taiwan forced by a corresponding oscillation in the wind stress curl. This so called "Philippines-Taiwan Oscillation" (PTO) is shown to control the interannual variability of the circulation of the subtropical and tropical western North Pacific. The PTO shares some characteristics of known Pacific indices, e.g. Nino3.4. However, unlike PTO, these other indices explain only portions of the Western North Pacific circulation. The reason is because of the nonlinear nature of the forcing in which mesoscale (ocean) eddies play a crucial role. In years of positive PTO, thermoclines east of Philippines rise while those east of Taiwan deepen. This results in northward shift of the North Equatorial Current (NEC), increased vertical shear of the Subtropical Counter Current (STCC)/NEC system, increased eddy activity dominated by warm eddies in the STCC, increased Kuroshio transport off the northeastern coast of Taiwan into the East China Sea, increased westward inflow through the Luzon Strait into the South China Sea, and cyclonic circulation and low sea-surface-height anomalies in South China Sea. The reverse applies in years of negative PTO. (PTO data may be downloaded from: http://aos.princeton.edu/WWW/PUBLIC/PROFS/PUBLICATION/pfo/) (Abstract ID 9635)

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SEMIANNUAL CYCLE IN ZONAL WIND OVER THE EQUATORIAL INDIAN OCEAN

A semiannual cycle in zonal wind over the equatorial Indian Ocean is investigated by use of ocean-atmosphere reanalyses, and linear ocean-atmospheric models. In observations, the semiannual cycle in zonal wind is dominant on the equator and confined below the planetary boundary layer (PBL). Results from a momentum budget analysis show that momentum advection generated by the cross-equatorial monsoon circulation is important for the semiannual zonal-wind cycle in the equatorial Indian Ocean. In experiments by a linearized primitive model of the atmosphere, semiannual momentum forcing due to the meridional advection over the central equatorial Indian Ocean is important to simulate the observed maxima of the semiannual cycle in equatorial zonal wind. Off Somalia, diabatic heating and surface friction over land weaken the semianual response to large momentum forcing there. (Abstract ID 12865)

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BIOLOGICAL INDICATIONS OF PHYSICAL OCEANOGRAPHIC FEATURES: CETACEAN DISTRIBUTION AND SMALL SCALE FRONTAL BOUNDARIES OBSERVED USING MODIS OCEAN COLOR

Cetacean sightings from five line-transect surveys conducted offshore of Ecuador are used in conjunction with MODIS (Moderate Imaging Spectoradiometer) observations of ocean color. Correlations between cetacean presence and ocean color are consistent between both the dry and rainy seasons, but higher chlorophyll values lagged cetacean sightings by 1-2 weeks. This lag between surface chlorophyll and cetacean presence is particularly prevalent for those cetaceans feeding well below the surface on higher trophic organisms. Sightings of cetacean species that feed close to the surface correlate with ocean color on scales ranging from days to a few weeks. Spatial scales in this analysis can be at least as small as 9km, indicating oceanographic parameters smaller than mesoscale features impact cetacean distribution. Additionally, ocean color for the study area is binned over varying spatial and temporal scales to assess proximity of cetaceans to areas where surface chlorophyll values increase abruptly. Viability of using these small-scale changes in surface chlorophyll as a means for defining biologically indicated frontal boundaries will be assessed. (Abstract ID 12865)

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ARE CHEMOSYNTHETIC COMMUNITIES SUPPORTED 100% BY NITROGEN FROM THE SUBSEAFLOOR? EVIDENCE FROM NITROGEN ISOTOPIC COMPOSITION OF AMINO ACIDS

Nitrogen isotopic composition of amino acids is a useful tool for understanding the nitrogen cycle in chemosynthetic communities as well as for estimating the trophic position of the organism. We determined $\delta^{15}$N values of amino acids from various organisms collected from deep-sea chemosynthetic communities at methane seep sites in Sagami Bay and the Japan Trench, Japan. $\delta^{15}$N of phenylalanine strongly suggested that several species, including Calyptogena soyoae and C. phaseoliformis, metabolize only $\delta^{15}$N-depleted (---13 permil) ammonium from the seep. In contrast, Bathymodiolus sp. indicated variable $\delta^{15}$N of phenylalanine ranging from -15 to 0 permil, suggesting they are supported by both chemosynthetic (seep water) and photosynthetic (sinking particle) nitrogen. To investigate the influence of symbionts, we isolated symbionts from C. phaseoliformis, and determined the $\delta^{15}$N of their amino acids. Glutamate from the symbiont is ~9 permil depleted in $\delta^{15}$N relative to that of adductor from C. phaseoliformis, implying the symbiont `provides' amino acids to the host in this case. In this presentation, we will show a comprehensive data set on $\delta^{15}$N map of amino acids from chemosynthetic organisms. (Abstract ID 10773)

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SUBMESOSCALE FLOWS OFF THE CALIFORNIA COAST: DIFFERENTIAL KINETIC PROPERTY CALCULATIONS FROM LAGRANGIAN OBSERVATIONS

Lagrangian observations collected off the Southern California coast as part of the SubEx I experiment are used to describe differential kinematic properties of the surface circulation on scales ranging from 100's of meters to kilometers. During the week of 11 April 2011, 9 GPS-tracked drifters were repetitively deployed on a 3x3 grid with 1 km spacing. The drifters sampled position every 10 minutes with spatial accuracy of a few meters. Divergence, vorticity, and strain are computed from the relative motion of drifters using two independent methods, least squares and area approaches. Similar results are obtained from the two methods. Divergence and vorticity often exceed several times f, the Coriolis frequency. Time series of these quantities are fairly smooth and can vary by more than 5f during periods shorter than 1 hour. Drifters deployed in a square configuration generally deform into a line within hours. Results provide observational evidence of organized flows and the ubiquitous presence of fronts on small scales within the submesoscale. Results support recent high-resolution model simulations showing enhanced energy within the submesoscale associated with ageostrophic
flows. (Abstract ID 10500)

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USE OF A FREE-FALL MOVING VESEL PROFILER TO CHARACTERIZE FRONTAL GRADIENTS IN THE CALIFORNIA CURRENT ECOSYSTEM

A computer-controlled free-fall Moving Vessel Profiler (MVP) has proven an effective means of localizing and characterizing sub-mesoscale fronts in the southern sector of the California Current System (CCE-LTER site). The MVP is presently equipped with a Laser Optical Particle Counter, rapid-response CTD, and Chl-a fluorometer. The MVP has several advantages over tow-yo devices: free-fall sampling provides a vertical profile at a fixed location without confounding horizontal changes with vertical ocean structure; launch or recovery requires only 5 min; the MVP profiles to depth while a ship is steaming at 12 kts or faster. We have now used the MVP to characterize submesoscale fronts on 6 cruises in the CCE-LTER region, spanning late spring through autumn. This paper will illustrate the utility of MVP data for characterizing gradients in Chl-a, particle size distributions, epsilon, and some features of the zooplankton assemblages associated with oceanic frontal features. (Abstract ID 12187)

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OBSERVED AND HYPOTHESIZED DECADAL VARIABILITY OF SUBTROPICAL AND CENTRAL MODE WATERS IN ASSOCIATION WITH THE KURISHIO EXTENSION VARIABILITY

The decadal Kuroshio Extension (KE) variability controls not only the formation of the Subtropical Mode Water (STMW) but also likely its circulation and dissipation. Specifically, during the unstable KE period when the regional eddy activity is strong, STMW tends to be more stirred zonally and more transported southward after spring. We further hypothesize that STMW in its formation region is dissipated after spring, mainly by vertical processes in the stable KE period and by horizontal processes in the unstable period. This is because thicker STMW in the stable period is more susceptible to the intensive breaking of downward-propagating inertial waves at its upper boundary, while the stronger eddy activity in the unstable period helps destroy the vertically uniform structure of STMW. Such hypothesized STMW variability would possibly affect the climate and primary production through the impact on the Subtropical Countercurrent and the nutrient supply from the subsurface to the surface layer, respectively. Also, the formation of a lighter variety of the Central Mode Water is more active during the unstable KE period, being out of phase with that of STMW. (Abstract ID 10450)

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EFFECTS OF TEMPERATURE AND PCO2 ON TEN CARIBBEAN CORAL SPECIES.

To compare the responses of Caribbean corals to climate change, ten common species are growing in a crossed elevated temperature and pCO2 experiment. Calcification, photosynthetic efficiency, zooxanthellae composition, and total lipid content will be measured to gauge how different components of the coral holobiont respond. Treatments consist of two temperatures (control: 27°C and sub-bleaching stress: 30°C) and three pCO2 levels (control: 390 ppm and elevated: 800 ppm, 1200 ppm). Previous work indicates corals may suffer tradeoffs between stress tolerance and calcification, which this study will further explore. We hypothesize stress-tolerant species will have lower overall calcification rates but more consistent lipid levels across stress tolerance and calcification, which this study will further explore. We hypothesize stress-tolerant species will have lower overall calcification rates but more consistent lipid levels across treatments than other species. This experiment will also clarify whether ocean acidification is a physiological stress in addition to a chemical stress. If ocean acidification is purely a chemical stress, calcification rates will decline with rising pCO2 while health indicators such as lipids should remain constant. Furthermore, relative rates of decline should be consistent across all species. This experiment will provide data on understudied species with results applicable to biologists, managers, and climate modelers. (Abstract ID 12881)

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EFFECT OF OCEAN ACIDIFICATION ON CELLULAR PHYSIOLOGY AND RELEASE OF DOM AND TEP IN TWO STRAINS OF EMILIANIA HUXLEYI

Ocean acidification (OA) is a pervasive environmental stressor caused by anthropogenic emissions of CO2. Changes in extracellular release of dissolved organic matter (DOM) and transparent exopolymer particles (TEP) by phytoplankton in response to OA has the potential to alter oceanic carbon sequestration rates. In order to determine the direction and magnitude of carbon cycle response, we investigated the effects of OA on the physiology and extracellular release of two E. huxleyi strains (RCC 1251 & RCC 1258) cultured at three pCO2 levels (380 ppm, 600 ppm, and 900 ppm). Changes in the particulate inorganic carbon to particulate organic carbon ratio (PIC:PCO), DOM, and TEP production were measured. While pCO2 did not alter growth pattern or primary productivity in RCC 1251, cell concentration and productivity were significantly reduced under 900 ppm compared to other CO2 treatments in RCC 1258 during exponential growth. Growth and productivity were also different between strains. These data would suggest that future DOM and TEP production in response to OA varied between E. huxleyi strains. (Abstract ID 10935)

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BELUGA WHALE VOCALIZATIONS ALONG THE ALASKA COASTAL CURRENT FRONT

Time series measurements of marine mammal vocalizations and oceanographic conditions (temperature, salinity, current speed and direction) acquired by moored instruments deployed at the mouth of Barrow Canyon show that beluga whale vocalizations were generally more common in the vicinity of the mooring when the instruments lay within the path of the Alaska Coastal Current (ACC). When the ACC flow is strong, it is separated from Arctic basin waters by a well-defined front that promotes aggregation of prey species. We speculate that the greater numbers of daily vocalizations are an indirect cue of enhanced feeding opportunities for greater numbers of beluga whales. (Abstract ID 12453)

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Yoshie, N., Center for Marine Environmental Studies, Ehime University, Matsuyama, A MODELING STUDY OF MARINE ECOSYSTEMS IN THE NORTH PACIFIC

We developed a plankton functional type model 3D-eNEMURO, which was an extended version of NEMURO (a lower-trophic-level marine ecosystem model by PICES Model Task Team), coupled with an ocean general circulation model ROMS (Regional Ocean Modeling System) in the North Pacific. To test the performance of 3D-eNEMURO, climatological forcing was applied and seasonal variability of the biological variables was evaluated. The results of 3D-eNEMURO showed sufficient performance to reproduce the distributions and seasonal variabilities of the plankton biomasses and nutrient concentrations. In addition, we developed a two-dimensional individual-based fish movement model coupled with fish bioenergetics along with the development of 3D-eNEMURO. Fish movement model was applied to Japanese sardine which is one of the commercially important species in the western North Pacific. Fish movement model successfully simulated the observed growth and migrations of Japanese sardine. We are planning to integrate 3D-eNEMURO and fish movement model. We will outline perspectives for future multi-trophic level ecosystem modeling studies to understand mechanisms of ecosystem responses to climate change. (Abstract ID 10965)

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WAVE-CURRENT INTERACTION IN AN IDEALIZED PLANE JET

Outflow jets from tidal inlets and estuaries are important exchange mechanisms between these embayments and coastal waters. Although it is known that wave-current interaction can be relevant in wave-dominated tidal inlets, the effect of surface gravity waves on the jet dynamics has generally been neglected. This study is intended to improve our understanding...
of the 3D physical processes involved in the interaction between surface gravity waves and currents in inlets. The COAWST modeling system, with the Vortex Force method, is applied to an idealized inlet test. For strong outflows, the main effect of waves is to decrease the offshore extension of the jet and an increase the setup in the inlet area. For weak outflows, the waves actually increase the offshore extension of the jet, in analogy to the familiar “rip-current” phenomenon. The main forces responsible for these changes are wave breaking-induced acceleration and bed friction. The vortex force is important in the strongly sheared zones at the edges of the outflow jet. The main influence of the outflow on waves is to increase the significant wave height in the convergence zone on the seaward side of the outflow jet. (Abstract ID 10494)

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CARBON CHEMISTRY VARIATIONS AT THE ICELAND SEA TIME SERIES STATION
The Iceland Sea is one part of the Nordic Seas. Cold Arctic Water prevails there and its deepwater, which supplies the Denmark Strait and the Iceland-Faroe overflows, is an important source of North Atlantic Deep Water. Carbon chemistry time series observations of pCO2 and total CO2 concentration have been conducted at quarterly intervals in Iceland Sea surface waters from 1985 and from 1994 for the whole water column. The time series is set at 68.00′N, 12.67′W where the water depth is 1850 m. These observations have revealed that surface pH in winter decreases at a high rate of 0.0024 yr⁻¹ and that the aragonite saturation horizon is currently at 1700 m and shoaling at a rate of 4 m yr⁻¹ (Olafsson, Olsdottir et al. 2009). We will examine the temporal carbon chemistry changes in the water column in light of hydrographic variability, the North Atlantic Oscillation (NAO) and the regional meteorological conditions. Olafsson, J. S. R. Olsdottir et al. (2009). “Rate of Iceland Sea acidification from time series measurements.” Biogeoosciences 6: 2661–2668. (Abstract ID 11317)

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A MODERN LAGRANGIAN VIEW OF THE DEEPWATER HORIZON OIL SPILL
Underlying the flow of a fluid are distinguished material surfaces which serve as the centerpiece structures of coherent patterns formed by passive tracers. Such distinguished material surfaces, widely known as Lagrangian Coherent Structures (LCS), thus play a critical role in controlling transport and mixing. These processes are at the heart of the problem of the evolution of oil in the ocean, such as the oil released into the Gulf of Mexico as a result of the explosion of the Deepwater Horizon oil drilling rig. We present a technique that allows one to unveil those LCS that are capable of explaining two major instability events of the oil revealed in images of the surface ocean. The major instability events of interest are: (1) the early movement of the oil slick into the open ocean and the subsequent development of a peculiar tiger-tail-shaped finger; and (2) the later movement of the oil slick to spread toward the coast. The technique consists in revealing special ensembles of fluid particle trajectories which form the cores of the attracting LCS responsible for producing the stretching leading to the development of the aforementioned major instability events. The technique relies exclusively on the analysis of past flow history information. The study reported is carried out based on the analysis of the output from an ocean general circulation model and the inspection of available surface ocean oil images. (Abstract ID 10257)

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MEASUREMENTS OF MICROBIAL PRIMARY PRODUCTIVITY IN HYDROTHERMAL VENT SULFIDES
Chemolithoautotrophy has been recognized for decades as the fundamental process responsible for immense prokaryotic and eukaryotic biomass around hydrothermal vents (Cavanaugh 1983). However, rates of primary productivity in these systems have to date received limited attention (Wirsen et al., 1993, Perner et al., 2011). Previous studies measured carbon fixation by microbes in vent fluids and microbial mats, but nothing is known about the rates of carbon fixation within the sulfide precipitates forming the vent “chimneys” or about how these rates vary within and among structures. Here we present direct measurements of carbon fixation rates by communities within hydrothermal vent sulfides along the Juan de Fuca Ridge through 14C bicarbonate radotracer experiments. Rates were higher in the outer walls than inner sections of the same chimney, and varied among nearby structures. Microbial communities are being surveyed to examine community composition in relation to carbon fixation rates. This work provides initial insights into the specific contribution that endolithic microorganisms make to vent primary productivity and how microorganisms may help to identify the role these systems play in global cycles. Citations Cavanaugh, C. M. (1983), Nature, 203: 58-61. Perner, M., Hentscher, M., Rychlik, N., Seifert, R., Strauss, H., & Bach, W. (2011). 1–11. Winser, C., Jannasch, H., & Mohnleaux, S. (1993). Journal of Geophysical Research, 98(B6), 9693–9703. (Abstract ID 9960)

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THE INFLUENCE OF AGULHAS CURRENT FLOW IN THE SOUTH ATLANTIC CIRCULATION
The region between the Atlantic and Indian Ocean is known for great turbulence activity and the large rings originated by the retroflection of the Agulhas Current. Previous studies have showed an increase in the Agulhas Current flow into the South Atlantic. Based on this previous hypothesis a HYCOM simulation from 1948 to 2010 was run, forced with the monthly averaged wind fields from NCEP/Reanalysis, to investigate the influence of this increased flow in the circulation pattern in the South Atlantic. The averaged surface eddy kinetic energy has showed high values westward of 10W supporting the evidences about the influence of the Agulhas Current flow in large areas of the South Atlantic. Positive trends in sea surface temperature and salinity were observed offshore the Southern African Coast, for the last 40 years. Another evidence of change is observed in the negative trend in the meridional heat flux across 34S. (Abstract ID 12582)

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ADÉLIE PENGUIN FORAGING BEHAVIOR AFFECTED BY LOCAL TIDES
Penguin foraging and breeding success depends on broad-scale climate and local-scale hydrographic features of their habitat. Dramatic warming at Anvers Island on the West Antarctic Peninsula over the last 50 years has led to a decline of Adélie penguin populations and the introduction of Chinstrap and Gentoo penguins. We investigate the effect of local tidally driven currents on penguin populations in the vicinity of Palmer Station, Antarctica during the breeding season. Adélie penguins on Humble Island change their foraging locations in response to short-term changes in tidally driven currents. Both the physics and foraging patterns suggest that Adélie penguins on Humble Island are responding to changing prey populations as they are concentrated and dispersed by changes in tidal phase. We tested our observations against ten of years Humble Island Adélie Penguin GPS locations and show that penguins regularly change their foraging locations with tidal phase. We also find that it can take up to four days after a change in tidal phase for these penguins to respond to the change, suggesting local currents can affect foraging behavior in Adélie penguins. (Abstract ID 9761)

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Remote estimation of chlorophyll a is increasing globally, yet turbulent, Case 2 waters present challenges. We are focusing on optical measures in diverse estuarine and nearshore waters. In 2011, we collected a set of water quality measurements and phytoplankton samples from 140 stations, located between Texas and Virginia, while simultaneously obtaining hyperspectral reflectance measurements. Chlorophyll a concentration varied from 2.0 - 41.3 µg/L, total suspended matter (TSM) concentrations from 0.9 - 105.0 mg/L, and colored dissolved organic matter (CDOM) absorbance at 440 nm from 0.08 - 4.71 m^-1. We are using HPLC to quantify the pigments and their composite absorption at each station and light microscopy to identify the taxonomic composition of each sample. The pigment and taxonomic composition of diverse phytoplankton populations, including lower diversity bloomers (dinoflagellates, cyanobacteria, and diatoms), are being compared to reflectance spectra using optical models. We are assessing the ability of remote sensing to taxonomically discriminate these coastal phytoplankton communities and to better parameterize our algorithms for Case 2 chlorophyll estimation. (Abstract ID 11956)

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THE CLIMATOLOGY AND VARIABILITY OF EIGHTEEN DEGREE WATER

THE potential of potential vorticity (PV) over the oceans is estimated from observations to produce climatological maps of PV flux and to study interannual forcing variability. Particular attention is paid to the North Atlantic subtropical mode water potential temperature range from 17 to 19 °C. The sea surface PV flux is estimated through buoyancy and wind stress contributions and using a climatological mixed layer depth product. Wind forcing of PV is strong in frontal regions and in the Antarctic Circumpolar current. When averaged following upwelling, however, buoyant forcing emerges as dominant. A major observational subtropical mode water program named CLIMODE was conducted during the winters of 2004/5 to 2006/7. Summer months during these years are very much in agreement with climatology; the winter months are slightly more variable. Attempts are made to relate PV forcing variability to the NAO, a major mode of North Atlantic atmospheric variability. Correlation between the flux and the NAO are significant, and increase in amplitude if analysis is restricted to the winter time frame. There is also a weaker correlation between the NAO and the net EDW flux the following year. Considerable variability of the flux is unaccounted for however, and we speculate this is a signal of intrinsic ocean variability. (Abstract ID 9625)

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INFLUENCE OF STRONG WIND EVENTS ON THE CIRCULATION AND ICE COVER IN A MAJOR EAST GREENLAND FJORD

Fjords in Greenland are subject to strong katabatic winds. Triggered by local weather systems and radiative cooling over the ice sheet, and accelerated by the topography and the coastal air-sea fluxes, these winds can reach intense speeds. In this presentation we examine the impact of extreme katabatic wind events on the circulation and ice cover in the Sermeq Kujalleq fjord. We also discuss their potential impact on the heat transport inside the fjord and the stability of Helheim glacier. Specifically, we identify katabatic wind events and determine their occurrence and frequency using meteorological data from a local station and an atmospheric reanalysis model. Using moored data from the fjord and a satellite product we investigate the response of the fjord circulation and the sea ice on the shelf to the wind events. (Abstract ID 10037)

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VERTICAL STRUCTURE AND PRODUCTIVITY FROM THE CARICAO TIME SERIES: IMPLICATIONS FOR INTERPRETING SATELLITE OCEAN COLOR

Ocean color is an effective tool for estimating primary production where most phytoplankton growth is near-surface. However, in stratified, nutrient-limited environments, some of the production occurs below the mixed layer, and may go undetected by remote sensing. This issue is explored through analysis of vertical profiles of density, primary productivity, chlorophyll, nutrients and phytoplankton in a 14 year, NSF-funded record from the Caricau (Carbon Retention In A Colored Ocean) Basin time series project located on the Venezuelan continental shelf ([10°N, 64°67’W]). Using a simple ID model for the vertical nutrient flux and uptake, we explain much of the variability of the vertical nutrient and chlorophyll distribution in the monthly station profiles. The model reproduces essential features of the observed vertical structure based on surface temperature and light penetration, and may be useful for predicting the timing and bias in ocean color-based chlorophyll and productivity within the basin. Unique aspects of the Caricau Basin and the applicability of the model to other locations are discussed. (Abstract ID 11855)

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HABITAT PREFERENCE OF PLEURAGRAMMA ANTARCTICUM, ELECTRONA ANTARCTICA AND EUPHASIA SUPERBA ALONG THE WESTERN ANTARCTIC PENINSULA USING ISOPOE SIGNATURES

We investigated the stable isotope (delta 13C and delta 15N) composition from muscle tissue in three species along the Western Antarctic Peninsula bounded on the north by Joinville Island and on the south by Charcot Island. All samples were collected between March and April 2010 during the austral fall. The species investigated all exhibit a circumantarctic range, but differ in their preference for coastal waters. Pleuragramma antarcticum, a pelagic notothenoid fish is found exclusively in the coastal Antarctic, Electrona Antartica, a mesopelagic myctophid, is an oceanic species found primarily off the shelf, and the Antarctic krill, Euphausia superba is abundant in both systems. We are looking for differences in the bulk isotope signature to see if it will discriminate between general habitat type, i.e. Antarctic Circumpolar Current, Antarctic Coastal Current, and a mixture of the two, and further, if the sampling locations can be resolved. (Abstract ID 11510)

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THE IMPORTANCE OF THE STRATOSPHERE FOR WINTERTIME ATMOSPHERIC RESPONSE TO ATLANTIC MULTI-DECADAL VARIABILITY

The winter North Atlantic Oscillation (NAO) changes drive a significant portion of Atlantic Multi-decadal Variability (AMV). However, whether ocean-atmosphere interaction, or other processes internal or external to the atmosphere force the NAO changes are still controversial. By using observational analysis and atmospheric model experiments we show that the AMV-warming drives precursory stratospheric vortex weakening and warming. These anomalies propagate downward, and cause a negative NAO in late winter, which results from reduced low tropospheric baroclinicity. The wave-induced stratosphere/troposphere dynamical coupling is important for the NAO response to the AMV and can only be simulated with a stratosphere resolving model. The stratospheric changes result primarily from the extra-tropical SST. Further long term experiments using two different stratosphere resolving Atmosphere/ocean coupled models confirm our results. These experiments show that the strength of atmospheric change associated with AMV-variability depends on the stratospheric resolution. Our results show that the stratosphere is a crucial element of extra-tropical atmosphere/ocean interaction and climate variability. The forcing of NAO by AMV, which is believed to be the delayed NAO response, suggest a self maintaining delayed oscillatory behaviour between atmosphere and ocean on multidecadal time scales. (Abstract ID 11829)

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BUOY OBSERVATIONS OF THE SURFACE HEAT FLUX AND WIND STRESS RESPONSES TO SST FRONTS

Surface heat flux, wind speed, and wind stress responses to SST spatial variability are investigated using moored buoy observations in the Gulf Stream and eastern equatorial Pacific. Responses of the fluxes and wind to SST are isolated by relating their differences between two buoys to the SST difference. Seventeen pairs of buoys, separated by between 150 and 350 km, are used to show that differences in the surface sensible and latent heat fluxes, the surface wind speed, and the surface wind stress magnitude between two buoys in a pair are highly correlated to, and satisfy linear relations with, the SST difference. The SST-induced responses of the fluxes and stress are generally stronger over the equatorial Pacific compared to near the Gulf Stream. The wind stress response to SST is accomplished mainly through the response of the surface wind speed to SST rather than a response of the air-sea temperature difference. The responses of the surface heat fluxes to SST, on the other hand, are driven largely by the responses of the air-sea temperature difference to spatial SST variability. In addition, the flux and stress responses to SST vary seasonally in sync with the seasonal pulsing of the large-scale wind speed. A straightforward manipulation of the buoy-derived fluxes and the bulk flux formulations demonstrate that the responses of the surface fluxes and stress to SST are modulated by the large-scale wind speed. (Abstract ID 12145)

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SEASONAL AND TIDAL VARIATIONS OF SUSPENDED PARTICULATE MATTER IN THE EAST CHINA SEA

Remothe, TOS/AGU/ASLO Abstract Book
To investigate the dynamics of suspended particulate matter (SPM) in the East China Sea (ECS), we developed a three-dimensional transport model for SPM. The SPM model was coupled with an ocean circulation model that can well reproduce the realistic flow fields to represent advection and diffusion of SPM. The SPM model also includes processes of tidal currents, river discharge, and resuspension at the seabed. In the present study, we focused on clay mineral dynamics in the ECS. The model showed a clear seasonal variation in the surface ocean with high concentration in winter and low concentration in summer. High concentrations were mainly formed in coastal regions where tidal currents (bottom stresses) are strong. These features were qualitatively consistent with results derived from satellite observations. The numerical experiments suggested that resuspension at the seabed plays an important role in the SPM distribution compared to riverine SPM, exclusive of the Yellow River mouth. In strong tidal regions, the SPM concentration changed with spring-neap tidal cycle and a bottom turbidity layer with thickness of about 5 m was formed during the neap tide. (Abstract ID 10135)

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CIRCULATION AND BATHYMETRIC EVOLUTION IN KATAMA BAY AND INLET, MA
Observations of waves, currents, and water levels were collected for 2.5 months at 15 locations spanning about 8 km from an ebb shoal in the Atlantic (waves), through Katama Inlet (400 m wide x 3 m deep x 200 m long) and Bay, and into Edgartown Channel (300 m x 8 m x 500 m), which connects the Bay to Vineyard Sound (no waves). Consistent with 1-dimensional model simulations, the tidal water-level fluctuations at the northern end of the Bay (mid way between the Atlantic and the Sound) are similar to those in Vineyard Sound. Large tidal pressure gradients across the Bay drive 2 m/s flows in Katama Inlet. During Hurricane Irene (6 m waves, strong southerly winds), about 2 m accretion was measured at the eastern side of the inlet and near the head of the ebb shoal channel, while about 2 m erosion was observed near the western side of the inlet. The tidal-, wave-, and setup-driven flows causing these bathymetric changes will be discussed. Funded by NSF/ONR. (Abstract ID 9458)

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DISRUPTIVE TECHNOLOGIES AND IMPACTS ON OCEANOGRAPHY IN 2030
It is tempting to consider progress as being driven by incremental change (e.g. digging deeper, but narrower holes), but oceanography is often profoundly affected by disruptive change. The recent integration of autonomous vehicles into research is an excellent example. What are other potential “game-changers” or disruptive technologies that may have a similar impact on oceanography twenty years hence? Ocean observatories making continuous observations over decades with well-documented observations (i.e. provenance), calibrated sensors and an accurate, shared time base are a potential example. At the same time steady, realistically declining, budgets are having a critical impact on the availability of high-demand global ships as well as the support of scientific careers. What will be the impact of increasing computational and networking capabilities on oceanography? Clouds may be an example of a disruptive technology providing immediate access to computation on demand as opposed to singular large machines dedicated to a few high-profile tasks. As autonomous observations become more ubiquitous, how will oceanography and analysis change? Can the rewards system characteristic of today’s academic environment change quickly enough to adapt to today’s changes? I shall seek to provide some insights into answers to these questions as well as trends to paint a likely low-resolution picture of oceanography in the future. (Abstract ID 10916)

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MOLECULAR DETECTION OF UNICELLULAR N-FIXING CYANOBACTERIA IN THE NORTHERN GULF OF MEXICO
Recent studies have shown that microbial nitrogen fixation occurs more widely than previously thought. The abundance of microbial nitrogen fixers is not restricted to oligotrophic environments but is found in coastal and estuary regions influenced by rivers as well. Unicellular cyanobacteria have been found to be significant diazotrophs whose abundance can be high in river influenced estuaries and coastal regions. The Northern Gulf of Mexico, including the coastal zone of the Mississippi River, is characterized by low dissolved inorganic N/P ratios, which is conducive to nitrogen fixation. This non-Redfield N/P ratio is in part caused by anthropogenic P discharge to the coastal zone. For the first time, we present the abundance of nif H copies and microscopic observations of numerous Coccosphaera-like cells in the Mississippi Sound. Molecular analysis of 16S rRNA gene, specific for unicellular cyanobacteria using PCR, and the nif H gene using QPCR demonstrate a strong seasonal abundance of these organisms in this region. (Abstract ID 11963)

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FLOODS, OCEAN STORMS AND STRATIGRAPHIC VARIABILITY OVER A YEAR-LONG EXPERIMENT ON THE MUDDY AND ENERGETIC WAIPAOA RIVER MARGIN

Sediment yields in the muddy Waipaoa River catchment of northeastern New Zealand are among the highest on earth; the product of tectonics, easily erodible lithologies, a vigorous maritime climate, and deforestation. Terrigenous inputs dominate the adjacent continental shelf sequence, with thick expanded sections that contain a high-resolution archive of environmental change. The multi-institutional MARGINS “Waipaoa Investigation of Seabed Energetics” project has the goal of determining the balance of shelf processes that generate the sedimentary record over sub-annual timescales. A recently completed year-long experiment collected around 230 multicores that were slabbed for X-ray analyses and subsampled for radiochemical tracers. Provisional comparison of X-rayographs at recoupied core sites indicates monthly stratigraphic variability, and that single events can lead to profound changes to the sea floor stratigraphy on the inner and mid-shelf. These data are compared to earlier MARGINS cores to reveal multi-annual stratigraphic variability and the history of marine events together with floods. This experiment raises significant philosophical questions about the fidelity and completeness of the geological record, and emphasises the transient nature of many deposits affected by strong oceanographic drivers. (Abstract ID 9493)

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PATTERNS OF BACTERIAL COMMUNITIES FROM THE MACKENZIE RIVER TO THE BEAUFORT SEA

We explored the patterns of bacterial community structure in a gradient covering waters from the Mackenzie River to the coastal Beaufort Sea, Canadian Arctic Ocean, investigating differences in river vs. marine communities, free-living vs. particle-attached communities and total vs. active communities. Fingerprinting analyses (capillary electrophoresis-single strand conformation polymorphism) showed no significant differences between total (DNA-based) and active (RNA-based) communities, suggesting that most present bacterial groups were active. However, bacterial community structure was significantly different when comparing riverine, coastal and marine bacterial communities. Direct multivariate statistical analyses showed that total community structure was mainly driven by salinity, suspended particles, amino acids and chlorophyll. Additionally, we observed significant differences between particle-attached (>3 μm) and free-living (<0.2 and 3 μm) bacterial communities in marine samples, but similar structure in the two fractions for coastal and river samples. High-throughput sequencing of selected samples confirmed these geographical differences. While Sphingobacteria and β-proteobacteria dominated the Mackenzie River, coastal water was characterized by a high contribution of Cyanobacteria. Finally, γ- and α-proteobacteria dominated the particle-attached and free-living fractions of bacteria in the Beaufort Sea, respectively. (Abstract ID 9589)

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THE PALEOFLOW THROUGH BERING STRAIT IS FORCED BY THE SOUTHERN OCEAN WINDS

Because North and South America are surrounded by water, they constitute a gigantic island whose peripheral sea level is controlled by the winds east of the island, winds along the western boundary of the island, the fresh water flux, and the meridional overturning cell. This idea has been explored using a series of analytical models to show that the Bering Strait (BS) flow is controlled by the interplay of the Southern Winds, and the North Hemisphere freshwater flux. Here, we compare paleo-records from BS and the Southern Ocean and reconstruct the Late Quaternary paleoflow employing a slowly-varying, time-dependent version of the coupled Sandal-Nof (SN) model. We observe a very strong correlation between the BS flow predicted by the analytical model and the paleo-record of BS flow when the coupled SN model is forced with paleo-proxies for the Southern Ocean winds and the global fresh water flux. Additional model simulations where the Southern Ocean winds, and the global fresh water flux are held with paleo-proxies for the Southern Ocean winds and the global fresh water flux. Additional model simulations where the Southern Ocean winds, and the global fresh water flux are held constant while the other forcing varies, indicates the correlation is due primarily to variations in the Southern Ocean winds. (Abstract ID 11558)

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HOLOTHURIA (SEA CUCUMBERS) DISTRIBUTION BASED ON THE PHYSICAL-CHEMICAL PROPERTIES OF SEDIMENTS

Holothurians are filter feeders in reef ecosystems, fulfilling roles as organic matter recyclers, coral health indicators and aquarium seafood biomass producers. Different species and life stages of holothurians show particle preference, such as nutritional value of sediments and sediment grain size. However, sediment parameters such as grain size, total organic matter, percent of nitrogen, percent of carbon and pigments content must be examined simultaneously because the animal–sediment relationship is still not well understood. This study expands on previous studies by considering multiple sediment characteristics, two species, two locations and multiple life stages of holothurians. Species characteristics are expected to differ between juveniles and adults. A distribution pattern is expected to be associated with body size length and levels of nutrients within the sediments where they feed. Specifically, juveniles of both species will prefer high nutrient value sediment regardless of grain size. These efforts will lead to
an attempt to increase holothurian abundances and could benefit both reef management and aquaculture fisheries. (Abstract ID 10499)

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viruses was detected by t=72. Dispersant addition appears to have an important effect on the production was positive for most treatments at t=24 for both June and September, but loss of in all treatments relative to t=0 in June, but depressed in all treatments in September. Virus experiments to quantify prokaryote growth rates and virus production rates were determined to simulate a surface oil slick. Cell and virus abundances along with parallel dilution experiments to quantify prokaryote growth rates and virus production rates were determined over time. The prokaryotes and viruses response to the addition of oil or glucose was similar to the control incubations with no additions, while the addition of dispersants alone or with oil resulted in a significant increase in both cells and viruses. Prokaryote growth was simulated in all treatments relative to t=0 in June, but depressed in all treatments in September. Virus production was positive for most treatments at t=24 for both June and September, but loss of viruses was detected by t=72. Dispersant addition appears to have an important effect on the prokaryote and virus communities, but the communities present may influence this effect. (Abstract ID 12239)

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Glucose, oil, dispersant and dispersed oil were added to coastal seawater at low concentrations using an OGCM, which takes account of the localized strong mixing and its 18.6-year period oscillatory temperature anomaly. Using a numerical adjoint, we performed numerical experiments to investigate possible impacts on large-scale phenomena, we performed numerical simulations with WAVEWATCH III and WAM. In its operational form, SWAN is presently not equipped to assimilate measured wave data, so that initial errors at the boundary can persist or grow as waves are propagated shoreward. An analytical adjoint developed by Walker (2006) improved SWAN's wave results in comparison to measured data in the center of a large nearshore domain but worsened performance along lateral boundaries (Veeramony et al., 2010). To address these shortcomings, a numerical adjoint is being developed that directly reflects the properties of discretized forward SWAN. This new adjoint will ultimately incorporate all of SWAN's input and boundary conditions in a linearized form. Initially, a simplified adjoint to stationary, homogeneous SWAN was built, and its performance was shown to be roughly equivalent to that of Walker's analytical adjoint (Orzech & Veeramony, 2010; Veeramony et al., 2011). More recently, this basic adjoint has been extended to include nonlinear wave triad interactions, wind forcing, and wave breaking. As a consequence, the numerical adjoint's performance has improved significantly beyond that of its analytical predecessor. In this presentation, the latest developments will be reviewed, including results from a series of process studies. (Abstract ID 11718)

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OSMATIC STUDY ON THE IMPACT OF THE 18.6-YEAR PERIOD TIDAL MIXING IN THE SUBARCTIC NORTH PACIFIC

Bidecadal variations of water masses have been observed in some regions around the subarctic North Pacific and we proposed a hypothesis that those variations are caused by the temporal variation of tidal mixing in the localized strong mixing regions, such as the Kurl Straits and the Aukutan Passes, related to the 18.6-year period nodal tidal cycle. To assess this hypothesis and investigate possible impacts on large-scale phenomena, we performed numerical experiments using an OGCM, which takes account of the localized strong mixing and its 18.6-year oscillation. These models succeeded in reproducing the observed variations around the strong mixing regions and these variations are explained by direct effect of vertical mixing. In addition, oscillatory temperature anomaly with 18.6-year period occurs not only in the vicinity of the strong mixing regions, but also broadly in the mid-latitude North Pacific, propagating eastward from the western boundary to the central North Pacific in decadal time scale. It is suggested that this propagating anomaly is caused by dynamical adjustment to density flux by localized mixing. (Abstract ID 10985)
Ostrovsky et al. (2000) presented an empirically based calibration of 18 laboratories using an enriched S\(^{13}O\) standard (3.41‰, Atlantis II), producing the first large-scale interlaboratory stable isotope calibration. Using benthic foraminiferal isotopic analysis produced on multiple mass spectrometers, various researchers have since reconstructed temperature-salinity and density variability profiles for many parts of the oceans. The use of an internal depleted S\(^{18}O\) standard (F:5.98‰, Extreme) allowed Goodkin (2007) to evaluate S\(^{18}O\) from a slow-growing Bermuda coral as a Sea Surface Salinity proxy on monthly resolution using relatively small samples (10-30µg).

The original Atlantis II standard has been exhausted. A new enriched S\(^{18}O\) standard has been developed using Lophelia pertusa, a cold-water coral collected in the Gulf of Mexico (740 m depth, 29.158N 88.017W). The second new standard, depleted in S\(^{18}O\), was collected from marble quarry in Portugal. Aliquots from both of these standards have been disseminated to laboratories around the globe. Results of our interlaboratory calibration using the enriched and depleted standards will be presented. (Abstract ID 11595)

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Wind stress variation over the horizontally variable roughness on ocean surface: Theory and experiment

The areas of suppressed (as over the oil spots and over "slicks" over strong internal waves) or enhanced (as over the converging currents) surface waves are ubiquitous in the ocean. This, in turn, results in large-scale horizontal variations of wind profile in the near-water boundary layer. Here, two new nonlinear models of wind profile variation over the water due to horizontal variation of surface roughness (short wind waves) are suggested. One is an extension of the known 2-layer model of turbulent boundary layer to three layers, which allows a smoother matching of flows in the layer. Another is the direct integration of Reynolds equations with a simple closure hypothesis. It is shown that within their applicability range, both models produce close results. We further present the results of laboratory experiments performed in a closed wind-wave tank. Wind-driven surface roughness was changed either by the surfactant oil to suppress the roughness or by adding a paddle-generated surface wave which increases the roughness. Wind speed above the surface was measured by Pitot tube and hot wire anemometer. Comparison between theoretical and experimental results reveals their quantitative agreement. (Abstract ID 11741)

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A new record of particle flux at the Bermuda Atlantic time-series site from neutrally buoyant sediment traps

We present the results of the first-time-series deployment of neutrally buoyant sediment traps (NBSTs) from 2007 to 2010 at the Bermuda Atlantic Time-Series Site (BATS). Upper ocean particle flux is a key parameter measured at U.S. ocean biogeochemistry time-series sites. Over the last two decades, biases caused by sample solubilization, swimmer removal methods, and hydrodynamic effects in traditional surface-tethered traps have been brought to light. NBSTs have been developed in an attempt to reduce the effect of hydrodynamic biasing. Two NBSTs were deployed each month at 150 m at the same time as surface-tethered particle-interceptor traps (PITS) deployed by BATS. In most months the two sediment trap systems agreed within a factor of two, within the range of agreement of two NBSTs or individual PITS tubes. However, on eight occasions over the course of the study there were large excursions in the PITS, which collected up to five times more material than the NBSTs. We investigate the possible causes of the discrepancies between the two systems and also the importance of swimmer removal techniques and sample blanks. (Abstract ID 11901)

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On the influence of mesoscale shear on surface mixed-layer instabilities

The ocean’s surface mixed layer is notoriously complex due to high spatial and temporal gradients of density and velocity fields. The understanding and modeling of such flows have a wide range of applications. For instance, anomalous currents and density perturbations in the acoustic and optical environment can affect a variety of naval operations. These flows can also influence strongly the dispersion of surface and sub-surface pollutants. Large eddy simulations of an idealized mixed-layer problem are conducted using the non-hydrostatic spectral element model Nek5000. Our particular interest is the influence of sub-surface mesoscale shear on the growth-rate and the finite-amplitude state of near-surface mixed-layer instabilities. We use passive tracer and particle releases, and 3D finite-time Lyapunov exponents to quantify the differences of turbulent frontal exchange between flows with and without shear. (Abstract ID 9972)

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Freshwater effluent tracking with GPS drift buoys

In many lakes, nutrient loading results in algal blooms and overgrowth of macrophyte algal beds, interfering with recreation and below-surface ecosystems. Dr. Idoio Boschi has studied this association in Conesus Lake, NY and discovered an inverse correlation between agricultural management plan implementation and algal biomass. This experiment aimed to verify this relationship by following tributary stream and lake currents to the macrophyte bed locations. Hox2 M-241 data loggers and real-time inexpensive commercial tracking devices were deployed in water-tight sealed PVC housing into the streams and central lake, respectively, to follow the effluent during Fall 2011. The Hox2 M-241 accurately tracked current at regular frequencies within the housing. The accuracy of the tracker was dependent on cell phone
Our research used the early developmental stages of two marine organisms, larval Pacific herring (Clupea pallasi) and green sea urchins (Strongylocentrotus) to test the ability of Smart Sponge® to remove some contaminants, the storm water and prevent their discharge to receiving waters. Although previous tests have shown the ability of Smart Sponge® to remove some storm water contaminants. This synthetic sponge encapsulates and solidifies the released materials. We used a 7-day survival and growth test protocol developed at Shannon Point Marine Center for the Washington Department of Ecology. Sea urchin embryo development tests were conducted using a published American Society for Testing and Materials (ASTM) protocol.

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An extraordinary lava pond complex is located on Axial Volcano’s distal south rift. It was discovered in EM300 multibeam bathymetry (collected 1998), explored and sampled with ROV Tiburon (2008) and surveyed with the MBARI Mapping AUV (2011). The ~1-m resolution AUV bathymetry shows a 61.5 km complex of 4 large and several smaller ponds with rims 57-95m above the floors. The combined volume before draining was 0.56 km³. The ponds overflowed to build lobate-flow levees with elongate pillows draining outer flanks, then drained, leaving lava veneer on vertical inner walls and sheet flows on the floors. ³C-dated foraminifera from basal sediments on pond floors are ~1500 year. Leave rim depths vary by only 10m. Deep collapse-pits in levees suggest porosity of pond walls. The eastern levee of one pond breached, draining the interconnected ponds, and fed thick, rapidly-emplaced, sheet-flows along the complex’s east side. These sheet-flows extend at least 5.5 km down-rift and have 19-33m deep collapses. Formation of these ponds requires long-lived, steady, moderate-eruption-rate lava effusion on nearly horizontal seafloor and may occur only on deep distal rift zones of central volcanoes. (Abstract ID 9783)

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Charakterization of faecal pellets

Our recent studies compared morphologies, composition and processes by faecal pellets of calanoid copepods (Eucalanus pilipes) with those of doliolids (Dioicoletta gigantea). While copepod pellets are compact and surrounded by a membrane, those of doliolids are loosely consolidated, lacking a membrane. Doliolid pellets consist of partly to fully digested undamaged phytoplankton, detritus and inorganic material. microscopic observation of “natural” pellets revealed that their composition varied depending on the particle suspensions encountered by the two zooplankton taxa. Doliolid pellets sink at a much lower velocity than calanoid pellets, both produced by species of similar carbon content. From our findings on pellet morphology, sinking rates and composition we hypothesize that doliolid pellets should be more degraded than copepod pellets prior to reaching the seafloor of the shelf. As our TEM observations reveal that the guts of starved and feeding doliolids contain few bacteria, pellet colonization by bacteria should occur after pellet release. This was observed in time-series experiments. Thus, the rate of pellet degradation would be related to the shelf microbial community, but also to pellets’ colonizable surface, composition and age. (Abstract ID 9400)

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Surface measurements of pCO(2) in the western tropical North Atlantic: quantifying the influence of the Amazon River Plume on gas exchange

While the tropical ocean is considered to be a source of CO2 to the atmosphere, the combined low-salinity waters and enhanced productivity of the Amazon River plume reverses the direction of that exchange, creating a significant CO2 sink. Ocean color satellites detect the areal extent of the plume, however in situ measurements of the relationship between CO2 and ocean color are limited. Here we extend those seasonal relationships to allow a better estimate of the annual impact of the plume. Measurements of pCO2 where the Amazon River meets the western tropical North Atlantic were continuously performed while underway and on discrete surface water samples during May-Jun 2010 and Sep-Oct 2011. In non-plume influenced waters, pCO2 values were ~420 µatm, whereas in plume-influenced regions, pCO2 values reached a minimum of 145 µatm, suggesting a spectrum of underlying processes (mixing, biological activity, and air-sea gas exchange). Furthermore, CO2 levels were inversely related to oxygen, salinity, and CDOM (colored dissolved organic matter). These data will be used to improve our understanding of how large rivers impact CO2 uptake by the tropical oceans. (Abstract ID 12359)

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Whitescap coverage using equivalent neutral winds

Wave whitescaping is a response to the stress imparted by the atmosphere to the ocean. Efforts have been made over the last 4 decades to analytically predict white cap coverage (W) using wind speed alone, while others have included atmospheric stability and kinematic viscosity. Values of W increase with wind speed, however there is little agreement between formulations of the actual value of W. One culprit to this disagreement is requiring atmospheric stability along with the wind speed to quantify a surface stress to be used in the calculation of W. Taking into account satellite-based scatterometer data, which calculates equivalent neutral winds based on the measured surface stress, this study attempts to update previous formulations of W with equivalent neutral winds in place of only a wind speed. (Abstract ID 11235)
The population of blue whales inhabiting the Northeast Pacific (NEP) moves seasonally from summer-autumn areas off California to winter-spring areas off Baja California and the eastern tropical Pacific. We hypothesized that blue whale migration in the NEP must be dictated by regions of persistent upwelling where populations of their krill prey reliably develop. The satellite tracks of 82 blue whales tagged over the period 1998-2007 were used in combination with remotely sensed variables and habitat models to predict their movement behavior in seasonal 0.5-degree grid cells in the NEP. Predicted foraging behavior was intense and extensive in the California Current in summer-autumn while it was lowest and restricted to the coast along Baja California in winter-spring. At this time the likelihood of foraging was highest in the eastern tropical Pacific. Model predictions were ecologically interpretable and response curves yielded insight about the environmental conditions most conducive to blue whale foraging behavior. Consideration of drivers of ecosystem structure and biogeography provided a useful framework to explore hypotheses about blue whale movement behavior in the NEP in relation to environment. (Abstract ID 10976)

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EXPLAINING A NARROW REGION OF HIGH CO2 UPTAKE IN THE GULF OF ALASKA: THE ROLE OF BIOLOGICAL PRODUCTION AND PHYTOPLANKTON COMMUNITY STRUCTURE

We report high-resolution (~4 km) estimates of air-sea CO2 flux, net community production (NCP) calculated from O2/Ar ratios and phytoplankton population abundances determined by continuous underway flow cytometry (SeaFlow) on a cruise across the Gulf of Alaska which crossed the transition zone between the high nutrient-low chlorophyll (HNLC) Alaskan Gyre and the coastal waters off the Aleutian Islands in May 2010. We observed high NCP and oceanic CO2 uptake in the transition zone (up to 400 mmol C m^-2 d^-1 and 200 mmol CO2 m^-2 d^-1 respectively), which comprised 58% of the total NCP and 68% of the total CO2 uptake across the cruise track in only 20% of the total area covered. Total phytoplankton abundance increased in this region, correlated with the increased NCP and CO2 drawdown. However, the phytoplankton populations that dominate in the transition zone are distinct from the dominant phytoplankton populations in either the coastal or open HNLC waters of the Gulf of Alaska. This suggests that the distinct ecological community at this narrow transition zone may provide a significant contribution to the regional biological carbon pump. (Abstract ID 10039)

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DETERMINING THE INFLUENCE OF BREAKWATER ON NEARSHORE SEDIMENTATION IN CHESAPEAKE BAY: METHODS AND OBSERVATIONS

This study describes nearshore Chesapeake Bay sedimentation at sites adjacent to and landward of 24 segmented breakwaters, varying in age (~19 y) and physical setting. Grain-size and organic-content profiles are first examined at the adjacent-exposed sites to establish regional trends. These trends are then compared with observations at the breakwater-protected sites to assess potential changes induced by breakwater installation. Sedimentation rates at all sites are calculated with 210Pb (half-life 22.3 y). At the breakwater-protected sites, these rates largely reflect pre-construction sedimentation, due to the long half-life of 210Pb relative to breakwater ages. Determining the post-construction sedimentation rate can be more difficult, because the signature of breakwater influence in the sedimentological record can be obscured. For example, if the source of sediment is not affected dramatically by construction, down-core profiles may not have obvious changes. However, the depth of breakwater influence can be interpreted by considering all the sedimentological evidence at a given location, and the post-construction rates are calculated from this depth. In general, the sedimentological response to breakwater construction is fairly unique for each location but depends on such factors as sediment supply, shoreline type, and construction technique. (Abstract ID 11139)

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NEAR-INERTIAL WAVE WAKES OF HURRICANES GUSTAV AND IKE OVER THE LOOP CURRENT

In late summer 2008, the eyes of hurricanes Gustav and Ike passed over the Loop Current (LC) within ~60km of a triangular mooring array of ~30km per side. The hurricanes excited intense near-inertial oscillations (NIOs) in their wakes. The observed NIOs in the LC-buoy have horizontal (vertical) wavelengths of ~600-800km (~900m) and rapidly (~80-90 m in day^-1) propagate into the deep ocean. The enhanced kinetic energy at depths of ~1000m suggests the focusing and trapping of NIOs at the depth where the effective Coriolis frequency is equal to the wave’s intrinsic frequency (i.e., a near-inertial critical layer). The anticyclonic structure of the LC provides the background environment proper for the NIOs’ downward propagation and trapping will bellow the main thermocline. Amplification at critical layers causes large vertical shear in the interior ocean which may increase the occurrence of wave breaking and turbulent mixing. (Abstract ID 11649)

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THE MAGELLAN PLUME

This presentation investigates, through numerical experiments, the dynamical mechanisms controlling the development of the Magellan Plume, a low salinity tongue that covers large part of the Patagonian Shelf. The model results indicate that the spatial extent and vertical structure of the plume is largely shaped by the tides, both through tidal mixing and residual currents. The interaction of tides and winds reinforce the downstream and upstream buoyancy transports, the former is driven by tidally induced homogenization and wind-driven enhancement of the northward transport while the latter is associated with the strengthening of a southward coastal current. Sensitivity experiments show that the downstream buoyancy transport decreases with increasing wind intensity due to enhanced mixing, while the upstream transport is reinforced by a stronger southward coastal current. Variations in the magnitude of the discharge modified the downstream penetration and cross-shelf salinity gradients, both increasing with larger discharges. Comparison with previous numerical studies over the shelf indicates that the discharge generates a northeastward current in the middle shelf, a recirculation gyre south of the inlet and a region of weak currents farther north. (Abstract ID 9966)

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SPATIAL AND TEMPORAL VARIABILITY OF PHOTOSYNTHETIC PARAMETERS DURING ICESCAPE 2010-2011

During ICESCAPE 2010-2011, we measured photosynthetic parameters in natural phytoplankton assemblages from the Chukchi and Beaufort Seas to better understand regional patterns in primary productivity and biogeochemical carbon (C) cycling. Water column samples were taken from two depths (typically ~2 m and ~25 m) at ~85 stations each year representing a wide range of ecological conditions, including sea ice-covered, shallow continental shelf, nutrient-rich winter water, and nutrient-poor post-bloom areas. The physiological response of phytoplankton to 18 light levels was used to assess photoacclimation, photosynthetic efficiency, and maximum chlorophyll-a normalized rates of C fixation. Phytoplankton vary their photosynthetic machinery in response to changing environmental conditions, such as fluctuating nutrients, irradiance, and temperatures, which in turn are controlled by physical parameters such as mixing and stratification. Future changes in sea ice coverage, temperature, and weather patterns will no doubt impact physical, chemical, and biological pathways for C in this dynamic Arctic region. This dataset represents an important
baseline of information for which to assess and predict future changes in the biological C pump. 

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(Abstract ID 10704)  

baseline of information for which to assess and predict future changes in the biological C pump. TOS/AGU/ASLO 2012 Ocean Sciences Meeting  

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The capabilities of POLCOMS (hydrodynamics) and ERSEM (Ecosystem) in reproducing the response to nutrient rich Mersey water. Glider data is compared with 3-D model data to test the development and evolution of the physical structure of the plume and the biological variability in vertical mass and heat transport to the deep ocean.
DISCHARGE IN THE ALTERED YEONGSAN ESTUARY, KOREA

Changes on the hydrographic and current profiles due to freshwater discharge in the Yeongsan estuary dam has altered the hydrodynamics of the estuary. The construction of the Yeongsan estuary dam has altered the hydrodynamics in the estuary. The dam has resulted in the formation of a weir on the estuary, which has significantly altered the hydrodynamics of the estuary. The weir on the estuary has resulted in a change in the hydrodynamics of the estuary.

PATCHINESS LENGTH SCALE OF EIGHTEEN DEGREE WATER

Characteristic length scales of Eighteen Degree Water (EDW) thickness and property are estimated using spatial correlation functions obtained from Argo float profiles. Since the decorrelation timescales are 20-30 days according to the previous estimates from sea surface height (SSH), Argo profile pairs obtained within 20 days in 1998-2008 in the EDW region are used to calculate correlations as a function of distance between the two profiles. Under the assumptions that the length scales are invariant over spatio-temporal domain and Argo profiles are randomly sampled, the spatial correlation function provides a typical patchiness length scale of EDW. The reliability of the method is tested with eddy-resolving ocean model output. Typical length scales of EDW thickness are 140-230 km which are comparable to the diameters of meso-scale eddies (120-230 km) estimated from the combined analysis of surface drifter and SSH data in this region. However, the property scales are much smaller than the thickness scale and eddy size. Seasonal variations in the length scale of EDW thickness are greater than those of the properties, especially in the northern region (32°–South of Gulf Stream).

THE ROLE OF KOSHU SEAMOUNT IN GENERATING THE KUROSHIO LARGE MEANDER SOUTH OF JAPAN FROM DATA-ASSIMILATED HYCOM OUTPUTS

Several mechanisms have been suggested to explain the transition of Kuroshio path from non-large to large meander south of Japan. Recently, a series of studies using satellite altimetry measurements, reanalysis data, and simplified numerical simulations demonstrates an essential role of Koshu Seamount located south of Cape Shiono-misaki, Japan, in generating the Kuroshio large meander. This study confirms the role of Koshu Seamount using data-assimilated Hybrid Coordinate Ocean Model (HYCOM) outputs. Analyses of model outputs reveal the interaction between two deep abyssal anticyclonic circulation around Koshu Seamount and the Kuroshio, which amplifies the trigger meander to create the large meander in 2004. The Kuroshio takes offshore non-large meander paths for about a year from fall 2008. During this period deep anticyclone around Koshu Seamount was not developed enough to create the Kuroshio large meander since its path doesn’t pass over Koshu Seamount. Scatter plot of upper stretching term versus deep one computed in a box surrounding Koshu Seamount shows negatively-correlated tight relationship between them when the large meander happens, suggesting that baroclinic instability is an important process to create the large meander.

A MODELING STUDY OF WATER AND SALT EXCHANGE FOR A HIGHLY STRATIFIED NORTHERN GULF OF MEXICO ESTUARY

A hydrodynamic model is applied to Mobile Bay, a northern Gulf of Mexico estuary, to study季.
the subtidal salt exchange with the Gulf of Mexico via Main Pass (MP) and eastern Mississippi Sound as well as Mississippian Plateau, Penobscot Bay, and the Gulf of Maine. In the tropics, the Kuroshio and eastern boundary current system (EBCS) is also involved. It is evident that the North Pacific Intermediate Waters (NPIW) are influenced by the EBCS and the Kuroshio. The properties of the NPIW are investigated using a suite of coupled climate models. It is found that the Kuroshio and the subtropical mode water influence on NPIW as well as high latitude circulations. The coupled models analyzed are NOAA/GFDL CM2.1, and CM2G which utilized an isopycnal ocean model GOLD. All models produce NPIWs (salinity minimum layers). Their properties and formation regions, however, are rather different. NPIW from CM2G is comparable to that of the observed one, but those from CM2M and CM2L1 are saltier and heavier. The distributions of an age tracer show that in CM2M and CM2L1 the low salinity waters originate not from the Okhotsk Sea but from the western part of the Kamchatka Sea. The water flows southward the Kamchatka Peninsula and the eastern edge of the Kuril Islands. Upon encountering the Kuroshio Oyashio extension the water penetrates below the subtropical mode water while moving eastward. The penetration occurs away from Japanese coast because of the too strong Kuroshio and thick mode water. In CM2G, the salinity minimum layer starts from the Okhotsk Sea to flow southward along the east coast of Sakhalin and through the Kuril Islands until encountering the Kuroshio Oyashio extension. In this model, the Kuroshio separates at lower latitude and the mode water is thinner so that NPIW forms along Japanese coast. (Abstract ID 10917)

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THE PROPERTIES OF THE NORTH PACIFIC INTERMEDIATE WATER FROM A SUITE OF NOAA/GFDL COUPLED CLIMATE MODELS

The properties of the North Pacific Intermediate Waters (NPIW) are investigated using a suite of coupled climate models. It is found that the Kuroshio and the subtropical mode water influence on NPIW as well as high latitude circulations. The coupled models analyzed are NOAA/GFDL CM2.1, which utilized in the IPCC A4R CM2M, an improved version of CM2.1, and CM2G which utilized an isopycnal ocean model GOLD. All models produce NPIWs (salinity minimum layers). Their properties and formation regions, however, are rather different. NPIW from CM2G is comparable to that of the observed one, but those from CM2M and CM2L1 are saltier and heavier. The distributions of an age tracer show that in CM2M and CM2L1 the low salinity waters originate not from the Okhotsk Sea but from the western part of the Kamchatka Sea. The water flows southward the Kamchatka Peninsula and the eastern edge of the Kuril Islands. Upon encountering the Kuroshio Oyashio extension the water penetrates below the subtropical mode water while moving eastward. The penetration occurs away from Japanese coast because of the too strong Kuroshio and thick mode water. In CM2G, the salinity minimum layer starts from the Okhotsk Sea to flow southward along the east coast of Sakhalin and through the Kuril Islands until encountering the Kuroshio Oyashio extension. In this model, the Kuroshio separates at lower latitude and the mode water is thinner so that NPIW forms along Japanese coast. (Abstract ID 10912)

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BUOYANT JET DISCHARGE

Measurements were collected during a three-day period of the wet season at three locations between tidal and wave variations, and turbulent kinetic energy (TKE) emanating from a buoyant jet discharge located in a fringing coral reef lagoon of the Yucatan peninsula, Mexico. Measurements were collected during a three-day period of the wet season at three locations in the lagoon (two inlets and the jet). Lagoon circulation is modulated by incident waves and semidiurnal tides. High wave activity caused wave setup in the lagoon. Jet TKE varied inversely with tides, up to 0.36 m2/s2 evident during the lowest tides. TKE variations were dominated by shear production, except during periods of TKE transition when buoyancy production dominated, jet discharge temperatures and salinities varied in conjunction with tides. Highest salinities (>34 psu) appeared at high tides during high wave activity periods, while lowest salinities (<29 psu) developed between high and low tides. This was caused by wave-induced setup driving more saline into the lagoon (wave-pumping). Wave-pumping may enhance salt intrusion during high tides, threatening delicate aquifer conditions and vital water resources for local communities.

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TIDE AND WAVE-INDUCED VARIATIONS IN TURBULENT KINETIC ENERGY AT A BUOYANT JET DISCHARGE

Velocity and hydrography measurements were obtained to determine the interactions between tidal and wave variations, and turbulent kinetic energy (TKE) emanating from a buoyant jet discharge located in a fringing coral reef lagoon of the Yucatan peninsula, Mexico. Measurements were collected during a three-day period of the wet season at three locations in the lagoon (two inlets and the jet). Lagoon circulation is modulated by incident waves and semidiurnal tides. High wave activity caused wave setup in the lagoon. Jet TKE varied inversely with tides, up to 0.36 m2/s2 evident during the lowest tides. TKE variations were dominated by shear production, except during periods of TKE transition when buoyancy production dominated, jet discharge temperatures and salinities varied in conjunction with tides. Highest salinities (>34 psu) appeared at high tides during high wave activity periods, while lowest salinities (<29 psu) developed between high and low tides. This was caused by wave-induced setup driving more saline into the lagoon (wave-pumping). Wave-pumping may enhance salt intrusion during high tides, threatening delicate aquifer conditions and vital water resources for local communities.

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CORRELATING PERTURBATIONS OF ENVIRONMENTAL PARAMETERS WITHIN THE NORTHERN GULF OF MEXICO

Time series of remotely-sensed sea surface temperature and chlorophyll concentrations from the northern Gulf of Mexico are analyzed and compared with eddy kinetic energy derived from numerical ocean model analysis fields. The combined time series are all taken from the public archives of NOAA's National Oceanographic Data Center and NOAA's CoastWatch. Perturbations from mean conditions in each seven-year time series are examined for events and extremes and correlated with both with synoptic events and climate variation time series. In addition, an analysis of Loop Current positional extremes as derived from ocean model sea surface height analyses and remotely-sensed sea surface temperature are correlated with these signals. Interconnection between biological response, as indicated by satellite derived chlorophyll, and physical ocean conditions have been previously demonstrated. The frequency, magnitude and relative importance of these perturbations over a short period within the northern Gulf of Mexico and potential forcing mechanisms are highlighted through this integrated approach based on data within the national archives. (Abstract ID 11870)

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AUV RESEARCH AND EDUCATION IN THE ROSS SEA: A BROADER IMPACTS EVALUATION REPORT

Rutgers University and Liberty Science Center partnered on the broader impacts of an NSF Antarctic Sciences Division funded mission. Ross Sea Connection, which ran from the summer of 2010 to May 2011, connected mission scientists with 25 middle- and high-school science teachers and students who were thousands of miles apart. The project's evaluation was designed to determine the success in bringing together scientists and educators to improve science education. All teacher participants were asked to complete a pre-survey before the project, daily surveys during the summer training session, a fall follow-up survey on their readiness for live calls from the Ross Sea, and a final interview or survey on the project's impact on them and their students. This presentation by the project evaluator offers a summary of the major evaluation findings. The results showed not only the professional development of teachers and education of students, but also the development of a relationship that teachers and students felt they had with the scientists and the science — this became their research project. (Abstract ID 11447)

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GROWTH RESPONSE OF A DIATOM TO CHANGING OCEANIC ENVIRONMENTS

As the carbonate chemistry shifts and temperature increases, impacting light and nutrient availability the environmental conditions of the future ocean will differ from today's in multiple ways. To investigate potential interactive effects between ocean acidification, temperature and light climate we generated growth response curves for the well-studied diatom Thalassiosira weissflogii using semi-continuous batch cultures. Growth was monitored in four replicate treatments during the acclimatization, until exponential growth remained constant for 8 generations. The acclimatization growth rate was established after 8 days to 1%/day. After 12-minutes we measured growth in four replicate treatments during the acclimatization, until exponential growth remained constant for 8 generations. Cellular characteristics and TEP production were determined at four time points once cells were fully acclimatized. Characteristics of cells tended to be a function of growth rate, independent of the environmental parameter regulating growth. Optimal growth temperatures the effect of ocean acidification was small, but at lower and higher temperatures growth was more diminished under future pCO2 conditions. The carbonate system appears to contribute, together with factors like light, temperature, turbulence and macro- and micro-nutrients, towards determining cell growth and competitiveness of phytoplankton. (Abstract ID 10594)

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TEMPORAL DYNAMICS OF PHYTOPLANKTON AND HETEROTROPHIC PROTISTS AT STATION ALOHA

Understanding the coupled temporal and spatial variability of primary producers and their consumers is essential for developing a comprehensive understanding of the trophic relationships at the base of the food web in the North Pacific Subtropical Gyre (NPSG). Based on epifluorescence microscopy, we assessed the abundances and biomasses of autotrophs and heterotrophic protists at Station ALOHA over 4.5 years from June 2004 to January 2009. Autotrophic: size structure and community composition varied seasonally. In addition, there is evidence that zooplankton trophic linkages may impact the structure of lower trophic levels in the NPSG on both seasonal and interannual timescales. Higher ratios of autotrophic to heterotrophic protists (A:H ratio) and a shift in the size structure of eukaryotic autotrophs (A-EUKS) during winter suggest a seasonal release from grazing pressure. Anomalous patterns of A:H variability during summer 2006 (low mesozooplankton, high A-EUKS and H-dinoflagellates) reveal that top-down forcing may also contribute to interannual variability of lower trophic levels. Continued studies of protistan abundances and biomasses are essential for developing a predictive understanding of community response in the NPSG to a changing climate. (Abstract ID 10777)

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THE RESPONSE OF THE ANTARCTIC CIRCUMPOLAR CURRENT TO WIND CHANGES IN PRESENT AND FUTURE OCEAN SIMULATIONS

We study the response of the Antarctic Circumpolar Current (ACC) to recent changes and possible future trends in the Southern Hemisphere westerly winds. Simulations are performed with the global NEMO-LIM ocean-sea ice model, using both climatological and interannual forcing for the period 1948-2007. The role of model resolution in affecting the ACC response to wind changes is investigated by comparing simulations with horizontal grid sizes of ~30 km (ORCA05) and ~15 km (ORCA025). The simulations show significant differences in the ACC response to the wind stress trend of the past decades. While the ACC transport increases by tens of Sv in the ORCA05 simulation, the ACC change is much more limited in the higher resolution simulation, in better agreement with available observations. Subsequently, we estimate the future evolution of the ACC by extracting wind anomalies from an ensemble of 21st century climate projections and by adding them to the present atmospheric forcing. The comparison between present and future climate simulations illuminates the sensitivity of the ACC to westerly wind variations and the processes governing the response behavior. (Abstract ID 9547)

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TSUNAMI-FORCED CURRENTS AROUND THE HAWAIIAN ISLANDS GENERATED BY THE GREAT EAST JAPAN EARTHQUAKE

Eight hours after the Great East Japan Earthquake struck on March 11, 2011, current meters deployed around the islands of Hawaii measured sudden elevated changes in velocity. NOAA's Center for Operational Oceanographic Products and Services current meter data showed strong uniform velocities throughout the vertical profile of the water column. Four acoustic Doppler current profiler stations within the island chain captured a time series at six-minute intervals. Hawaiian water level gages sampling at one-minute intervals measured a 4 m water level range which correlated with rapid accelerations exhibited at current meter stations, where velocities shifted 130 degrees and up to 270 cm s⁻¹ over 12 minutes. The ringing of the currents in and out of Kahului Harbor for 3 days, followed by an anomalous persistent flow out of the harbor for a day and a half peaking at 40 cm s⁻¹ over a day and a half. These stations represent valuable data for understanding the tremendous power derived from the horizontal movement of water caused by tsunami. Data will be used to verify tsunami models where the currents are largely not understood resulting in better contingency planning, warnings and damage impacts. Future data collections will sample currents at 1 minute intervals to capture peak speeds more precisely. (Abstract ID 11670)

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THE CONTRIBUTION OF MUSSEL EXCRETION TO COASTAL PRIMARY PRODUCTION DETERMINED USING STABLE ISOTOPE TRACERS

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Rocks on shore productivity is thought to be predominately fuelled by new nitrogen from upwelling. However, along the Washington State outer coast, high densities of mussels (Mytilus californianus) experience significant concentrations of regenerated nitrogen in form of ammonium. To determine to what extent regenerated nitrogen may be responsible for fuelling coastal primary production, we employed stable isotope tracers (\(^{15}\)NH\(_4\)\(^{+}\), \(^{15}\)NO\(_2\)\(^{-}\), and NO\(_3\)\(^{-}\)) to track the pathways for inorganic nitrogen fluxes. These tracers were added to exposed rocky shore tidepools using them for the first time as natural mesocosms for these experiments. Discrete water and algal tissue samples were taken after tracer addition at several time points over the course of half a tidal cycle for stable isotope analysis. Results show isotope dilution of Discrete water and algal tissue samples were taken after tracer addition at several time points track the pathways for inorganic nitrogen fluxes. These tracers were added to exposed rocky shore tidepools using them for the first time as natural mesocosms for these experiments. Results show isotope dilution of NH\(_4\)\(^{+}\) to NO\(_3\)\(^{-}\) in 3 hours where \(8^\text{th} \Delta\)NH\(_4\)\(^{+}\) = 1000‰, indicative of NH\(_4\)\(^{+}\) production, oxidation, and uptake by macroalgae. These results show that regenerated nitrogen is an integral part of rocky intertidal biogeochemistry and a contributor to local coastal primary productivity. (Abstract ID 11648)

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Improvements in seawater carbon system measurements based on the use of sulfonephthalein indicator dyes

High precision carbon system measurements are required to document the evolving changes in seawater CO\(_2\) system chemistry that accompany oceanic uptake of anthropogenic CO\(_2\). Prior work has shown that spectrophotometric measurements of pH, DIC, TA and pCO\(_2\) are simple, fast, and precise. However, the accuracy of spectrophotometric CO\(_2\) system measurements can be adversely impacted by impurities in the sulfonephthalein indicator dyes that are used for such measurements. In particular, it has been shown that vendor-specific impurities create errors in seawater pH determinations obtained with meta Cresol Purple (mCP), the preferred indicator for direct water column determinations of seawater pH. In order to ensure measurement accuracy, and inter-comparability on a global basis, impurities must be removed from all indicators that are used for CO\(_2\) system analyses. This presentation describes procedures for (a) HPLC purification of mCP, (b) determination of the physical-chemical characteristics of mCPand (c) purification of large batches of indicators by flash chromatography. (Abstract ID 9498)

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HICO calibration analysis two years post launch

Soon after the Hyperpectral Imagery for the Coastal Ocean (HICO) started collecting imagery in September 2009, it became apparent that direct application of laboratory derived corrections and calibration coefficients resulted in at sensor radiances that were too low. Initial efforts to adjust the coefficients used in the calibration process resulted in HICO version 3 which is the first widely distributed data version. Since then, it has become clear that the initial adjustments are insufficient for some ocean color applications. Ocean color algorithms are very sensitive to even small errors in the calibrated at sensor radiances since water leaving radiation is often less than ten percent of the total at sensor radiances. Over the last couple of years, HICO has collected several thousand images including over one hundred diagnostic images such as dark scenes collected with the sensor in the stop position. This presentation summarizes efforts undertaken since the HICO version 3 release to refine the level 0 to level 1 processing to produce data as close to ocean color quality as possible. (Abstract ID 11370)

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Algal chemical defenses: from compounds to communities

Macroalgae and benthic cyanobacteria are becoming increasingly abundant on many coral reefs worldwide. The die-off of the long-spined sea urchin Diadema antillarum in Caribbean waters in the 1980s coincided with a dramatic increase in macroalgal biomass on reefs. An increase in abundance of this keystone herbivore should decrease macroalgae on Caribbean reefs, and scientists and resource managers are interested in its recovery. We investigated the feeding preferences of this herbivore for different macroalgae and cyanobacteria that are common on Caribbean reefs. Diadema antillarum was more selective than expected in its food choices and tended to avoid some chemically-rich macroalgae and cyanobacteria. Macroalgae and cyanobacterial secondary metabolites may also be important for competition. Experiments were designed to test interactions between chemically defended species of algae and cyanobacteria and different life history stages of corals. Extracts and isolated compounds from macroalgae and cyanobacteria negatively influenced the settlement and metamorphosis of coral larvae. On reef flanks, increasing abundance of chemically defended macroalgae and benthic cyanobacteria, the rebuilding of coral populations may be slowed due to recruitment inhibition caused by algal natural products. (Abstract ID 12097)

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Biological relevance of submesoscale dynamics in the highly stratified, oligotrophic ocean

Submesoscale processes have been shown to be important in regions of low stratification and deep mixed layers. We investigate the importance of submesoscale nutrient injections in a region of shallow mixed layers and high stratification the North Pacific ocean. A simple, nitrogen-based plankton model is embedded into a regional ROMS configuration for the Hawaiian region centered on the location of HOT Station ALOHA. As the grid resolution is increased, larger velocity variance combined with larger buoyancy variance just below the mixed layer show the average depth of the nutricline and increase the frequency of episodic nitrate injections. As a consequence, large phytoplankton species, absent at lower resolutions, emerge. Modeled new production at the location of Station ALOHA is enhanced during episodic injection events, which are followed by large export events. These results are relevant in the context of the observed production patterns. In regions with low surface NO\(_3\)/PO\(_4\) ratios, episodic injections supply an excess of PO\(_4\) relative to Redfield stoichiometry. Phosphate is a limiting nutrient for the growth of nitrogen-fixing diazotrophs at Station ALOHA, which may help explain the observed primary production pattern. (Abstract ID 12509)

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The spectral optical properties and relative radiant heating contribution of dissolved and particulate matter in the surface waters across the Fram Strait

The Fram Strait is the key region for exchange processes between Arctic Ocean and North Atlantic. With two major near-surface currents, the warm and salty West Spitsbergen Current and cold low-salinity East Greenland Current, its waters encompass two distinct oceanographic environments. During autumns of 2009 and 2010 comprehensive observations were performed on transects along 79°N across the Fram Strait. Samples for chlороphyll dissolved organic matter (CDOM) and particulate absorption were collected and analyzed together with distribution of temperature and salinity in surface waters (0-100 m). Large spatial variations in the distribution of CDOM and particulate matter as well as their relative contributions to total absorption were apparent, with high contrast between waters of Arctic and Atlantic origin. In addition, estimates of underwater light profiles and radiant heating rate (RHR) of the upper layer were obtained using a simplistic exponential RHR model. This is one of the first detailed observations of ocean water optical properties across the northern Fram Strait, and might have potential implications for biological, biogeochemical and physical processes in the region. (Abstract ID 10170)

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The KILO NALU Observatory: seven years of discovery

The Kilo Nalu observatory has been in operation on the south shore of the island of Oahu since 2004, providing baseline observations on wave and current characteristics along with water properties as well as contributing to the broader Hawaii Ocean Observing System (HOOS). Baseline data has enabled resolution of the coastal response to storms events, identification of thermally driven cross-shore exchange processes, and observation of near- bed thermal inversions driven by radiative heating. KNO observations have also captured multiple tsunami events including the recent 2011 Tohoku event, which have highlighted the role of tsunami-generated coastal trapped waves. KNO has also hosted an array of research experiments at two nodes in the coral forereef environment. These have included dispersion and transport measurements and abdominal deployments for resolution of turbulent buoyancy fluxes, passive acoustics experiments, and observations of turbulent wave and current boundary layers. We present an overview of key results from Kilo Nalu observations and experiments and discuss some of the challenges associated with maintaining
extended real-time observations in the tropical reef environment. (Abstract ID 12740)

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A REALISTIC, LARGE-SCALE LABORATORY EXPERIMENTAL STUDY OF INTERNAL TIDE GENERATION AT THE LUZON STRAIT.

The Luzon Strait, located between Taiwan and the Philippines is a fine example of internal tide generation by complex bathymetry. Strong internal tides propagate away from this double-ridge system resulting in some of the largest internal solitary waves observed worldwide. In recent years, this setting has been the focus of extensive field studies, remote observations and numerical simulations. To complement the aforementioned studies, we performed an internal tide laboratory experiment on an unprecedented scale. The experiment was conducted at the Coriolis facility in Grenoble, France. We modeled the generation of internal tides using realistic three-dimensional topography, density stratification and barotropic tidal forcing; the latter was achieved through the use of novel prismatic tide generators. Particular care was taken to achieve dynamical similarity with the ocean, with the values of dimensionless groups such as criticality, Froude number and tidal excursion being closely matched to the Luzon Strait. In this talk, we describe the design, fabrication, execution of this one-of-a-kind laboratory experiment, as well as summarizing key findings. Further details are given in a related poster presentation. (Abstract ID 10666)

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LAGRANGIAN BUOY MEASUREMENTS OF WAVE-CURRENT INTERACTIONS

The interaction between ocean waves and strong tidal currents is important for many aspects of coastal dynamics. However, detailed field observations with in-situ instruments are rare. Using newly instrumented Lagrangian drifter buoys, we have made observations of waves and currents in the approaches to San Francisco Bay and in the Sacramento River. Tidal currents in these areas can exceed 2.5 m/s, which results in refraction of longer swell waves and partial blocking of shorter wind waves. Pronounced blocking was observed in Raccoon Strait where the tidal flow accelerates over a shallow sill and opposes high-frequency surface waves. To resolve the various spatial scales involved in these dynamics, Lagrangian drifters using GPS and accelerometer sensors were developed. The GPS sensors measure lower-frequency horizontal motions to resolve surface currents and swell waves, whereas the accelerometer sensors resolve the steep high-frequency wind waves. Preliminary results show that the new instruments are well suited for investigating the dynamics of wave-current interaction in coastal areas. To resolve non-linear aspects of waves interacting with strong tidal flows, and can be used to estimate dissipation from breaking waves. (Abstract ID 10443)

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IT’S ALL IN WHO YOU KNOW — TEACHERS CONNECTING STUDENTS TO SCIENTISTS AT SEA IN REAL TIME

Live ship-to-shore connections between scientists at sea and student or family learning groups can be highly motivational. Shore-side participants express and demonstrate a desire for further learning about the science and careers they experience during these immersive events. Teachers are known to influence career paths and college choices. Can they have the same effect when serving as at-sea facilitators for interactions between scientists working aboard the nation’s vessels and children and youth onshore? Do their established relationships with students improve or multiply the effect of live science? How can we measure differences in impacts of teacher-facilitated interactions? Initial findings from data collected during fifteen live programs over two eight-week expeditions aboard the Integrated Ocean Drilling Program’s JOIDES Resolution will be presented. (Abstract ID 12748)

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TEMPORAL AND SPATIAL VARIABILITY OF PRIMARY PRODUCTION AND CHLOROPHYLL IN THE WATERS OFF THE WESTERN ANTARCTIC PENINSULA (WAP) REGION

Temporal and spatial variability of primary production (PP) and chlorophyll-a (Chl-a) were studied off the continental shelf of the Western Antarctic Peninsula (WAP). Preliminary results indicate an offshore-onshore and north-south gradient in both PP and Ch-a. The primary production to chlorophyll-a ratio (PP/Ch-a) was also computed and showed an overall north-south gradient, with a positive increase southward. We speculate that this trend could be due to grazing, oceanographic processes, photosynthetic efficiencies of the plankton or a combination thereof. Three ‘hotspot’ sites within the WAP (off Anvers Island (AI), off Crystal Sound (CS) and off Marguerite Bay (MB)) were further investigated. All three sites showed above average rates and concentrations of PP and Chl-a, respectively; when compared with adjacent waters. Waters around MB had the highest PP rates (2.35 ± 0.69 g C m⁻² day⁻¹), while those off AI in the north had the lowest rates (1.04 ± 0.09 g C m⁻² day⁻¹). Overall PP for the WAP region during the peak growing season (January) was maximal on yearday 23 (1.05 ± 0.12 g C m⁻² day⁻¹). (Abstract ID 10926)

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SUBTHERMOCLINE EDDIES OVER THE WESTERN ANTARCTIC CONTINENTAL SLOPE AS OBSERVED BY SEAGLIDER, 2003-09

A 5.5 year time series of Seaglider surveys along two transects crossing the Western Antarctic continental slope revealed the presence of multiple small, subsurface-intensified eddies. These appeared to be predominantly though not exclusively anticyclonic, with the latter-like anticyclones carrying warm, salty core water properties typical of the California Undercurrent (‘cuddles’). Several objective criteria designed to detect strong subthermoline vorticity and water mass anomalies revealed that gliders performed 60 total eddy crossings; closer inspection for repeated crossings found 17 individual anticyclones and 9 cyclones. The eddies’ size and characteristics - strong azimuthal velocities, horizontal radii of 25-30 km, vorticity anomalies in some cases almost 50% below or above ambient values - are on average consistent with Submesoscale Coherent Vortices. Their incidental observation within a long time series allows an estimate of their role in offshore tracer flux, with anticyclones accounting for an estimated 30% of the poleward freshening of the undercurrent. The relative frequency and anomalous core water properties of Washington slope subthermoline eddies suggest that they are a significant mechanism for lateral exchange in the northern California Current System. (Abstract ID 11874)

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SEA LEVEL RISE AND RESONANCE IN THE GULF OF MAIN

A state-of-the-art tidal model was used to simulate the tides in the Bay of Fundy (BoF)/Gulf of Maine under different levels of future sea-level rise (SLR). The aim was to use SLR to increase our understanding of resonance in the Earth’s tide system, rather than to make realistic predictions. SLR was therefore implemented in two ways by raising sea level and either allowing land to flood or adding vertical walls around the present day coastline. The BoF is extremely sensitive to SLR and how it is implemented. With no flooding, the bay reaches N₂ resonance. With above 1 m SLR and M₂ resonance with 1.5m SLR, whereas the Bay of Boston reaches M₂ resonance with more than 25m SLR. However with flooding of low-lying land the response is far weaker, with a difference in tidal amplitude between the SLR implementations of some 20 cm with 15m SLR. The N₂ resonant state in the BoF and the M₂ resonance in the Bay of Boston fit well with established resonance theory. The natural resonance period for the BoF was calculated of 11.2h. (Abstract ID 9850)

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ESTIMATIONS OF (BACK)SCATTERING COEFFICIENTS OF MINERAL PARTICLES IN LAKE ONTARIO IN SUPPORT OF OPTICAL CLOSURE AND PARTITIONING OF PARTICULATE SCATTERING

Light-scattering attributes of mineralogic particles from the upper waters of Lake Ontario, collected from a late summer and an early spring cruises, were characterized by scanning electron microscopy interfaced with automated image and X-ray analyses (SAX). SAX results were used to estimate mineralogic scattering and backscattering coefficients \( b_s \) and \( b_r \), when combined with independent estimates of organic particulate scattering and backscattering through empirical bio-optical models, supported good optical closure with bulk measurements of particulate scattering and backscattering coefficients. \( b_s \) and \( b_r \) (2007 summer cruise). Calcite precipitates (with small
organic features serving as nucleation sites) contributed significantly to $h_c$ and especially $h_f$ (e.g., 75%) in late summer of 2007 in central portion of the lake. Organic particles dominated the $b_r$ and $h_r$ for the 2008 spring cruise, whereas clay minerals made noteworthy or important contributions. The optical modeling closure and subsequent partitioning of $b_r$ and $h_r$ advance our understanding of aquatic optical variability and provide ground-truth for remote sensing. (Abstract ID 11418)

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STORM SURGE ENSEMBLE MODELING USING A SUITE OF HURRICANE WIND MODELS

It is critical to accurately forecast hurricane storm surge that threatens an area. Guidance for storm surge can be made with a single model simulation based on the official hurricane forecast. Unfortunately, hurricane forecast errors would completely overwhelm the predicted storm surge. Probabilistic hurricane storm surge (P-Surge) addresses the uncertainty in hurricane forecasts by running thousands of simulations to account for hurricane forecast errors in location, size and intensity. However, while the official hurricane forecast has historically been the most accurate prediction, it doesn’t capture the scenarios represented by the various hurricane models. Furthermore, a better ensemble can be generated by expanding from p-surge’s use of one storm surge model and its associated parametric wind model. Therefore, NOAA is researching additional storm surge ensemble modeling methodology. This particular methodology uses many hurricane wind models to generate conditions for running storm surge predictions through a single-storm surge model and statistically analyzes the output. The statistical analyses can be applied to future ensembles with multiple sources of wind fields and multiple storm surge models. (Abstract ID 9860)

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ADJUSTING THE WIND STRESS DRAG COEFFICIENT IN STORM SURGE FORECASTING USING AN ADJOINT TECHNIQUE

A three-dimensional ocean model and its adjoint model are used to adjust the drag coefficient in the calculation of wind stress for storm surge forecasting. A number of Observing System Simulation Experiments (OSSE) with different error source imposed are designed and performed. The results show that the wind stress drag coefficient can retrieve its "true" value when the error source only comes from the drag coefficient itself. When the error source comes from the wind speed, the drag coefficient is adjusted to an "optimal value" to compensate wind error and minimizes the distance between the modeled and observed water level and improves the forecasting of the specific storm surge. In practice, the "true" drag coefficient is unknown and the wind field may contain large errors. In addition, forecasting errors may also come from the imperfect model physics and numerics, such as insufficient resolution and inaccurate physical parameterizations. Our results demonstrate that storm surge forecasting errors can be reduced through data assimilation by adjusting drag coefficient regardless the error source. Therefore, although data assimilation may not fix model imperfection, it is effective in improving storm surge forecasting by adjusting the drag coefficient using adjoint technique. (Abstract ID 9496)

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THREE-DIMENSIONAL VORTEX DYNAMICS OVER EVOLVING RIPPLED BEDS

Sediment transport, coherent flow structures, and bedform morphology are strongly coupled and three-dimensional. Consequently, these boundary layer processes must be studied using three-dimensional measurement techniques or with three-dimensional numerical models that dynamically couple the interactions between the processes. Here we present three-dimensional simulations of the complex turbulent flow over evolving sandy rippled beds. The numerical model (SEDiM3D) employs mixture theory by treating the fluid-sediment mixture as a continuum with closures that parameterize the effective properties of the mixture (e.g., hindered settling, effective viscosity and diffusion). Calculations of the variance of the three-dimensional vorticity in the cross-flow direction exhibit large differences (up to 30%) over a wave period. The three-dimensionality of the turbulent vortices may explain differences in comparisons of the vortex locations in the three-dimensional simulations and those locations observed in two-dimensional planar Particle Image Velocimetry (PIV) images taken in the laboratory. The simulation results will be used to estimate an effective bed shear stress for equilibrium vortex ripples as a function of ripple characteristics and wave forcing conditions. (Abstract ID 11548)

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MERGING OPTICAL DATA FROM MULTIPLE PLATFORMS AND SENSORS TO STUDY THE DISTRIBUTION PATTERNS AND DYNAMICS OF TWO CO-OCCURRING PHYTOPLANKTON BLOOMS

During October 2010, a bloom of the toxic dinoflagellate Pseudo-nitzschia australis occurred in northern Monterey Bay, CA. In the same region, a second bloom, in close proximity, but spatially distinct, of the dinoflagellate Procentrum micans also emerged. Physical processes (internal tides, upwelling, eddies, and freshwater runoff) influenced the dynamics and interaction of the blooms. During a 9-22 October research cruise in the Bay, 64 hydrocasts provided water samples and high vertical resolution data from an optical sensor suite. Altering with the discrete hydrocast station sampling, surveys were performed with a ScanFish towed undulating vehicle equipped with a (smaller) suite of optical sensors. Concurrently, two Slocum gliders, with fluorescence (Fl) and backscattering (BB) sensors, were deployed on the northern shelf of the Bay along a linear array of four current profiler moorings. Using the station data, we developed relationships between the optical data to distinguish the two phytoplankton blooms. These relationships were then applied to the Fl and BB data from the mobile platforms (gliders and ScanFish) and remote sensors, to study the temporal-spatial patterns and dynamics of the phytoplankton blooms. (Abstract ID 10612)

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ARCTIC OCEAN CIRCULATION PATTERNS DERIVED FROM OBSERVED AND MODELED OCEAN BOTTOM PRESSURE ANOMALIES

An accurate monitoring and interpretation of the changes in the Arctic Ocean circulation is essential to understanding the role of the Arctic in climate. Due to its direct relationship with sea surface topography, freshwater, heat and mass distribution, the time-varying ocean bottom pressure (OBP) is a useful tool to investigate the dynamics of the circulation. Here we compare monthly variations of OBP from the satellite mission GRACE, from two ocean models and from available tide and pressure gauges in the Arctic. We use maximum covariance analysis to reconstruct new OBP fields, using the modes of variability that explain most of the squared covariance between each record of OBP and the in situ data. We evaluate the reconstructed OBP fields and investigate the ocean circulation associated with the seasonal to inter-annual changes in OBP, in light of atmospheric forcing. Largest RMS variability of OBP is found in the shallow waters of the continental shelf (e.g., East Siberian Sea), consistent with previous findings in which OBP variability in the deep basin is largely reduced due to baroclinic adjustment at inter-annual timescales. (Abstract ID 10672)

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THE ROLE OF SHORT TERM SEDIMENT RESUSPENSION ON THE RELEASE OF NUTRIENTS AND METALS FROM ESTUARINE SEDIMENTS

The role of sediment resuspension on the release of trace metals and nutrients from estuarine sediments is currently under investigation in the Great Bay Estuary, New Hampshire. Resuspension was simulated using a laboratory erosion chamber on cores collected from multiple sites with varying sediment characteristics. Turbidity and suspended solid measurements revealed that the critical shear stress for erosion ranged from 0.15 to 0.2 N/
C. squamosus

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eroded particles will be determined to examine the role of particles on sequestration or release events. Continuing work will investigate the release of dissolved trace metals including silver, suggesting that rapid oxidation and adsorption removes some dissolved species during erosion events. There was no significant release of iron and phosphate, except at the critical shear stress, Irene verified particle movement at the shear stress 0.15 N/m². In most experiments, release of dissolved trace metals including silver, chromium, cobalt, zinc and copper. In addition, the metal and phosphate concentration in eroded particles will be determined to examine the role of particles on sequestration or release of nutrients and metals during resuspension events. (Abstract ID 12470)

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TOPOGRAPHIC CONTROL OF THE CYCLONIC CIRCULATION IN THE SOUTHERN GULF OF MEXICO

Until recently, the Bay of Campeche was one of the most undersampled areas of the Gulf of Mexico. Three years of mooring and drifter observations of the upper-layer velocity field have greatly improved our understanding of the dynamics in this region. They show that the mean cyclonic circulation, previously reported in the literature, is a persistent feature that extends down to 800-1000m. The gyre's size and location appear determined by the topographic configuration of the isobaths in the region, which consists of a deep basin to the west, and a shallow, gently sloping submarine fan to the east. Data suggest that the flow is equivalent barotropic, and that potential vorticity conservation explains the gyre's topographic control. Preliminary results indicate that the interaction of the gyre with Loop Current eddies and wind-stress curl variations can also be explained by this hypothesis. (Abstract ID 10692)

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AMINO ACID ANALYSIS OF THE CYTOCHROME C OXIDASE SUBUNIT 1 (COI) FROM CARIBBEAN CHITON (MOLLUSCA: POLYPLACOPHORA)

The evolutionary relationships among four Caribbean species representing the genus Chiton Linnaeus were studied using the complete cytochrome c oxidase subunit 1 (COI) mitochondrial gene sequence, obtaining 690bp for each of the species. The analysis of the nucleotide divergences establishes a major relation between C. marmoratus Gmelin, 1791 and C. squamosus Linnaeus, 1766, with a 13.4% of divergence. C. tuberculatus Linnaeus, 1758 is the most genetically distant species and C. viridis Spengler, 1797 is located in an intermediate position. We translated the nucleotide sequences using the invertebrates mitochondrial codes, obtaining 202 amino acid sequences. The four species COI peptide sequences shown high homology (>99% identity). C. tuberculatus and C. viridis amino acid sequences are identical for the fragment studied. Otherwise, C. marmoratus and C. squamosus have identical amino acid sequences, but they differ from the other pair in two of the amino acids. Our peptide sequence data suggest two clades in the Caribbean for the genus Chiton: C. tuberculatus-viridis and C. marmoratus-squamosus. The resemblance of the amino acid sequences, do not correspond with the classification base in morphology data. (Abstract ID 9083)

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A REAL-TIME SEA-LEVEL MONITORING NETWORK FOR MASSACHUSETTS BAY

A major threat to coastal populations is storm and wave damage which may be increasing with climate change-induced sea-level rise. Therefore, the Center for Coastal Environmental Sensing Networks (CSEN) has developed a new, inexpensive sea-level sensor, and is integrating it into a network of sea level gauges for Massachusetts Bay that leverages existing infrastructure, integrates new and old monitoring stations and provides real-time data through the use of Web 2.0 standards. CSEN has partnered with NOAA National Weather Service and the Gulf of Maine Ocean Observation System (GoMOOS) in this effort. The installation of new tide gauges directly benefits local communities by providing stakeholders with real-time measurement of sea-level to accurately assess and groundtruth predictive models of sea-level. In addition, the real-time sea-level data can be integrated with networks of environmental monitoring sensors and can increase the accuracy of numerical models provide decision makers with real-time and predictive tools. We will describe the current status of the project with particular emphasis on the integration of real-time sea-level data into the Massachusetts Bay Hydrodynamic Model and the IOOS cyberinfrastructure. (Abstract ID 12620)

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THE RELATIONSHIP BETWEEN INTERNAL WAVES AND THE DISTRIBUTION OF ZOOPLANKTON IN THE EPIPLIMNION OF LAKE OPEONGO, CANADA

Using field data from July and August 2009 and 2010 we report observations of the relationship between enhanced zooplankton patchiness and the presence of internal waves in the weakly stratified epiplumion during periods of intermediate winds in Lake Opeongo, Ontario. While the epiplumion is often assumed to be homogeneously turbulent, numerous studies have shown that the epiplumion does not necessarily have uniform properties, and often displays intermittent mixing and weak temperature gradients. Statistical analysis of zooplankton distribution from July 2009 show that the small scale spatial variability of small zooplankton (200-400 um) is greatest during periods of intermediate gradient Richardson Numbers, Rg ~ 0.5. We calculate that the variance of isotherm displacement is also a maximum for Rg ~ 0.5. In our presentation we discuss the occurrence of these internal waves, their relationship with values of Rg and the effect of these waves on the distribution of zooplankton in the epiplumion. Our main observation is that increased variance of isotherm displacement at moderate Rg values is linked to the increased variation of zooplankton patchiness at those values of Rg. (Abstract ID 10252)

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FIELD OBSERVATIONS OF THE OPTICAL PROPERTIES OF MELTING FIRST YEAR ICE

The sea ice cover of the Chukchi and Beaufort Seas is undergoing significant changes in its extent, thickness, snow cover, and seasonal timing of summer melt, fall freezeup, and snow accumulation. These physical changes in the ice are affecting the partitioning of solar radiation in this region. During icebreaker cruises in June – July of 2010 and 2011 we measured the physical and optical properties of melting first year sea ice. The optical observations provided a detailed characterization of the backscattered and transmitted components of the spectral radiation field. Special attention was paid to investigating the spatial variability of light transmitted through bare and ponded ice. Transmitted PAR and visible light through ponds were 3 to 10 times greater than through bare ice. There were not distinct boundaries in the light field at pond edges under the ice. The transition in transmitted light between bare and ponded ice occurs over a length scale of 2 to 4 times the ice thickness. The size and spatial distributions of ponds directly affect the depth dependence of the light field under the ice. (Abstract ID 10949)

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ESTIMATES OF NET PHYTOPLANKTON PRODUCTIVITY (NPP) AND NET COMMUNITY PRODUCTIVITY (NCP) FROM A LAGRANGIAN MIX-LAYER FLOAT

Net phytoplankton productivity (NPP) and net community productivity (NCP) are rarely measured on identical space and time scales. NPP is measured with tracers in bottles for < 1 day; NCP is derived from changes in biogeochemical inventories over submesoscale to mesoscales for days to months. We use two-months of measurements along a mixed-layer Lagrangian float trajectory in the Iceland Basin in spring 2008 to compare estimates of NPP and NCP. The float measured PAR, chlorophyll fluorescence, POC from optics, oxygen, nitrate, temperature, and salinity. Times series of vertical profiles of PAR and chlorophyll biomass were constructed from float data. Photosynthesis vs. irradiance experiments (IHC) from April and May cruises provided model coefficients to compute NPP based on Jassby and Platt's (1976) tanh-equation, for hourly and one-meter bins, integrated over the euphotic zone. Modeled NPP was compared with Alkire et al.'s (this session) NPP estimates from changes in oxygen, nitrate, and POC for three specific time period – early bloom, main bloom and post bloom. These results show how a combination of float observations can be used for both productivity estimates. (Abstract ID 11623)

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A COMPUTATIONAL APPROACH TO COPEPOD BIOGEOGRAPHY

Climate change is altering the spatial and temporal pattern of environmental conditions in the ocean. Understanding how these changes will impact the distribution of species is a complex problem. A species' biogeographic range is strongly influenced by the distribution of the physical conditions (primarily temperature). However, biological factors such as primary productivity and the abundance of predators and competitors also influence where a species is found. Using a generic model of growth and development, we can predict the generation time, egg production rate, and adult body size as a function of temperature and food (chlorophyll) of the dominant calanoid copepod species in the North Atlantic (Calanus glacialis, C. finmarchicus, and C. helgolandicus). These three properties define a trade-off between large size and high egg production vs. small size and short generation time that determine, in part, the biogeographic limits of these species. Mortality rate remains the main unknown; however, by examining the current distribution of these species related to their computed population characteristics, we can uncover relationships between mortality and both temperature and body size. (Abstract ID 11903)

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A VARIABLE RESOLUTION GLOBAL OCEAN MODEL

The Model for Prediction Across Scales (MPAS) is a new software framework for the rapid development of climate model components on unstructured grids. The grids may be quasi-uniform, variable density on a sphere or rectangular domain, and may use quadrilateral cells, triangle cells, or Voronoi tessellations. MPAS variable density grids are particularly well suited to regional climate simulations. MPAS is developed cooperatively by NCAR MMM and the LANL COSIM team. The MPAS-Ocean component now includes most of the features of a full ocean-climate model. High resolution global simulations with full bathymetry have been run for hundreds of simulated years and produce realistic currents and eddying behavior. MPAS-Ocean may be run with a z-level, z-star, or idealized isopycnal vertical coordinates, and includes high order horizontal and vertical advection and implicit vertical mixing. Recent work on split explicit barotropic/baroclinic timesteping has improved performance by a factor of 12 over Runge-Kutta timesteping. (Abstract ID 10300)

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CONTINUOUS FLUID DISCHARGE NEAR THE MACONDO WELLHEAD

The Deepwater Horizon disaster in April-July 2010 injected an estimated 8.5 x 10^9 tons of oil and gas into the Gulf of Mexico. The well was permanently sealed in September 2010, however, that does not necessarily indicate that fluid discharge has ceased in the vicinity. During a November/December 2010 research cruise, anomalous levels of radium isotopes observed near the wellhead suggested continued active fluid seepage. Discharge of subsurface fluids is the only process capable of producing the observed water column anomalies which were of similar magnitude to those observed at known, active hydrocarbon seeps. Short-lived radium isotopic enrichment decreased with distance from the wellhead, suggesting a localized source. We cannot determine whether the source of the fluids is from leakage through the borehole around the casing, from slow percolation out of the sediments, or from some nearby fracture zone. These results demonstrate the utility of using radium isotopes as an indicator of fluid discharge from the seabed in hydrocarbon-rich areas where other sensors often do not have the resolution necessary to detect anomalous water quality parameters. (Abstract ID 11662)

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SEASONAL VARIATIONS IN THE CONTRIBUTION OF MARINE PLANKTON TO THE FOOD WEB OF THE COLUMBIA RIVER ESTUARY IN THE U.S. PACIFIC NORTHWEST

The expansive Columbia River plume strongly influences biogeochemical-geophysical dynamics in coastal waters of the northern California Current. Yet, the reciprocal influence of the coastal ocean on estuarine biogeochemistry remains poorly characterized, largely due to challenges imposed by sampling in a highly dynamic environment. Using data from moored in situ biogeochemical sensors (chlorophyll, active fluorescence, and spectral fluorescence) in the lower estuary and plume, together with samples collected during research cruises (microscopy, imaging flow cytometry, and gene sequence analysis), we characterized seasonal changes in the contribution of marine plankton to estuarine food webs. Tidally driven invusions of marine waters rich in living phytoplankton were observed near the estuary floor throughout the year. Analysis of species composition and fluorescence signatures indicated that marine taxa accounted for a greater proportion of estuarine plankton in late summer compared to spring, reflecting seasonal variations in river discharge volume. The data demonstrate the power of combining in situ observations, molecular data, and microscopic analyses to advance our understanding of the linkages between the coastal ocean and estuary in terms of plankton standing stocks and organic matter. (Abstract ID 10460)

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ASSESSING AGGREGATE DISTRIBUTIONS AND FLUXES USING THE SOLOPC

The vertical flux of particles in the ocean drives the movement of organic carbon to the deep ocean. We have been studying the particle distribution and flux using the SOLOPC, a profiling Lagrangian float (SOLO) with a Laser Optical Particle Counter (LOPC). We can distinguish between aggregate-like and zooplankton-like particles with diameter >1 mm but needed a way to separate the smaller particles. Coagulation models predict a Gaussian-shaped volume spectrum of aggregates. Successful separation results from fitting a Gaussian curve to the volume spectrum of particles with diameter <1 mm. The particle volumes derived from the Gaussian curves are positively correlated with both fluorescence and the volume of larger particles classified as aggregate-like, suggesting that these particles are truly aggregates derived from phytoplankton. The residual (total minus Gaussian) volumes are highly correlated with the volumes of large, zooplankton-like particles. We calculated the downward velocity of the Gaussian curves are positively correlated with both fluorescence and the volume of larger particles classified as aggregate-like, suggesting that these particles are truly aggregates derived from phytoplankton. The residual (total minus Gaussian) volumes are highly correlated with

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LARVAL TRANSPORT EXCHANGE ACROSS AN ESTUARINE-SHELF INTERFACE: IMPLICATIONS FOR LARVAL TRANSPORT

The interaction of estuarine and coastal ocean circulation affects delivery of planktonic larval stages to estuaries, which are important nursery habitats for many species. Observations and hydrodynamic model simulations of the Narragansett Bay estuary and the adjacent shelf reveal...
complex circulation dynamics at the interface between the estuarine and coastal waters. We compare these dynamics with observed vertical distributions of fish larvae near the estuary mouth to investigate processes and pathways of larval transport. During the winter, classic two-layered estuarine flow extends onto the shelf, allowing potentially continuous ingress of larvae. During the summer, a persistent coastal current bypasses the estuary mouth and near-bottom circulation is weak and rotary. Larvae are predicted to enter the estuary via two different pathways: (1) a narrow zone along the coastline upstream of the estuary or (2) during episodic wind-driven events. Variation in seasonal reproductive cycles and swimming behavior will impact rates of delivery of larvae into the estuary. We discuss the physics of exchange at the mouth of Narragansett Bay and implications for fish population connectivity in the region. (Abstract ID 11424)

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NEAR-N OSCILLATIONS AND DEEP-CYCLE TURBULENCE IN AN UPPER EQUATORIAL OCEAN MODEL

Direct numerical simulation is used to investigate night-time near-n oscillations of isotherms and turbulent mixing in a model of the upper Equatorial Undercurrent (EUC). The model consists of a westward moving surface mixed layer above a stably-stratified EUC flowing to the east. In this model, an asymmetric Holmboe instability emerges at the base of the mixed layer and moves westward at the speed of the local velocity. At the crests of the Holmboe waves, secondary Kelvin-Helmholtz instabilities develop, leading to turbulent events. Sparsely vortices formed by the Kelvin-Helmholtz instability are occasionally ejected downward and stretched by the EUC shear into a horseshoe configuration creating intermittent bursts of turbulence at depth. The Holmboe instability leads to the oscillation of the isotherms that are indicative of propagating waves. Although correlated in space and time with the turbulent bursts, the oscillations are not directly responsible for the generation of turbulence. Taken together, these oscillations and intermittent turbulent bursts are qualitatively similar to the near-n oscillations and the deep-cycle turbulence observed in the Pacific Equatorial Undercurrent. (Abstract ID 10620)

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HIGHLY-RESOLVED FLOW COMPUTATIONS IN THE HUDSON RIVER ESTUARY

We present highly-resolved computations and measurements of flow in a bend of the Hudson River Estuary around the Indian Point power plant, where thermal discharge may affect the ecosystem. ROMS modelling is performed in a domain between the USGS gauging stations at Poughkeepsie and Piermont. Higher-resolution Large Eddy Simulation (LES) is then done to resolve large-scale turbulent motions in the near-bank regions, applying the standard Smagorinsky model in the commercial software FLASE 6.3.26. In a shear layer at the edge of a shallow region, vortices are observed to roll up in the LES though not in k-epsilon URANS on the same grid. Proper Orthogonal Decomposition (POD, equivalent to Empirical Orthogonal Functions) is found to effectively identify these vortices. To check the computations, field measurements of discharge, and velocity and temperature profiles, around the ADCP station at West Point and the thermal plume from the power plant are performed. (Abstract ID 11363)

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LEARNING FROM THE GLOBAL OCEANS: THE ECOLOGICAL IMPACTS OF CO2 ACIDIFICATION OF LAKE SUPERIOR AND LAKE MICHIGAN

The pH of the surface ocean is predicted to drop 0.3-0.4 units by 2100 assuming steady fossil fuel consumption. Model projections of Lakes Superior and Michigan suggest a similar decline in pH by 2100 as the surface ocean. In response to predictions for marine ecosystems, the NOAA Ocean Acidification Steering Committee released the NOAA Ocean and Great Lakes Acidification Research Plan in April 2010. Initiatives for the Great Lakes have not been implemented, leaving them under-studied with respect to carbon acidification. This project assesses expected changes in carbonate chemistry and the subsequent ecological impacts in Lakes Superior and Michigan in order to make a case for high-quality monitoring coupled with biological research. We use biogeochemical models to make projections based upon atmospheric pCO2 scenarios. Using such models, we have studied past events of acid rain to better understand each lake's sensitivity to pH changes under various biochemical conditions.

Lastly, we are interviewing leading O.A. and Great Lakes' scientists on likely impacts, particularly on calcareous species and early life stages, making this an interdisciplinary first look at Great Lake acidification. (Abstract ID 11354)

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TRACKING CHANGES IN THE SMT WITH MAGNETIC SUSCEPTIBILITY IN GAS HYDRATE BEARING STRATIGRAPHY

On marine continental margins, anaerobic methane oxidation at the sulfide-methane transition (SMT) can result in dissolution of existing ferrimagnetic minerals (e.g. magnetite) and precipitation of authigenic sulfide minerals (e.g. pyrite, greigite), altering the original magnetic susceptibility of the bulk sediment. We utilized existing data from drill sites on the Indian (Expedition NGHP-01), Cascadia (ODP-146 and 204, IODP-311), Gulf of Mexico (ODP-96; JIP-01), and the Blake Ridge-Carolina Rise (ODP-164) margins to identify possible zones of decreased magnetic susceptibility associated with stagnation of the SMT. Estimates of grain size coupled with measurements of magnetic mineralogy are used to interpret the source of the magnetic susceptibility signal. Drawdowns in magnetic susceptibility, relative to trends in mean grain size, are present in NGHP-01 and JIP-01 cores, occurring at the modern SMT and intervals below. Past changes in the position of the SMT recorded as drawdowns in magnetic susceptibility may allow for the reconstruction of the SMT through time and serve as a proxy for changes in the methane and/or sulfate flux. (Abstract ID 10323)

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DYNAMICS OF WIND-FORCED UPWELLING IN THE ALASKAN BEAUFORT SEA AND ASSOCIATED SHELF-BASIN FLUXES

Upwelling occurs frequently along the continental slope of the Alaskan Beaufort Sea, driven by remote Pacific-born storms (Aleutian lows). These events result in a cross-stream exchange of heat, salt, and nutrients that can significantly impact both the Beaufort shelf and the interior Canada Basin. Here we use wind data, atmospheric re-analysis fields, oceanic data, and a simplified ocean numerical model to investigate the dynamics of the upwelling and the nature and magnitude of the cross-stream exchange. We focus primarily on a single storm event that occurred in November 2002 when the region was roughly 50% covered by pack-ice. The presence of ice enhanced the ocean response to the storm and the return flow was not confined to the bottom boundary layer. This is consistent with the momentum balance which includes a significant contribution from the cross-stream advection of alongstream momentum. An analysis of the parcel trajectories during the storm from the model reveals varying patterns across the shelfbreak and continental slope. Seasonal trends in the upwelling are discussed using a two-year mooring time series. (Abstract ID 9769)

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MOORED OBSERVATIONS OF INTERNAL TIDES IN LUZON STRAIT

Luzon Strait is a two-ridge system located between Taiwan and the Philippines, where strong barotropic tidal flow generates large-amplitude diurnal and semi-diurnal internal tides. The ridge spacing and geometry varies from north to south, making resonance possible at some locations and frequencies. In summer 2011, eight moorings were deployed along two lines across the ridge system to study the generation, propagation, and dissipation of internal tides. Full-depth profiles of velocity and temperature at the eastern edge of each line allow calculation of energy and flux over four spring-neap cycles, for diurnal and semi-diurnal frequencies. Depth coverage at most of the other sites was incomplete, but sufficient to assess energy and the depth structure of the tidal and low-frequency flows. Energy flux was strong (>30 kW/m), with O(25%) differences seen between successive spring tides. A strong (>0.75 ms in the upper 500 m) but temporally variable Kuroshio was observed, primarily on the northern line. The 3-D plus time picture obtained from the moored array of the internal tides, the low-frequency flow, and their interaction, will be presented. (Abstract ID 10523)

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SEDIMENT-NUTRIENT DYNAMICS OF THE TURBIDITY MAXIMUM ZONE

This interdisciplinary study investigates key relationships between suspended sediments, estuarine hydrodynamics and macronutrient (nitrogen, phosphorus) concentrations within the turbidity maximum zone (TMZ) of two important macrotidal European estuaries (Tamar, UK & Seine, France). In situ measurements and sampling were performed during spring tide conditions in 2010 and 2011. Parameters recorded were current velocity and turbulent kinetic energy from an ADCP, salinity, temperature and turbidity from a CTD, particle size and concentration data from a LISST-100X and LabsFLOC apparatus and N and P concentrations from surface and bottom water samples. Data acquired suggest that both large-scale (e.g. salinity, current velocity) and small-scale (e.g. flocculation) physical processes directly affect dissolved N and P concentrations. However, the release of different N and P species varied with different physical conditions. For example, the dissolved ammonium concentrations co-varied with salinity variations, while nitrate and phosphate co-varied with particle size. This study demonstrates the importance of an interdisciplinary approach to studying N and P dynamics in important anthropogenically impacted estuaries. (Abstract ID 10517)

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DYNAMICAL INFLUENCE OF BUOYANCY FORCING ON INTERANNUAL TROPICAL SEA LEVEL VARIABILITY

Satellite altimetry has revealed complex spatial patterns of interannual regional sea level variability. To attribute these patterns, investigators have examined the ocean's dynamical response to winds and its local (passive) response to surface heating. Although skillful in many regions, these processes alone cannot explain sea level variations in some tropical regions, potentially implicating distinct dynamics. To study the dynamics of interannual sea level variability, we use an ocean state estimate constrained by dynamics and most available observations; through a set of numerical experiments, we isolate the influences of anomalous winds and buoyancy exchanges on sea level. In tropical regions characterized by net evaporation, observed buoyancy-driven sea level variations have a strongly non-local, dynamic character. Targeted investigation in the tropical South Atlantic reveals that these signals are explained mostly in terms of propagating Rossby waves driven primarily by surface heat fluxes. Moreover, these heat-driven signals are largely compensated by wind-driven changes; correlation between surface heat flux and wind stress anomalies suggests that surface heating mainly comprises latent fluxes and hints at potential air-sea coupling. (Abstract ID 9743)

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OIL, FLOODS, AND HYPOXIA: ZOOPLANKTON DYNAMICS IN THE NORTHERN GULF OF MEXICO IN 2010 AND 2011

The recent unprecedented events in the Gulf of Mexico, the MC252 oil spill in 2010 and record flooding of the Mississippi River in 2011, are likely to have far reaching impacts on many aspects of the northern Gulf of Mexico (NGOMEX) pelagic ecosystem. We had collected five years of data on the physical conditions and plankton populations prior to these major events, and were able to conduct surveys in both 2010 and 2011 to assess impacts on mesozooplankton populations. Data from net tows, pump and niskin bottle samples, optical plankton counters, and hydrographic instruments were used to compare zooplankton community structures and physical characteristics between years and across gradients in the NGOMEX region. These findings will be put into the context of the Gulf of Mexico ecosystem as a whole and in light of the seasonal hypoxia that occurs on the Louisiana Shelf. (Abstract ID 10741)

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QUANTIFICATION OF CESIUM IN SEAWATER OFF JAPAN USING EXTRACTION WITH PAN-AMP RESIN AND QUANTIFICATION VIA GAMMA SPECTROSCOPY

The March 2011 earthquake off the Japanese coast and subsequent tsunami that devastated the Fukushima Dai-ichi nuclear power plant resulted in the largest accidental release of Cesium 137 and 134 to the oceans. Seawater samples were collected in June 2011 from 15 to 600 kilometers off the coast of Japan as part of initial mapping of the spread of contamination in the ocean. Cesium was extracted from unfiltered and filtered (<1.0 µm) seawater using an exchange resin based upon an organic polymer (polycrylonitrile, PAN) containing ammonium molybdenophosphate (AMP) (F. Sebesta and V. Stefala, 1990). The PAN-AMP resin can be directly used for gamma spectroscopy for 134Cs and 137Cs. Stable 135Cs was added to evaluate extraction efficiency and quantified by ICPMS. Our 5 ml AMP-PAN resin column was on average 95% efficient in the removal of Cesium from 20 Ltr samples at an average flow rate of 35 ml/min. Measured activities of 134Cs and 137Cs ranged from a few Bq/m3 to >1000 Bq/m3. The extraction column can be adapted to different sample volumes and easily used in the field. (Abstract ID 10448)

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VARIABILITY IN CALANUS spp. POPULATIONS ON THE EASTERN BERING SEA SHELF DURING THE RECENT COLD PHASE

The eastern Bering Sea shelf has been experiencing a sequence of extremely cold years marked by intense ice coverage and late ice retreat since 2008. Distributions of zooplankton communities during these conditions were investigated in 2008-2010 as a part of the collaborative BEST-BSERP program. Calanus spp. were the dominant mesozooplankton copepod species over the eastern Bering Sea middle shelf. Spatial and temporal variability in abundance and stage distributions of Calanus spp. copepoides in spring and early summer along the shelf were examined in relation to the seasonally progressing ice retreats. Adult females occurred in early spring, and their abundance was one order of magnitude higher in 2009 than in 2008, indicating a potential for a stronger spawning event in 2009. The recruitment of copepodites coincided with the ice retreat from the southern shelf and was delayed in the north where the ice remained. The delay in development was evident in early summer when younger developmental stages dominated the population in ice-free waters in the north, while older stages occurred in the south. Despite the differences in brood stock, the abundance of copepodites in early summer was lower in 2009 than in 2008, suggesting that factors other than reproductive success may have controlled the summer Calanus population during this recent cold phase in the Bering Sea. (Abstract ID 12228)

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FISH AND SHARK RESPONSES TO NON-LINEAR INTERNAL WAVES: FORAGING AND VERTICAL RE-DISTRIBUTION

Fish and sharks respond to large-amplitude internal waves (IWs) that are generated semi-diurnally at Race Point (RP), a headland at the northern tip of Cape Cod, Massachusetts. SAR observations indicate that RP IWs tend to impact Stellwagen Bank’s southern flank, a shallow bank 10 km distant from RP. Sand lance, a planktivorous fish, moved up in the water column in response to surface-intensified, horizontally propagating IWs approaching this area. Sand lance may have responded to zooplankton patches concentrated in the waves. Fish near the bottom might have detected the IWs via changes in pressure and velocity produced by the waves. We estimated the wave properties with a fully-nonlinear model that provides estimates of wave-induced pressure and velocity fields over the full depth. Small sharks responded to IWs in two ways. First, sharks moved up and down in concert with the IWs. Second, shark vertical distribution changed from vertically extended to bottom-trapped constrained during the passage of the waves. Compression of vertical range may be related to observed two-way circulation, and shear zone avoidance. (Abstract ID 11036)
**THE SIMRAD ME70 MULTIBEAM ECHOSOUNDER IN THE GULF OF ALASKA**

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**SEAFLOOR CHARACTERIZATION FOR TRLAWLABILITY AND FISH HABITAT USING THE SIMRAD ME70 MULTIBEAM ECHOSOUNDER IN THE GULF OF ALASKA**

Rockfish (Sebastes sp.) stocks that associate with ragged seafloor types are difficult to assess due to limitations of traditional bottom-trawl sampling gear. Alternative methods that include acoustic remote sensing and video imagery may improve stock assessment in untrawlable locations. Acoustics can also be applied to identify locations where alternative assessment methods are required. We use the Simrad ME70 multibeam echosounder (ME70) and trawl survey performance data to develop a seafloor trawlability classification scheme for locations in the Gulf of Alaska (GOA). We surveyed areas of the GOA (20-500 m depth) using the ME70 aboard the NOAA ship Oscar Dyson during summer 2011. Seafloor parameters derived from the ME70 data were used to classify seafloor trawlability including, the average backscatter measured as a function of incidence angle, scintillation index from the backscatter, and seafloor rugosity from the depth soundings. We present a preliminary seafloor trawlability classification for areas of the GOA. The next phase of this work will characterize seafloor habitats for harvested species in our survey area using ME70 data, video imagery, and species occurrence data from the trawl survey. (Abstract ID 12768)

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**AUV-ASSISTED CHARACTERIZATION OF BEACHROCK FORMATIONS IN VATIKA BAY, LACONIA, GREECE AND THEIR RELEVANCE TO LOCAL SEA LEVEL CHANGES AND BRONZE AGE SETTLEMENTS**

The coast around Vatika Bay has suffered changes in elevation over the last few thousand years. The causes, dates and magnitude of these changes are of interest to archeologists studying Pavlopetri, a submerged Bronze Age town at the western end of the bay. Multiple, distinct bands of submerged beachrock can be observed from shore and satellite imagery. The nearest bands are approximately 150 m from shore, in depths of 3-4 m. In 2011 we complemented direct observation, towed side-scan sonar mapping and radiocarbon dating of diver-collected cores, with the novel use of a small imaging AUV. This robot collected thousands of high resolution stereo images over an area of approximately 140 m x 40 m. The stereo imagery and navigation information were combined to create a large 3D photo mosaic, revealing fractured slabs, their height, and distinct morphology of each band. We present results from radiocarbon dating of the cores, and the structure of the beachrock formations from sonar and 3D mosaics. We discuss the implications on sea level changes for that area and for the town of Pavlopetri. (Abstract ID 12615)

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**QUANTIFICATION OF THE BASIN-SCALE DEcadAL CHANGES IN THE DISTRIBUTION OF OCEANIC INDUSTRIAL CARBON BY EMLR.**

The eMLR method was proposed as a means to estimate the change in anthropogenic carbon in the ocean in the context of data sets that are sparse in space and time. Performance of the eMLR method is tested using a global ocean general circulation and biogeochemistry model where the true signal is known. eMLR results applied to the model fields show that the integrated basin-scale change in the North Atlantic anthropogenic carbon inventory can be estimated to within 10% of the true value. The analyses show that model selection is a function of the observational network as data set variance is influenced by the geographic distribution of the samples available. Best results are obtained when multiple regression formulas are used throughout the water column although different formulas yield results of similar quality allowing for some plasticity with regards to model selection with real data sets. The fact that...
good results are obtained in the dynamically active and hydrographically complex North Atlantic suggests that eMLR can be expected to produce accurate estimates of the change in anthropogenic carbon in other basins. (Abstract ID 12711)

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PRODUCTIVITY IN THE GREENLAND SEA: PRELIMINARY RESULTS FROM AN APEX PROFILING FLOAT

An Apex profiling float was deployed in August 2011 in the Greenland Sea after the spring / summer bloom. The float is equipped with nitrate, oxygen, and bio-optical sensors for chlorophyll fluorescence, and optical backscatter. It will profile to 1000 m every five days / summer bloom. The float is equipped with nitrate, oxygen, and bio-optical sensors for chlorophyll fluorescence, and optical backscatter. It will profile to 1000 m every five days.

(Abstract ID 10682)

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ORIGINS OF FEATURES IN WAVE номер-FREQUENCY SPECTRA OF SPACE-TIME IMAGES OF THE OCEAN

Wave-number-frequency spectra from Doppler radars show energy along the ocean wave dispersion relation and additional energy that lie above and below this relation. We show that the strongest of these additional features are not due to second-order interactions or wind turbulent eddies. Rather, the behavior of these features can be explained by the interference of long ocean waves, which cause short gravity waves to break near local maxima of surface slope. Doppler spectra indicate that maximum speeds reached by water parcels on the sea surface are less than 5 m/s, much lower than the phase speeds of the dominant waves but consistent with short gravity wave phase speeds. The most likely speed of these parcels is about 3 m/s, close to the speed of the linear feature in the wavenumber-frequency spectrum. We therefore suggest that the short gravity wave most likely to break is the one whose phase speed nearly matches the speed of the slow interference pattern that causes the linear spectral feature. (Abstract ID 9791)

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DIETARY HISTORY AND LIPID RETENTION IN BERING SEA EUPHSAUSIDS – A SEASONAL STUDY

Euphausiids are an essential link between lower trophic levels and larger predators including seals, walruses, seabirds, and commercial fishes. In the Bering Sea, the transition from spring bloom to summer is accompanied by substantial changes in the prey available for consumption, particularly at the lowest trophic levels. As part of the Bering Sea Ecosystem Study, shipboard pulsed feeding experiments were conducted with the netic euphausiids Thyasira raschii to explore the diet history and seasonal lipid retention by krill in this dynamic system. Individual lipid biomarkers and lipid classes were followed over multiple seasons and included periods of starvation to infer both food quality and nutritional impact. Changes in the suite of lipids, including wax esters and tocopherols, were apparent between spring and summer; additionally, a fatty acid (C28:8) specific to prymnesiophytes and dinoflagellates was only observed in summer. Shipboard feeding found that euphausiids quickly incorporate specific lipid markers after starvation with selective retention over time, especially among essential fatty acids. (Abstract ID 10593)

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A COMPARISON OF FLUVIAL AND AEOLIAN TRANSPORTED BLACK CARBON TO DEEP MARINE SEDIMENTS IN THE EQUATORIAL ATLANTIC

BC is a resistant form of organic carbon that is ubiquitous to the marine environment since it is a byproduct of the incomplete combustion of biomass and fossil fuel burning. BC is deposited into the ocean through fluvial and Aeolian transport, but the magnitude of these two pathways has not been well studied since fluvial deposition is presumed to be the main mechanism. Two cores were analyzed for BC using an IRMS. Core 1a is situated in the fan of the Amazon River. The BC accounted for 35.5-91.6% of the total organic carbon (TOC) with the TOC and BC having an average δ13C of -21.0 and -31.5‰, respectively. Core 9a was taken in the open equatorial Atlantic basin, away from fluvial influence (07'26.721'N, 24'00.376'W). BC accounted for 20.3-49.9% of the TOC with BC and TOC having an average δ13C of -18.0 and -26.3‰, respectively. While Amazonian River deposition is a significant contributor to BC to marine sediments, Aeolian transported BC is still an important fraction that is needed in mass balance evaluations. (Abstract ID 10394)

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MORPHOLOGICAL PROPERTIES OF THE ICE IN THE CHUKCHI AND BEAUFORT SEAS DURING THE 2010 AND 2011 ICESCAPE MISSIONS

The Chukchi and Beaufort seas have been the site of tremendous changes in the makeup and morphological properties of the sea ice cover over recent decades. Historically predominant thick, old multyear ice has been increasingly replaced by relatively thin first year ice. The
seasonality of melt, patterns of ice transport, timing of ice retreat, and dynamics of melt pond formation have all changed as a result, with impacts on the freshwater, light, and energy budgets of the region. In transit, on ice, and remote sensing observations from the 2010 and 2011 ICESCAPE missions are presented and compared with historical observations in the region to quantify these changes. Detailed characterization of ice thickness, melt pond coverage, ice deformation, and the spatial variability of the ice surface conditions in the region are discussed, with focus on the aspects of change having close relevance to biochemical systems. (Abstract ID 11774)

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INTRASEASONAL WAVES IN THE EQUATORIAL ATLANTIC

Intraseasonal westward propagating signals in the tropical Atlantic have been associated to tropical instability waves, short Rossby waves, and vortices. Surface larvalan flagellate data were combined with satellite altimeter and model wind data to produce time series of geostrophic velocity vector maps. Six cross-basin longitudinal sections between 10°S and 10°N were selected based on the zonally averaged velocity, its shear or variance. At these sections periodic fluctuations of the zonal and meridional surface velocities are analyzed in terms of zonal propagation velocity, period, wavelength, amplitude and variance. Seasonal modulation of the intraseasonal fluctuations is clearly observed. The spatial distribution of these anomalies is studied from the reconstruction of the filtered signals, focusing on specific regions of the spectrum. In that, planetary wave fronts are distinguished from vortices. The vertical reach of the oscillatory signal is quantified with Argos profiler data, as well as the Rossby radii of deformation. (Abstract ID 10634)

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NEW INSIGHTS FROM COMBINED THEORY, MODELLING AND OBSERVATIONS INTO MACRO-TIDAL RESIDUAL CIRCULATION

Liverpool Bay is a macro-tidal shallow sub-section of the semi-enclosed Irish Sea, where the UK National Oceanography Centre maintained a multiple platform, multidisciplinary ocean science Observatory for 10 years. This work develops classical theory on the residual circulation to show that the residual circulation is better constrained by knowledge of the surface velocity than the freshwater flux. This is then used to (i) explain the spatially varying nature of the ADCP derived residual circulation profiles (ii) assess the source of errors in high resolution coastal ocean simulations of the residual circulation, (iii) propose a new technique for extracting added value from long term mean HF radar and CTD survey data to infer depth, and spatially, varying residual velocities. This product would be prohibitively expensive to directly measure with multiple moorings, and is not well represented in numerical models. (Abstract ID 11717)

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RESPONSE OF ORGANIC CARBON ACCUMULATION IN ENGLERIGHT LAKE, CA TO CLIMATE AND ANTHROPOGENIC IMPACTS IN THE WATERSHED

On an annual basis the amount of organic carbon (OC) stored in lakes and reservoirs is comparable to the amount delivered by rivers to the coastal ocean. Recent studies have shown that the construction of dams and impoundments reduced the amount of sediment accumulating in estuaries and coasts, implying that the delivery of carbon and materials associated with sediments should be similarly reduced. This study focused on sediments accumulating behind the Englebright Dam in northern California in order to characterize changes in OC signatures related to watershed management and climate changes throughout the existence of this reservoir. Grain size and radiocarbon dating were used in combination with measurements of organic biomarkers and stable isotopes to determine sediment and OC accumulation in Englebright Lake. Stable isotopic data suggest a response to the type of deposition (e.g., bottomset or foreset) and anthropogenic impacts, while organic biomarker concentrations show a strong response to climatic forcings. This presentation will focus on relationships between sediment and OC accumulation resulting from land-use and precipitation changes in the Englebright Lake watershed. (Abstract ID 10834)

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AN ASSESSMENT OF DEEP STERIC HEIGHT VARIABILITY OVER THE GLOBAL OCEAN

An ocean state estimate constrained by most available data is explored to assess characteristics of variability in deep steric height --- a mostly unobserved quantity; yet important for understanding the relationship between sea level, heat content and other ocean climate parameters. Results are based on monthly-averaged steric height anomalies, vertically integrated over the “unobserved” deep ocean (below ~1700 m). Excluding linear trends, variability in deep steric height is typically 10–20% of that in the upper ocean, with larger values seen in extensive regions. Enhanced deep variability, at monthly to interannual time scales, occurs in areas of strong eddy energy. Deep signals are mostly thermoclinic in nature, with halosteric contributions tightly correlated and generally compensating the Atlantic and Indian oceans and adding in the Pacific. Potential inference of deep signals from knowledge of the upper ocean is hampered by poor correlations, and regressions based on upper-ocean steric height fail to represent the estimated deep variability. Results are discussed in the context of designing an ocean observing system capable of determining deep steric height variability and long term trends. (Abstract ID 11274)

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GRADIENTS IN INTACT POLAR MEMBRANE LIPIDS ACROSS THE MEDITERRANEAN SEA ARE RELATED TO PHOSPHATE AVAILABILITY

Intact polar membrane lipids comprise a significant fraction of cellular material in plankton and the relative abundance of different lipid headgroup classes contributes to the variation in cellular demand for carbon, nitrogen and phosphorus. It has previously been shown in cultures that in low phosphorus conditions some plankton species are capable of increasing the ratio of non-phosphorus lipids to phospholipids in their membranes as an adaptation to phosphorus stress. As a part of the Biogeochemistry from the Oligotrophic to the Ultraoligtrophic Mediterranean cruise we examined the distribution of several classes of intact polar dicylglycerolipids (IP-DAGs) across the Mediterranean, and found that phospholipid concentration as a percent of total lipids correlated with phosphate concentration. Additionally, microcosm incubations were amended with phosphate and ammonium which elicited a shift in the ratios of IP-DAGs. These experiments were used to assess the relative contribution of community shifts and physiological response to the observed variation in IP-DAGs across the Mediterranean. This study is the first to demonstrate the dynamic response of membrane lipid composition to changes in nutrients, in a natural, mixed planktonic community. (Abstract ID 12110)

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Effective conservation strategies for migratory species must incorporate information about movements and locations of high-use foraging areas. We used satellite telemetry, bulk epidermis, and compound-specific nitrogen isotopic analysis of amino acids (AA-CSIA) to reveal divergent migratory strategies and within-population segregation of foraging groups of critically endangered leatherback turtles (Dermochelys coriacea) across the Pacific Ocean. Bulk skin δ^15N values showed strong bimodal distribution with distinct low δ^15N and high δ^15N groups. When linked with telemetry results, all turtles tracked to the eastern Pacific were within the high-δ^15N group, whereas all but one turtle moving to western Pacific sites were in the low-δ^15N group. AA-CSIA revealed that trophic position was the same for turtles foraging in the eastern and western Pacific and that the biomass in bulk skin δ^15N values resulted from differences in isotopic composition of source nitrogen at the base of the food web. Isotopic compositions provide information on foraging area before nesting, whereas satellite telemetry pinpoints areas leatherbacks used after nesting, indicating that leatherbacks returned to the same ocean region from where they originated prior to nesting. (Abstract ID 12030)

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SEDIMENTARY ENVIRONMENTS AND PROCESSES OFFSHORE IN EASTERN LONG ISLAND SOUND

Multibeam bathymetry data originally collected during NOAA hydrographic survey H11997 and the sea-floor sampling and photography stations occupied to verify them reveal sealed composition and terrain, 2) provide information on sediment transport and benthic habitat, and 3) are part of an expanding series of studies providing a fundamental framework for research and management activities in this major East Coast estuary. The funnel-shaped geometry of the eastern Sound constricts tidal flow, producing currents of greater strength, coarser grained sediments, and sedimentary environments characterized by erosion or non-deposition. Evidence for high-energy conditions revealed by the multibeam bathymetry include bedrock outcrops, ledge deposits of boulders on the submerged flanks of a moraine, deep scour depressions, and a gravel pavement that arms the sea floor throughout much of the eastern study area. Sedimentary environments characterized by coarse bedload transport and sandy sediments become more prevalent where tidal-current speed decreases westward as the Sound widens. A large field of transverse sand waves with waves exceeding 30 m in relief stretches across the western study area. Smaller fields of transverse and barchanoid waves are also present in this region. Sand wave orientation and asymmetry indicate predominant net westward sediment transport, and the presence of ripples and megaripples on the stoss slopes of bedforms indicate that transport is active. (Abstract ID 9309)

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DISTRIBUTION OF THE TOTAL DISSOLVED COPPER ALONG THE LINE P TRANSECT OF THE NORTHEAST SUBARCTIC PACIFIC OCEAN

Copper (Cu) is a bioactive trace metal required for a suite of physiological processes in marine biota with a particular nutritional role in iron (Fe) limited phytoplankton (Annett et al. 2008, Semeniuk et al. 2009), Biological availability of Cu is strongly dependent upon its speciation, which in the oceanic surface waters is dominated by complexation with strong organic ligands (Cu-L). The focus of this study is to establish the speciation of Cu along the line P transect in the northeast Pacific including the concentrations of the total dissolved copper (CuTOT), labile Cu, Cu-L as well as the stability constants of Cu binding ligands (logK). The area of study presents a natural Fe availability gradient from coastal waters to the offshore Fe limited station (USP), and has been the focus of the longest historical time series programme in the west coast region. Using a flow injection analysis (FIA) method, we measure the total dissolved Cu from vertical profiles (22 depths, 0-2000) at five major stations along the line P. Some preliminary results on the Cu binding ligands will also be presented. (Abstract ID 12661)

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AN INTERACTIVE MAP AS SCIENTIFIC AND OPERATIVE TOOL FOR OCEANOGRAPHIC AUTONOMOUS OBSERVATIONS, NETWORKING AND OUTREACH

Working within the field of Marine Bio-geochemistry and -optics, the OAO (Oceanographic Autonomous Observations) team uses and develops automatic platforms. These comprise gliders and profiling floats together with their scientific payloads. Amongst the various advantages of such new technologies: the possibility to be deployed even in remote oceanic areas and the ability to provide multiple datasets in near real-time. Within the context of OAO’s ongoing national/international projects, thus occurred the need to facilitate the handling of large datasets or with respect to the spatio-temporal resolution as well as their accessibility by visualization. To meet these objectives, an (online) interactive global map has been designed. This map allows to display each instrument with detailed information together with its acquired data. Several features included (e.g. satellite and modeling layers) help to operate these observation systems, to react quickly if necessary or required and to interpret the data. The interactive map has already proven to be a useful tool within the network of collaborating scientists, and is more and more used and adapted as a way to outreach to non-scientists. (Abstract ID 11154)

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CASE STUDY FOR IOOS DATA INTEGRATION: NEARSHORE CONDITIONS AT WAIALAE-KAHALA BEACH PARK, OAHU

The Integrated Ocean Observing System (IOOS) regional association for Pacific Islands, PacIOOS, maintains a wide array of data services that provide real-time and archived data streams for the region. The data and data services adhere to national standards, and this allows for more straightforward data integration. As a practical example, influences on near-shore water quality at a public beach on the southeast coast of Oahu, Hawaii were examined
by combining data and numerical model output from a variety of sources. Water quality measurements of turbidity, alkalinity, salinity and fecal indicator bacteria (FIB) were analyzed. It was found that wave energy accounted for the strong seasonal trends in water turbidity from 2005 to 2009, while precipitation events accounted for the spikes in turbidity. Quantitative estimates of two FIB, enterococci and Clostridium perfringens, indicate correlations with rainfall and turbidity data but not the seasonal wave forcing, such that extreme rainfall, turbidity, and high concentrations of bacteria coincided. Therefore, while this beach does exhibit relatively high turbidity, the seasonal variations do not pose as harmful a threat as the episodic events. (Abstract ID 10707)

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UPPER OCEAN RESPONSE TO TYPHOONS DURING THE 2010 SEASON

As part of the Impact of Typhoons on the Ocean in the Pacific (ITOP) campaign, two deep-sea moorings were deployed in the Philippine Sea. Each mooring consisted of an Air-Sea Interaction Spar (ASIS) buoy tethered to an Extreme Air-Sea Interaction (EASI) buoy, which was anchored to the seabed. Atmospheric and oceanographic instruments fastened to each recorded the dynamics of the marine boundary layer (MBL) above and below the surface of the ocean during the 2010 Pacific typhoon season. Various stand-alone instruments monitored ocean temperature and pressure, and current velocity and direction to depths of 500m for 85 days. The moorings were subjected to wind speeds over 30 m/s and significant wave heights up to 10m through exposure to 4 major typhoons: Dianmu, Fanapi, Megi, and Chaba. The response of the upper ocean to these typhoons will be discussed, with a focus on changes in surface sea temperature (SST) and mixed layer depth resulting from cold winds. Results will be validated by comparisons with conductivity, temperature, and depth (CTD) measurements, expendable bathythermograph (XBT) measurements, and models. (Abstract ID 10295)

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SURFACE CURRENTS IN THE NORTHEAST CHUKCHI SEA

Surface currents representative of the upper 2 m of the water column were measured over a 30,000 km² area in the northeast Chukchi Sea by High Frequency Radar from September - November 2009 and July - November 2010. The radar mask captures both the Aleaskan Coastal Current (ACC) and the shelf farther offshore, including the southeastern flank of Hanna Shoal. Intra- and inter-annual differences suggest a highly dynamic and complex flow structure. Flow variability is a maximum and along-shore polarized within the ACC but weaker with little polarization offshore. The cross-shore correlation scale of the alongshore velocity is ~35 km, consistent with the width of the coastal current. The mean September-October ACC surface flow is southwest under calm winds, in contrast to historical subsurface current records, which show mean northeast flow. At the head of Barrow Canyon the flow often has large relative vorticity (Rossby number ~0.5) and divergence and is the site of short-lived, cyclonic, 30 km-wide eddies. Interannual differences and surface transport estimates for 2009 and 2010 will also be presented. (Abstract ID 11885)

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CONTEMPORANEOUS OBSERVATIONS OF MESOSCALE AND SUBMESOSCALE PROCESSES WITH DRIFTERS AND A GLIDER

As part of the Ligurian Dispersion Experiment (LINDEX10) surface drifters and a glider were operated contemporaneously to measure the surface mass properties and currents in the southern Ligurian Sea and northern Tyrrhenian Sea in summer 2010. The instruments were released in the vicinity of a front associated with the Arno River plume in very small clusters in order to study mesoscale and mesoscale processes. The deployment locations were fine-tuned by using data not derived from in-situ CTD casts, from the available satellite images and from the outputs of a circulation model. The drifters and glider were operated for about two weeks, during which the glider route was continuously modified during the frequent surfacings in order to collect nearly contemporaneous information of the water column below the majority of drifters. The drifters headed southward and mainly explored the sea north and east of Elba Island. (Abstract ID 10373)

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PHENOLOGY OF PLANKTON DURING A TEN YEAR STUDY IN BOOTHBAY HARBOR, MAINE USA

Time series observations are necessary to determine concurrent ecological responses to climate variability and change. Weekly high-tide observations of phytoplankton, bacterioplankton, and eukaryotic heterotrophs were made between 2001 and 2011 in Boothby Harbor, Maine using imaging-in-flow and flow cytometry. Strong seasonal patterns emerge in these populations and chlorophyll a that correlate with changes in temperature and the onset of the spring and fall phytoplankton blooms. Over this ten-year period different trends were observed among the plankton groups. Synedrosos, pico-eukaryotes (2-20µm), cryptophytes, and heterotrophic eukaryotes all increased in abundance, with the largest positive anomalies observed between 2009-2011. Since 2002 and 2007, positive trends have been observed in sea surface temperature and chlorophyll a, respectively. The variability in the seasonal timing among these different plankton groups could be due to changes in local physical forcing or climate warming. Mismatches synchrony between trophic levels due to changes in seasonal timing of primary production may alter recruitment success of higher trophic level species (Ji et al. 2010). These data provide a basis for future modeling of planktonic organisms capable of tracking changing environmental conditions. (Abstract ID 11863)

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OVERVIEW OF SATELLITE OBSERVATIONS AND THEIR EFFECTIVENESS IN OPERATIONAL MODELING

In the past decade, variational state estimation methods have been used by Numerical Weather Prediction centers around the world and are now becoming a crucial component in ocean modeling. These methods combine near real-time observations with predictive models to provide superior estimates than either alone. The Integrated Ocean Observing System (IOOS) was initiated by NOAA for these integration efforts, and satellite observations provide the bulk of near-real-time operational observations. One important aspect of any system is evaluating its operational effectiveness. In solving the state-estimation problem, the dynamical covariance between the observations is computed with the full model dynamics, whilst the impact of each observation is used to determine the relative importance of different observations to the ocean estimate. In this overview, I will present how these models and real-time observations are fully integrated into operational use and present methods and results of how the impact of individual observations on the ocean estimate is determined. Several overview regions and dynamical scales will be shown from planetary scale in the Atlantic down to sub-mesoscale around Hawaii. (Abstract ID 9345)

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THE USE OF AUTONOMOUS GLIDERS TO OBSERVE CROSS-FRONTAL CHANGES IN ZOOPLANKTON DISTRIBUTIONS, HABITAT CHARACTERISTICS, AND DIEL VERTICAL MIGRATION BEHAVIOR

Oceanic fronts may be associated with dramatic cross-frontal changes in zooplankton distributions. Abundances, and behavior. Autonomous gliders are good platforms for observing these phenomena due to low-cost, long duration missions that can traverse thousands of kilometers of trackline, recording data at high spatial resolution. Here we present results from the analysis of six years of data from the ongoing CCE-LTER Spray glider program which has deployed gliders nearly continuously along two cross-shore transects in the Southern California Current Ecosystem since 2006, comprising nearly 40,000 km of trackline. We focus on oceanic front crossings as observed in the glider data (CTD, fluorometer and acoustic backscatter (750 kHz)) and examine the hydrographic properties of fronts that are associated with changes in zooplankton distributions and diel vertical migration behavior. We also examine cross-frontal
changes in zooplankton habitat characteristics as seen in cross-frontal changes in vertically integrated chlorophyll-a fluorescence, depth of the deep chlorophyll maximum, and modeled water clarity. The seasonality of physical and biotic fronts is addressed. (Abstract ID 10808)

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SPATIOTEMPORAL VARIABILITY OF THE PHOTOCHEMICAL EFFICIENCY OF CO2 AND CO PRODUCTION IN THE NORTHERN GULF OF MEXICO: ESTIMATING THE IMPACT ON CARBON CYCLES

The Northern Gulf of Mexico is a dynamic environment, receiving enormous and variable inputs of terrigenous organic matter from the Mississippi River System. Understanding the carbon cycle and processes regulating air-sea carbon fluxes in this region requires investigation of the multiple controls on this system. To this end, we investigated the photochemical production of both CO2 and CO from sixty samples collected on four research cruises during 2009-10. For each sample, an apparent quantum yield (AQY) spectrum, defined as the molar ratio of photochemical product (CO2 or CO) to photons absorbed, was determined from laboratory irradiation experiments. The variability of AQY spectra was assessed based on seasonal and spatial scales and on water optical properties to define AQY spectra appropriate for this region. AQY spectra were used to calculate photochemical CO2 and CO production for estimation of the impact of photochemical oxidation on carbon cycles in this river-impacted marine system and to compare results with studies from different oceanic environments. (Abstract ID 12672)

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BOTTOM TOPOGRAPHY MAPPING VIA ASSIMILATION OF SEA SURFACE HEIGHT DATA

A data assimilation method has been developed to combine existing bathymetric data, sea-surface height measurements from satellite altimeters, and hydrodynamic constraints to create more accurate and dynamically-constrained gridded bottom topography maps. The approach has been evaluated with an identical twin experiment in the region around the Taiwan Strait, in which Smith and Sandwell v12.1 topography is taken as the true topography to be reconstructed, starting from ETOP02 v2. By using a barotropic shallow water model to assimilate SSH data along Jason-1, Jason-2, and ERS ground tracks, we can substantially improve the bottom topography while bringing the modeled SSH into agreement with the observations. The results demonstrate the potential of using hydrodynamic constraints to improve ocean bottom topography, particularly in regions such as the continental shelves where gravimetrically-constrained topography is less accurate. (Abstract ID 12665)

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DELAYED SETTLING OF MARINE SNOW PARTICLES THROUGH SHARP DENSITY TRANSITIONS AND CONSEQUENCES FOR MARINE CARBON CYCLING

Marine snow is fundamental to marine carbon cycling both in its importance in carbon flux from the euphotic zone and because it serves as ‘hot spots’ for microbial activity and organic matter remineralization. Understanding the function of marine snow in carbon biogeochemistry requires knowledge of the small-scale settling dynamics of marine snow particles in different physical environments. We will present data demonstrating that marine snow particles significantly decrease their settling velocity and can even come to a complete stop when passing through sharp density transitions in the water column. Using laboratory experiments with natural marine snow aggregates formed in roller tanks, we describe how the sinking behavior of these particles is determined by their size, composition, shape, and the steepness of the density gradient. This phenomenon can affect the vertical distribution of marine aggregates by allowing the formation of thin marine snow layers following phytoplankton blooms in coastal waters. We will illustrate how these layers can result in locally decreased carbon export and enhanced microbial organic matter remineralization. (Abstract ID 12397)

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WHEN PHOTOCHEMICAL YIELD UNECOUPLES FROM PHOTOSYNTHESIS

The chlorophyll variable fluorescence is widely used as an indicator of phytoplankton physiology and sensitive proxy for photosynthesis and primary production in general. In most cases the correlation between photochemical activity of Photosystem II that is directly monitored by variable fluorescence and the physiological processes holds well. However, there are several known examples of ecophysiological relevance where the correlation breaks and the data obtained by variable fluorescence do not provide quantitative information about the downstream physiology. In these cases the variable fluorescence can still be employed as bioindicator of specific physiological conditions, e.g. of nutrient stress. We will present and analyze several examples of laboratory and field data when the maximal photochemical yield uncoupled from the growth and primary productivity. Our data indicate that this often happens when the phytoplankton is under strong diel forcing, such as synchronized diatom cultures grown on chemostat under nitrogen limitation or diazotrophic cyanobacteria grown in the laboratory bio reactor under the light-dark cycle. Another sort of uncoupling was observed in the field data obtained during the transect along the nutrient gradient (NFe) across the South Pacific Gyre (BIOSCOPE cruise). (Abstract ID L1340)

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THREE-DIMENSIONAL DS ANALYSIS OF STIRRING IN AN OVERTURNING EDDY CIRCULATION

Stirring and mixing in the ocean involves stretching, folding and filamentation of fluid elements. Dynamical systems provide for a very helpful Lagrangian analysis of these processes, one that has been applied successfully to horizontally two-dimensional flow fields. The analysis centers on the calculation of hyperbolic trajectories and their stable and unstable manifolds: so-called Lagrangian Coherent Structures. The analysis applies in situations where the vertical velocity is weak. Our work explores three-dimensional stirring in cases where the vertical velocity is substantial. As a model we use the classical ‘rotating can’ flow, which has a spiraling overturning circulation typical of many ocean eddies. We calculate the three dimensional extensions of stable and unstable manifolds; these form a Lagrangian template for stirring. Chaotic stirring is found in certain regions of the flow field. We compare different methodologies for calculation of the Lagrangian coherent structures and for quantification of the stirring rates. (Abstract ID 9873)

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SEAFLOOR TERRAIN AND SEDIMENT CHARACTERIZATION AT MOLOKAI, LOIHI, AND CROSS SEAMOUNT VIA SEAFLOOR MAPPING

The seafloor around Hawaii has a wide range of terrains, dominated by many different processes of sediment erosion and deposition. To examine the application of seafloor mapping and analysis in the study of seafloor terrain, research was conducted aboard the R/V Thomas G. Thompson using Kongsberg Simrad EM302 20-kHz Multibeam Echosounder, data analysis via Caris’ and ArcGIS, surface sediment sampling by Shipek grab sampling and sediment grain-size analysis. Ten locations were sampled across three survey regions: Molokai, Loihi, and Cross Seamount. ArcGIS analysis produced values for scale and bathymetric position index (BPI) over both large and small scales. Sand dominated locations had slope values 10–34 degrees; while clay dominated locations had slope values 11–31. All sediment types were found over locations classified as ridges, valleys, slopes, and flat regions based on the BPI. There was no significant correlation between sediment grain-size and terrain characteristics. Without further study, consisting of more sampling locations over a wider range of bathymetric features and terrain characteristics, this method of bathymetric sediment and terrain analysis cannot accurately predict sediment type. (Abstract ID 10545)

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EFFECTS OF OCEAN ACIDIFICATION ON REPRODUCTIVE PROCESSES OF THE MARINE PLANKTONIC COEPOID CALANUS FINMARCHICUS

Calanus finmarchicus is a dominant species of copepod in the North Atlantic and a
fundamental link in marine food webs across its range. This project investigates whether higher CO2/lower pH at expected future levels will cause a significant decrease in C. finmarchicus egg hatching success. Eggs were exposed to seawater of varied pH ranging from 8.0 (ambient) to 6.5. Experiments consisted of a control and up to 5 treatments maintained by bubbling a gas mixture of CO2, N2, and CO2 at a predetermined rate. Females were sorted from the catch of zooplankton from nearby Gulf of Maine coastal waters and incubated for 24 h to obtain eggs. Replica batches of eggs were placed into dishes with 80 µm mesh lids to allow for water exchange. Results from 5 trials indicate that seawater with pH as low as 7.10 has no significant effect on the hatching success. At pH 6.5, however, hatching success drops to 0%. Our next objectives are to determine more precisely the critical pH at which hatching success drops off and to evaluate treatment effects on nauplius viability. (Abstract ID 11801)

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**MICROZOOPLANKTON COMMUNITY STRUCTURE AND GRAZING IMPACT ALONG THE WESTERN ANTARCTIC PENINSULA**

Microzooplankton play a key role in the structure and functioning of ocean food webs, yet relative to microzooplankton there are few studies of microzooplankton in the Southern Ocean. We describe microzooplankton taxonomic distribution and grazing rates along the western Antarctic Peninsula (WAP), a region of rapid climate change, in the austral summers of 2010 and 2011. Major taxa of microzooplankton (e.g. ciliates, heterotrophic dinoflagellates) in whole water samples and larger protozooplankton (e.g. radiolarians, foraminifera) from vertical net tows were enumerated with microscopy. Grazing rates were measured by the dilution technique and using flow cytometry. Changes in abundance and biomass of the major microzooplankton taxa occurred with distance from shore and with depth, as well as along latitudinal gradients. Grazing rates on phytoplankton ranged from 0.10 – 0.56 d−1, removing 30 – 153% of the potential primary production. Grazing rates on bacterioplankton ranged from 0.05 – 0.63 d−1, removing 42 – 200% of the potential bacterial production. Microzooplankton selectively grazed on high nucleic-acid content bacteria. These results highlight the importance of micrograzers in this region and the complexity of the WAP food web. (Abstract ID 9945)

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**CAPTURING STOMMEL’S DEMON WITH A GLOBAL WATER MASS ANALYSIS**

We use hydrographic data from the 2009 World Ocean Atlas and the GLODAP database to perform a global water mass analysis. The inversion methodology combines the maximum entropy deconvolution method with a prior constructed from a steady-state data-assimilated circulation model. The analysis provides a quantitative estimate of where and at what phase entropy deconvolution method with a prior constructed from a steady-state data-assimilated circulation model. The analysis provides a quantitative estimate of where and at what phase.
conditions, mechanisms and variability of FW accumulation and release in the BG region, and the sensitivity of these processes to atmospheric and ocean circulation regimes, ocean mixing, changes in the FW sources (rivers, precipitation, ocean straits), and sea ice and atmospheric thermodynamic conditions. In this presentation we analyze historical and recent observational changes in the FW sources (rivers, precipitation, ocean straits), and sea ice and atmospheric the sensitivity of these processes to atmospheric and ocean circulation regimes, ocean mixing, TOS/AGU/ASLO 2012 Ocean Sciences Meeting

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POST-ERUPTIVE HYDROTHERMAL CONTRIBUTION TO THE WATER COLUMN ABOVE AXIAL SEAMOUNT

In April 2011 Axial Seamount erupted along the south rift zone from the east wall of the caldera down 9km of the southern flank. Two expeditions, a NOAA NeMO cruise in July and an OOI-RSN cruise in August, conducted water column sampling campaigns at Axial to assess the magnitude and composition of the hydrothermal plumes associated with the known vent fields and newly erupted lavas. The deep water column signal was characterized by profile measurements of temperature, beam attenuation, light backscatter, and oxidation-reduction potential (Eh); this data was augmented by discrete water sample measurements of H2, CH4, 3He/4He, and bacterial abundance (counts). At three and four months after the eruption no megaplumes were detected, as the plumes were 30-100 meters thick with typical rise heights of 75-150m. However, a water column signal derived from snowblower vents driven by post-eruption enhanced hydrothermal circulation was observed, as were elevated methane concentrations 5-20 meters off bottom, presumably associated with widespread diffuse flow. The profile data collected shipboard by the OOI-RSN is publicly available at www.interactiveoceans.org. (Abstract ID 11285)

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IMPROVING SCIENCE COMMUNICATION IN COMPLICATED, STAKEHOLDER INVOLVED, OCEAN AND COASTAL MANAGEMENT PROCESSES

Climate change adaptation, coastal and marine spatial planning, ecosystem-based management, adaptive management. All these techniques rely heavily on huge data sets, complex scientific models, and the involvement of stakeholders. Success will be achieved not just on our ability to communicate scientific knowledge to non-scienists, but also on how well we integrate science into these high-stakes planning processes. The Marine Life Protection Act Initiative has often been called innovative for the way it incorporated science into such a large-scale, public-participation-heavy planning process. But in southern California, it appears to have fallen short of both the management and public involvement goals (the planned MPA network does not meet minimum science guidelines and a subset of the stakeholders involved are suing to prevent the MPA network from going into effect). This presentation will take the audience inside the southern California process to demonstrate how the science was used and share a stakeholder’s insight on how it could be improved. (Abstract ID 10059)

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APATITE DISSOLUTION RATES AS A FUNCTION OF GRAIN SIZE

Permeable reactive barriers (PRBs) are a promising method for immobilizing uranium in groundwater. One material under evaluation for use in PRBs is apatite, due to its high sorption capacity for trace elements, widespread availability, and low cost. Previous studies have shown that groundwater that interacts with uranium- and apatite-bearing formations contain a much lower concentration of uranium than expected, due to the formation of autunite, a uranyl phosphate mineral that is sparingly soluble. Autunite formation is thought to occur in the leached layer of apatite, as phosphate and calcium released from the dissolving apatite react with the uranium. To aid in the design of PRBs for uranium immobilization, batch experiments were conducted to determine apatite dissolution rates as a function of grain size. For the experiments, three grain sizes of apatite (190µm-325µm, 250µm-425µm, 425µm-84µm) are being used. Calcium and phosphate concentrations are measured in solution at specific time intervals during the eight hour experiment. Using calcium as the reaction progress variable, we aim to determine apatite dissolution rates with the initial rate and the derivative methods. Calculated dissolution rates will then be regressed against grain size to determine if there is a relationship. Data collected from this project can be used to determine the most efficient size of apatite for constructing an effective PRB for uranium immobilization. (Abstract ID 9411)

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"TH-PU DISEQUILIBRIUM ALONG THE WESTERN ATLANTIC OCEAN DURING GEOTRACES AG02 AND POC EXPORT FLUX ESTIMATES

This is commonly used as a proxy for oceanic sinking particulate organic carbon fluxes. Here, almost 60 vertical profiles were sampled along the AG02 section in the western Atlantic from 64ºN to 50ºS in 2010 and 2011, along with measurements of Fe, Al, Mn, and ligands. AG02 is characterized by a variety of hydrographic structures, areas affected by significant dust inputs, and different biological productivity regimes. Our results show an apparent deeper deficit of "TH at high latitudes, possibly related to Labrador Sea Water associated with North Atlantic Deep Water formation. Trace metal data suggests inputs of Saharan dust at about 20ºN that are not reflected by a deficit of "TH versus "PU. However, a clear depletion of "TH in the upper 50 m is observed at about 15ºN as a consequence of Orinoco River influences. Extensive particle remineralization is suggested by excess "TH at 400-600 m depth around 25ºS. In the southern hemisphere, the "TH deficit was largest in the subpolar and equatorial regions and smaller in the subtropical gyre and mirrors fluorescence throughout the upper 200 m. (Abstract ID 11677)

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INTRASEASONAL VARIABILITY IN MAKASSAR STRAIT: FLOW INSTABILITY-GENERATED EDDIES AND REMOTE WIND-FORCED INTERNAL KELVIN WAVES

Moored data across the thermocline and greater depths during 2006-2012 are examined to explore the characteristics and genesis of intraseasonal variability in Makassar Strait, the main inflow passage of the Indonesian throughflow (ITF). We identify two main intraseasonal motions featuring in Makassar Strait: monthly eddies and 2-3-month internal Kelvin waves (IKWs). The eddies display their robust signatures beneath the strongest thermocline and are evident in the data as flow fields resembling vortex motions and as vertical displacements of isotherms signifying potential vorticity conservation. Background flow instability in the northern Makassar Strait provides energy for the eddy formation. The IKWs manifest their signatures as equally-partitioned kinetic and potential energy, semi-geostrophic balance between along-strait flow and coriolis, vertically propagating waves, and non-dispersive dispersion relation. Within thermocline, the equatorward IKWs penetrate the ITF transport for up to 2 S. The IKWs are not locally generated but remotely forced by intraseasonal winds over the equatorial Indian Ocean, which are frequently coincident with strong Madden-Julian oscillation phases. (Abstract ID 10832)

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A KERGUELLEN REGIONAL SEA LEVEL PRODUCT TO SUPPORT THE KEOPS2 EXPERIMENT

The KEOPS2 campaign (P. S. Blain, Observatoire Océanologique de Banyuls sur mer, UPMC) will take place during October-November 2011 around Kerguelen Islands. The aim is to elucidate the response of ecosystem functioning and of the biogeochemical cycles to natural iron fertilization, a key factor controlling ecosystem dynamics (including CO2 export) in the Southern ocean and other basins. It is a multidisciplinary campaign heavily relying on high quality satellite data. A specific support from CNES will enable KEOPS2 to benefit from such products, both in real time and delayed time production. CNES contributes its skills and knowledge, via Salto/DUACS project and in collaboration with LEGOS, to specifically

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process altimeter products and derives for Kerguelen area. They consist in Mean Dynamic stratification via surface freshening and run-off from the mountains. Spatial patterns of rainfall patterns in the Philippines region. In particular, episodic wind surges that are frequent during the northeast monsoon serve to enhance and detach counter-rotating eddies in the ocean adjacent to the islands of Luzon and Mindoro. The release and westward propagation of these mesoscale dips has been modeled in our high-resolution coupled simulations, and observed by satellite. In addition, an oceanic dipole pair was surveyed during the Intensive Observational Period (IOP) research cruise in winter 2008 as part of the Philippines Straits Dynamics Experiment (PhiEx). The role of the different orientations of the wind (easterly surge vs. northerly surge) has been examined and multiple dipole eddy cases have been accumulated over several seasons. We will compare and contrast the different cases with reference to in situ and satellite observations, as well as the model fields. In addition, a comprehensive set of meteorological station data at over 50 sites throughout the Philippine islands is probed to examine patterns in rainfall and winds during November 2007- March 2008. Precipitation was at a 40-year high during that winter, which impacted the near-surface ocean by increasing the stratification via surface freshness and run-off from the mountains. Spatial patterns of rainfall are examined and compared with high-resolution two-way coupled model results. (Abstract ID 12068)

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A SLOW DOWN OF ANTARCTIC BOTTOM WATER PRODUCTION AND CIRCULATION BETWEEN THE 1980S AND 2005
We quantify a statistically significant reduction in Antarctic Bottom Water (AABW) volume within the Southern Ocean and along the deepest, southern limb of the Meridional Overturning Circulation (MOC) between the 1980s and 2000s. AABW has warmed globally during that time, contributing roughly 10% of the recent total ocean heat uptake. This warming implies a global-scale contraction of AABW. We estimate rates of change in AABW-related circulation in most of the world’s deep basins by finding average volume losses or gains within them for the colder potential temperature classes using all available repeated hydrographic sections. The Southern Ocean is losing water below 0°C at a rate of 8.2 ± 2.6 Sv. This bottom water loss causes a descent of isotherms throughout much of the water column until a near-surface recovery, apparently through a surge of Circumpolar Deep Water from the north. Lesser deep losses of AABW are also seen along three of the four northward outflow routes of AABW, suggesting a global scale slowdown of the bottom limb of the MOC. (Abstract ID 9660)

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COUPLED OCEAN-ATMOSPHERIC INTERACTIONS AND LOCAL IMPACT OF MESOSCALE SST ON ATMOSPHERIC BOUNDARY LAYER ALONG KUROSHIO CURRENT SYSTEM
We examine the air-sea interactions and impact of local mesoscale sea surface temperature (SST) features in the Kuroshio Current system using the Scripps Coupled Ocean-Atmosphere Regional (SCOAR) model. Satellite observation studies have shown that in this region, there is a tight coupling between SST gradients and wind stress derivatives, as well as significant coupling between sea level pressure anomalies with wind convergences, and the SCOAR model has reproduced many aspects of the observed coupled processes. For investigations to identify the impact of the ocean mesoscale on the atmospheric boundary layer and atmospheric circulation, we implemented a 2-D spatial filter on the SST fields that forces the atmosphere at each coupling step within SCOAR and compared it with the fully-coupled, unsmoothed SCOAR run. The results are important for understanding the effect of mesoscale oceanic feedback on atmospheric stability, overlying winds, and surface heat flux. It also enables us to examine the feedback of downwelled winds that has seen mesoscale SST versus smoothed, large-scale SST, on upwelling intensity and variability, and its impact upon upper ocean heat content and mesoscale eddy statistics. (Abstract ID 11781)

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WHAT DOES THE FOSSIL RECORD OF MARINE MAMMALS TELL US ABOUT THE EVOLUTION OF TOP OCEAN PREDATORS?
Since the Triassic, many different lineages of marine tetrapods have independently invaded marine ecosystems from separate terrestrial ancestors. Most lineages are completely extinct, although those with Cenozoic origins, such as marine mammals, survive to the present day. In an evolutionary view, it is unclear how marine tetrapods have successfully transitioned from ecological nonexistence (terrestrial ancestry) to trophic dominance. Here, I review several examples of approaches that use the fossil record of marine mammals to illuminate broad ecological and evolutionary patterns that would otherwise be unknown from other datasets. These examples include: measuring the fidelity of modern cetacean death assemblages to their source communities to elucidate the spatiotemporal scales of cetacean diversity; studying stratigraphically constrained fossil assemblages in Chile, California and Maryland to chronicle community evolution; using body size proxies in a phylogenetic context to understand the evolution of gigantism in cetaceans and pinnipeds; and plotting the ecological history of gray whale habitats using eustatic sea-level change. These studies highlight the importance of several themes beyond paleontological data, including taphonomy, tectonics, phylogeny and allometry. (Abstract ID 9438)

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GROWTH AND NITROGEN-FIXATION RATES IN LABORATORY CULTURES OF THE DIATOM HEMIAULUS-RICHELIA SYMBIOSIS.
Marine phototrophic N-fixation occurs in a variety of taxa including free-living and symbiotic coccolid and filamentous cyanobacteria. Diatoms-cyanobacteria symbioses are ubiquitous in tropical seas and reach 10⁶ heterocysts L⁻¹ in the mesohaline zone of the Amazon River plume. They appear important in other tropical river plumes as well. However, there are few data to constrain their rates or provide input to models. Using laboratory cultures, we have documented maximum growth rates of 1 d⁻¹ for two species of *Hemiaulus*. N-fixation by symbionts was light dependent with little dark fixation. Maximum fixation rates ranged from 2.4-5.8 X 10⁻⁹ mol N/heterocyst/min, depending on the light acclimation level. Growth and N-fixation fit a hyperbolic tangent function with little evidence of photoinhibition. *Hemiaulus* retained its symbionts in the presence of inorganic N and did not utilize nitrate significantly. The lack of DIN utilization and growth in N-free medium suggests the host diatoms are not competing with asymptotic diatoms for nitrogen sources. The lack of photoinhibition is consistent with the near surface habitat of this group. (Abstract ID 11596)

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OCEAN SURFACE CURRENTS FROM FEATURE TRACKING OF BIODVGENIC SURFACE SLICKS IN SAR INTENSITY IMAGES.
Spaceborne SAR (Synthetic Aperture Radar) offers repeatable weather-independent ocean surface observation capabilities at high spatial resolution. SAR backscatter from the ocean is reduced by biogenic surface slicks. A major source of surface slicks in the coastal regions is due to coastal upwelling and upwelling-related slicks have been observed in SAR images. Since these slicks are advected by ocean surface currents, it is possible to derive surface currents by from their movement. This paper discusses methods for tracking surface slicks in sequential SAR imagery to derive surface currents in the coastal regions. The US West Coast sees upwelling in the summer due to dominant southward alongshore wind flow and is chosen as the region of interest. A prominent difficulty in detecting surface slicks in SAR intensity images is the presence of other physical phenomena that cause low-backscatter, such as low winds, atmospheric gravity waves, atmospheric fronts, and oil spills. A discussion is provided on possible methods to separate surface slicks from these "false alarms." Preliminary results of surface current fields generated from SAR will be shown and analyzed. (Abstract ID 11672)

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USE OF INTERNATIONAL HYDROGRAPHIC OFFICE TIDAL DATA FOR IMPROVED TIDAL PREDICTION.
The International Hydrographic Office (IHO) tidal data bank is being used to improve tidal prediction in coastal areas with complex topography and coastlines using the U.S. Tidal Inversion Software (OTIS). Due to the unknown accuracy of the IHO data and complex or uncertain bottom topography nearby the stations, quality control of IHO data is being done. The first step in this process is to categorize each IHO data site with regard to proximity to rivers, lagoons, man-made harbors, and other factors that might influence tidal elevation. The
second step is to compute quantitative metrics such as water depth, distance to the continental shelf break, and horizontal length scale of station site morphology. Our analysis is comparing modeled and observed tidal in order to develop objective criteria for inclusion of stations in the data assimilation OTIS model, based on the categorical and quantitative station metrics. Our final goal is to find out exactly which gauges will be usable for data assimilation according to model resolution and other factors. (Abstract ID 12413)

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MODELING THE CIRCULATION AND TRANSPORT CONNECTIVITY IN THE INTRA-AMERICAS SEA

The Intra-Americas Sea (IAS) circulation and transport connectivity are investigated using a nested regional ocean circulation hindcast model in conjunction with Lagrangian particle tracking simulations. A 4-year (from 2007 to 2010) regional circulation hindcast is carried out. Model validations against a series of observations (including the Florida Current transport time series, AVISO Sea Surface heights, and ship CTD data) are performed, showing major circulation systems in the IAS including Caribbean Current, Yucatan Current, Loop Current and Loop Current Eddies in the Gulf of Mexico, and the Gulf Stream are all reasonably well simulated. Based on surface current hindcast, particle tracking calculation and connectivity matrix are further used to quantify seasonal characteristics and interannual variability of transport connectivity in the IAS. (Abstract ID 11573)

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IMPACT OF HUMAN ACTIVITIES ON THE COASTAL ECOSYSTEM: A CASE STUDY OF THE NORTHERN GULF OF MEXICO AFTER HURRICANE KATRINA

The population in New Orleans shrank by nearly 50% immediately after hurricane Katrina in August 2005, and then increased by ~60% in the past five years. Such a rapid increase in population and associated activities offer a rare opportunity to study the influence of human activities on the coastal environment. In this study, using satellite-derived information of water clarity, zooplankton and organic/inorganic particles, we evaluated the change of the coastal ecosystem in the Northern Gulf of Mexico before and after hurricane Katrina, and evaluated the relation between the change and the discharge measurement of New Orleans. Our preliminary results suggest that human impact on the coastal ecosystem can be minimized as long as adequate management plans are implemented. (Abstract ID 16583)

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INTERNAL TIDE GENERATION WITHIN THE GEOSTROPHIC BACKGROUND

Internal tides and geostrophic motions are two types of general phenomena in the ocean, although they occur on different scales. In the South China Sea, internal tides are generated from the interaction of barotropic tides with the irregular topography of Luzon Strait, and then evolve into internal solitary waves in deep water. Coincidently, the Kuroshio, the west boundary current of the Pacific Ocean, passes through the east of Luzon Strait, causing thermocline tilting and flow intrusion. The Kuroshio intrusion is apparent and constantly exists in winter. Previous observations in the South China Sea show variable internal wave responses to different hydrologic conditions in Luzon Strait. In view of this, we use linear theories to investigate internal tide generation within the geostrophic background. Thermocline tilting due to a longitudinal geostrophic flow causes asymmetric internal tide generation in transverse, which is one of the reasons why internal wave signatures are seldom observed on the east side of Luzon Strait. The local internal wave speed turns out to be a key parameter to determine the asymmetric generation of internal tides. The analysis also reveals the Doppler effect caused by flow intrusion. Finally, a regional numerical model is applied to Luzon Strait in order to verify the above results and further examine the nonlinear effects. (Abstract ID 9587)

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DECADAL PREDICTIONS OF THE DYNAMIC STATE OF THE KUROSHIO EXTENSION SYSTEM

The Kuroshio Extension is an eastward-moving, inertial jet in the subtropical western North Pacific Ocean after the Kuroshio separates from the coast of Japan. Being the extension of a wind-driven western boundary current, the KE has long been recognized as a turbulent current system rich in large-amplitude meanders and energetic pinched-off eddies. An important feature emerging from recent high-precision satellite altimeter measurements and eddy-resolving ocean model simulations, is that the KE system exhibits clearly-defined decadal modulations between a stable and an unstable dynamic state. The decadal-modulating KE dynamic state not only exerts a great impact on the regional sea surface temperature, heat content and watermass properties, it also brings about significant changes in marine ecosystems and fisheries in the western North Pacific Ocean. Here we show that the time-varying KE dynamic state can be predicted at lead times of up to 5~6 years. The long-term predictability rests on two dynamic processes: (1) the oceanic adjustment is via baroclinic Rossby waves that carry interior wind-forced anomalies westward into the KE region, and (2) the KE variability induces a negative feedback response in the overlying atmosphere that enhances the oceanic variance with a preferred timescale of ~10 years. This second process is a novel addition and is at the heart of the prolonged multi-year predictability of the KE dynamic state. (Abstract ID 9754)

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THE SCATTERING OF INTERNAL TIDES OVER ABRUPT CONTINENTAL SHELF FEATURES

Tide is observed and modelled over irregular continental margins, where submarine canyons and promontories (internal tide generation "hotspots") impose strong along-shelf bathymetry gradients. The 2D barotropic and 3D baroclinic solutions are solved along realistic shelves (West-Berian margin) and idealized bathymetry configurations. This approach enables the evaluation of the impact of such bathymetry features at the internal tide generation and scattering. Each feature shows different tidal flow modulation, as the result of distinct ageostrophic fluid vorticity production. Interference processes, function of the bathymetry configuration and stratification are shown to play a crucial role in the observed internal tide patterns, generally complex along irregular continental margins. Both 2D and 3D results are verified over realistic modelling results and validated by insitu measurements. Key words: barotropic tide, baroclinic forcing term, tide interference patterns, submarine canyons and promontories. (Abstract ID 11161)

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DISTINGUISHING BETWEEN ANTHROPOGENIC CO2 UPTAKE AND ACCUMULATION IN THE OCEAN BASED ON C13 MEASUREMENTS

Detecting changes in the rate of ocean uptake of anthropogenic CO2 will not be easy. On regional scales, it will be necessary to distinguish changes in the ocean inventory of anthropogenic CO2 caused by ocean transport from air-sea CO2 exchange. Measuring decadal changes in the δ13C of dissolved inorganic carbon (DIC) can help separate the impact of ocean transport versus air-sea CO2 exchange on anthropogenic CO2 accumulation in the ocean. Measuring the air-sea δ13C disequilibrium yields a means to quantify the air-sea 13CO2 flux and compare to it measured inventory changes in δ13C/DIC on basin scales. In the N. Atlantic we find the 8C/DIC accumulation rate significantly exceeds the air-sea 13CO2 flux during the 1990s, whereas in the N. Pacific the opposite is observed. We will compare observations with modeled estimates of anthropogenic 8C/DIC and DIC changes to GCM simulations of the anthropogenic 8C/DIC and CO2 perturbations to evaluate the impact of inter-basin ocean transport on the distribution of anthropogenic CO2 accumulation in the ocean. (Abstract ID 10923)

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SPECIMED: A MULTI-YEAR SURVEY OF MEDITERRANEAN PELAGIC COASTAL ECOSYSTEMS IN A CONTEXT OF GLOBAL CHANGE

SPECIMED (Structures of Planktonic Ecosystems in the Northwestern Mediterranean) is a multi-year program which has been initiated by the French oceanographic community in the framework of the MERMEX (Marine Ecosystems Response in the Mediterranean Experiment) Project. SPECIMED is an interdisciplinary program studying coupled physical, geochemical and biological processes that ultimately control the function of Mediterranean coastal ecosystems. As a step towards operational management of marine ecosystems SPECIMED aims at understandings and predictive capability via modelling of how marine biogeochemical cycles and ecosystems respond to human impacts and climate change. In the initial phase,
SPECiMed focuses on the sensitivity of marine biogeochemical cycles and ecosystems in the Gulf of Lions to global climate change by deciphering the mechanisms regulating the interrelationships between phytoplankton diversity, biogeochemical macronutrient cycles and physical environment, between bacterial and phytoplankton diversity, and between zooplankton and phytoplankton diversity, at different event, seasonal and interannual scales. The results from the monthly cruises conducted since June 2010 enable us to document some features and correlations of the seasonal variability of the physical mesoscale field together with the ecosystem functioning. (Abstract ID 9511)

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PHYSICAL AND BIOLOGICAL CONTROLS ON THE DISTRIBUTION OF TRACE METALS (FE, CU, MN) AROUND KERGUELEN ISLANDS (SOUTHERN OCEAN)

Trace elements such as iron (Fe), manganese (Mn) and copper (Cu) are crucial for phytoplankton growth, being involved in critical electron transport processes, for example. The concentrations of a suite of dissolved trace elements (Fe, Mn, Cu, Co, Al, Ni, Zn, Ba, Mo, Cd and Pb) were determined in the water column of the Kerguelen plateau during the KEOPS 2 cruise (October-November 2011). To perform this study, samples were pre-concentrated at sea using an automated method adapted from Milne et al. (2010), and analyzed by isotope Dilution-Sector Field-ICP-MS. Samples above the plateau and in the water column of the open ocean were collected in order to study the impacts of the distributions of trace elements on the spring phytoplankton bloom. Moreover, a newly formed eddy was followed from the plateau to the open ocean in order to study the impact of physical mixing on distributions of trace elements. This study will advance our understanding of the natural fertilization of waters surrounding the Kerguelen plateau by trace elements, and their role in Southern Ocean carbon cycling. (Abstract ID 9568)

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INTER-ANNUAL VARIABILITY OF THE PLANKTONIC COMMUNITIES IN THE NORTHEASTERN CHUKCHI SEA: 2008-2010

The planktonic communities of the northeastern Chukchi Sea were surveyed as part of an interdisciplinary baseline study supported by ConocoPhillips, Shell and Statoil. Chlorophyll-a, macronutrients and zooplankton were sampled across three 900 NV3 grids, thrice per ice-free season from 2008-2010. 2009 saw an earlier retreat of ice cover and warmer SSTs than 2008, while 2010 appeared intermediate. The spring bloom was captured in 2008 and 2010, but not in 2009 when low concentrations of nutrients and chlorophyll were observed. Eighty taxonomic categories of zooplankton, including 11 meroplanktonic, were observed with greatest diversity found within the copepods, followed by the cladocrians. Most species are of subarctic Pacific origin. A seasonal evolution of the community structure was apparent over each survey area. Cold oceanographic conditions in 2008 slowed growth of the zooplankton, in 2009 the early bloom supported a moderate-biomass zooplankton community and 2010 supported the largest zooplankton community. Biomass changes were driven by increases in large-bodied lipid-rich copepods. Inter-annual differences in ice-melt, water temperatures, northward transport of water masses, nutrients and chlorophyll create a region with highly variable pelagic productivity. (Abstract ID 11998)

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A VISION FOR THE FUTURE: A NATIONAL STRATEGY OF REGIONAL OBSERVING PLANS

The Regional Associations (RAs) that support the Integrated Ocean Observing System (IOOS) encompass 11 Large Marine Ecosystem (LMEs) that range from the cold waters of the Chukchi Sea to the warm waters of the tropical Pacific Islands. Ten-year build out plans outline the observations, modeling, data, product development and management needed to address the societal themes of maritime operations, climate variability, ecosystems, water quality and fisheries and coastal hazards The National Synthesis links the 11 regional observing plans together into a national network that, for the first time, articulates the base capacity needed to address the national priorities. The Synthesis identifies the common elements and regional differences that are critical to ensure sustained observations for the nation. (Abstract ID 12701)

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RACHEL CARSON AWARD LECTURE - SIGNIFICANCE AND INSIGNIFICANCE OF THE 2011 MISSISSIPPI FLOOD TO SURROUNDING WATERS

The flood of the Mississippi River in 2011 broke many freshwater discharge and nutrient load records. The MR drainage contributes 90% of the sediment, nutrients and fresh water to the northern Gulf of Mexico, and its influence reaches thousands of kilometers away. The record flow forced breaking levees in Missouri and opening major spillways, the Morganza into the Atchafalaya River basin and the Bonnet Carré north of the city of New Orleans into Lake Pontchartrain, and proffered expectations of dense harmful algal blooms in receiving waters and the largest-ever “dead zone” (area of low oxygen) offshore. Not all expectations were realized, with lower than expected chlorophyll biomass and HAB concentrations in Lake Pontchartrain (high flushing and high turbidity) and a smaller area of shelf hypoxia (tropical storm action and ocean currents). More detrimental effects were the severity and volume of low oxygen elsewhere, noxious and harmful algal blooms went and east of the delta, and large, persistent areas of low oxygen east of the delta in summer. The 2011 scenario mirrors climate change expectations for the watershed. (Abstract ID 12900)
LONG-TERM CHANGES IN PHYTOPLANKTON PHENOLOGY IN THE NORTH ATLANTIC

Since phytoplankton phenology has been established to be of critical importance for larval fish recruitment and further recognised as an indicator of ecosystem health, systematic methods to estimate phenology from different data sources (remote-sensing, in-situ, models) have been developed. Validation and interpretation of phenological changes observed from different ocean-colour remote sensors have remained challenging, partly because of a decadal gap between existing time-series, but also mostly because of scarcity of long-term in-situ time-series with high spatial and temporal resolution. Here, we show a complementary analysis of the long-term changes in phytoplankton phenology in the northeast Atlantic using ocean-colour remote-sensing data from SeaWIFS (1997-2010) and CZCS (1978-1986) and in-situ data from the Continuous Plankton Recorder. Latitudinal examination of the phenological changes shows a trend for an earlier start of the phytoplankton blooming period concomitant with longer duration, revealing in places a merging of the spring and fall blooms and/or a shift in the strength of the spring compared to fall bloom. The results are discussed in relation with long-term changes in environmental forcing, in particular sea-surface temperature, stratification and wind stress curl. (Abstract ID 11003)

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FLUOROMETRY-BASED DETECTION OF FRESHWATER INFLOW EFFECTS ON ESTUARINE PHYTOPLANKTON DEPOSITION

The Caloosahatchee estuary (Florida, USA) receives regulated, highly variable freshwater discharges from an upstream dam. Water residence times and local light environments change in response to variations in discharge, influencing the distributions of phytoplankton and benthic microalgae in the downstream estuary. The juvenile stages of many coastal fishes consume grazing and deposit-feeding benthic invertebrates and thus are trophically dependent on the distribution and quality of epibenthic organic matter. Phytoplankton deposition may either support benthic consumers by contributing organic matter as a food source or hinder it via decomposition-induced hypoxia. During a two-year study, we used a novel combination of water-column fluorometry, benthic fluorometry, and proportion of centric vs. pennate diatoms at the sediment-water interface to detect and classify phytoplankton deposition at 14 locations along the principal estuarine axis. Benthic microalgal production dominated near the estuary mouth and during low-discharge periods when light attenuation by colored dissolved organic matter and phytoplankton was low. Phytoplankton deposits formed in the middle estuary (during high freshwater discharge) or upper estuary (low discharge) and were sometimes associated with strongly reduced dissolved oxygen concentrations. (Abstract ID 11533)

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EQUILIBRIUM TRANSPORT IN DOUBLE-DIFFUSIVE CONVECTION

A theoretical model for the equilibrium double-diffusive transport is presented which emphasizes the role of secondary instabilities of salt fingers in saturation of their linear growth. Theory assumes that the fully-developed equilibrium state is characterized by the comparable growth rates of primary and secondary instabilities. This assumption makes it possible to formulate an efficient algorithm for computing diffusivities of heat and salt as a function of Prandtl number and decreasing with diffusivity ratio. Theory is successfully tested by a series of direct numerical simulations which span a wide range of parameters. (Abstract ID 10498)

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SUBANTARCTIC MODE WATER NUTRIENT MODIFICATION EN ROUTE TO THE EQUATORIAL PACIFIC THROUGH SHADOW ZONE MIXING AND ORGANIC MATTER REMINERALIZATION

The shadow zones of the Eastern Tropical Pacific are, by definition, poorly ventilated by the greater gyre circulation. However, despite this relatively weak mixing, biogeochemical processes within these shadow zones—such as the reduction of nitrate via denitrification—have a great impact on the geochemistry of nutrients throughout the Pacific. Understanding these water mass interactions is important for understanding the circulation of the Pacific and improves predictions of the biogeochemical response to changes in shadow zone volume. Here we examine the influence of the shadow zones on the greater Pacific with nitrate N and O isotope measurements from throughout the South Pacific. Using this coupled nitrate isotope approach, we find that nitrate within Subantarctic Mode Water—the ultimate source of low latitude nutrients—is modified by two dominant processes: (1) mixing with the South Pacific shadow zone and (2) the remineralization of organic matter. (Abstract ID 12008)

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LAGRANGIAN MEASUREMENT OF CONTINUITY OF SUBSURFACE UNDERCURRENT FLOW ALONG THE WESTERN UNITED STATES

Alongshore flow segments of Ralos floats deployed off the central California coast between 1992 and 2010 are described. The floats were primarily deployed in the California Undercurrent, mostly at intermediate depths (150-650 m), but some much deeper (~1500 m). Results of examination of the flow segments are shown, including relationships of flow depth with flow segment length and continuity, average flow speed, and seasonal/variability. The role of water depth is also examined with respect to the flow segments. Generally, poleward flow segments are longer, closer to shore, and have greater mean speed than their equatorward counterparts. Flow speed appears to be dependent upon (fetch) depth. Northward flow appears to be continuous at least through Cape Mendocino. (Abstract ID 12368)

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WAVE-FORCED FLOW OVER A SHALLOW REEF FLAT ON KWAJALEIN ATOLL

Kwaialein Atoll, Republic of the Marshall Islands, is comprised of many small islets connected by active shallow reef passes or ‘hoa’ Flow through these hoa, which are open to both the ocean and lagoon, is an integral part of the overall lagoon circulation at Kwaialein. Here we present observations of wave-forced transport across a shallow reef pass connecting the island of Roi-Namur to its neighboring atoll. Located on the windward side of the atoll, this site is subject to steady wave forcing that sets up a pressure head over the reef top and, in turn, drives a mean along-channel flow of ~0.5 m s⁻¹ directed into the lagoon. Setup at the reef edge is calculated from offshore wave heights and is used to predict the flow according to an along-channel momentum balance between bottom friction and the pressure gradient. A quadratic drag relationship provides the best fit to the observations, yielding a drag coefficient that is consistent with previous estimates over reef substrate. The broader effect of wave-driven transport through hoa on the overall lagoon circulation is considered. (Abstract ID 12107)

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DISTRIBUTION OF NUTRIENTS AND ORGANIC CARBON, NITROGEN AND PHOSPHORUS IN THE SOUTHEAST BEAUFORT SEA: IMPLICATIONS FOR PRIMARY PRODUCTION

Primary production (PP) is strongly conditioned by nutrient supply in the Arctic, but the respective roles of rivers and oceanic processes in this regard remain to be assessed. The extent to which PP relies on inorganic versus organic forms of nitrogen (N) and phosphorus (P) is also uncertain. Here we report on the distributions of inorganic N (DIN) and P (DIP), dissolved organic N (DON), P (DOP) and C (DOC) as well as particulate organic carbon (POC), N (PON) and P during large collaborative projects (e.g. Malina, ArcticNet) in the southeast Beaufort Sea. Results show a clear enrichment of neritic surface waters with DIN, DON, DOC, DON and POC from the Mackenzie River. By contrast, river discharge lowered the concentration of DIP which was close to the detection limit inshore but very high offshore. Riverine signals attenuated within a short distance from the coast. Away from the river mouth, localized elevations in dissolved and organic constituents were consistent with upwelling, whose surface expression was visible only in the particular pools. The implications of upwelling and river supply for PP are discussed. We propose that large deliveries of N relative to P by rivers relax nearshore communities from N limitation, enabling them to tap into excess DIN of Pacific origin. A coarse budget was made to assess the importance of seasonal river supply on the availability of N and P on the inner Mackenzie shelf. (Abstract ID 11735)

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REMOTE SENSING THE PHYTOPLANKTON PATTERNS OF THE RED SEA
Phytoplankton plays a key role in the marine food web, biogeochemical cycling and climate processes. The Red Sea hosts one of the most diverse marine ecosystems, while it is one of the warmest and most saline seas. Using 12 years of satellite remotely-sensed data, the surface Chlorophyll-a (Chl-a) distribution and abundance is described. The Red Sea is an oligotrophic region and is divided into three distinct Chl-a abundance areas, starting from the most oligotrophic to more eutrophic areas (from North to South). Chl-a depicts a strong seasonal pattern, and varies from 0.1 mg/m$^3$ (North) to 0.7 mg/m$^3$ (South Red Sea). In the northern part, Chl-a peaks in winter and is mainly controlled by deep mixing, whereas the middle and southern parts have two distinct peaks, one during winter and one in June. Those two signals are apparent in every area, however, the summer signal is reduced significantly with increasing latitude (from 12°N to 28°N). During summer, although stratification levels are high, nutrient rich waters fuel the surface areas through Gulf of Aiden. The quality of SeaWiFS in relation to available in situ and case II products is evaluated. (Abstract ID 11398)

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PHYSICAL CONTROLS ON AN ESTUARINE HARMFUL ALGAL BLOOM
Harmful algal blooms of the genus *Alexandrium* produce a toxin associated with Paralytic Shellfish Poisoning and can cause significant economic and human health impacts. In the northeastern US and Canada, *Alexandrium* blooms occur both in the open waters of the Gulf of Maine and in coastal embayments and estuaries, and the links between these populations are not well understood. Combining observations and a numerical model, we evaluate the bloom dynamics in one such estuary, the Nauset Marsh System on Cape Cod. Several physical factors, including bathymetry, stratification, and convective mixing, combine with the organism mortality to promote retention of cells within subembayments of the estuary. The model is used to link the spatial heterogeneity in estuarine residence time to organism growth rates, and the residence time distributions are consistent with the bloom intensity. Export of cells from the estuary to the coastal ocean is limited, but import from the coastal bloom to the estuary is observed. Exchange of cells between the estuary and coastal ocean is sensitive to the timing and magnitude of meteorological forcing during bloom development. (Abstract ID 11883)

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LAB-SCALE NUMERICAL SIMULATION OF INTERNAL TIDE GENERATION AT AN INCISED GAUSSIAN RIDGE
The numerically simulated generation of internal tides is considered over lab-scale incised ridge topography. Both the main ridge and the cut in the main ridge are defined by Gaussian distributions. The finite-volume, three-dimensional, unstructured, z-level grid, nonhydrostatic, parallel coastal-ocean solver, SUNTANS is used to simulate this internal tide. Given the abrupt topography, vertical accelerations will be significant. Therefore, nonhydrostatic effects and a highly refined grid resolution of 2.7 mm in each of the three coordinate directions are needed to accurately portray the internal wave evolution. Using a uniformly stratified fluid and a barotropic sinusoidal forcing, numerical simulations are executed. When the barotropic tide flows across the ridge, the vertical displacement of the stratified water generates high baroclinic barotropic sinusoidal forcing. The characteristics of flow are discussed, including phase averaged and mean velocity, vorticity and density fields. The domain size and grid resolution resolve both mesoscale and submesoscale eddies. In simulations forced with downfront winds, we find excessive subgrid dissipation prevents efficient extraction of available potential energy and delays the onset of frontal building. Among the two subgrid models tested, the subgrid dissipation obtained using the Smagorinsky model agrees better with scaling arguments in the literature. (Abstract ID 12089)

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WIND MEASUREMENTS FROM ASIS AND EASI BUOYS DURING THE ITOP EXPERIMENT
Two atmospheric/oceanic moorings were deployed in the Philippine Sea, 740 km east of southern Taiwan, as part of the Impact of Typhoons on the Ocean in the Pacific (ITOP) experiment in 2010. Each mooring was set up with an EASI (Extreme Air Sea Interaction) buoy anchored to the sea bottom and tethered to an ASIS (Air-Sea Interaction Spar) buoy that was free to weathervane. The ASIS tether length was 60 m and the distance between moorings was approximately 180 km. Wind speed and direction were measured with 10 independent wind probes at sampling frequencies of 20 Hz and 5 Hz. The two ASIS buoys were equipped with a single sonar anemometer (Gill), whereas the two EASI buoys hosted 2 propeller (RM Young, K Gill) and 2 sonic anemometers each. The wind records include 4 major typhoons (Dianmu, Fanapi, Megi and Chaba) that passed as close as 61 km from the mooring sites. Results from validation of the measurements with ship anemometers, satellite altimeter and inter-comparisons are shown and the source of significant discrepancies with early model estimates is explored. (Abstract ID 10222)

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ASSESSMENT OF PARASITISM IN *PTEROIS VOLITANS/MILES* (SCORPENAIDAE) FROM COASTAL WATERS OF PUERTO RICO
*Pterois volitans* and *Pterois miles*, natives of the Pacific Ocean and Red Sea respectively, have recently invaded marine waters of Florida and the Caribbean. Information regarding their biology and ecology is scarce. Parasitological studies of these fishes can provide insight into their susceptibility to local parasite species, whether non-indigenous parasites were introduced along with the fishes and, incidentally, their food habits and possibly habitat preferences. Isolated parasite records have reported only ectoparasites. The objective of this research was to determine whether the local lionfish populations are hosts for parasites from Puerto Rico or their native habitats, and, if present, what are the species, the species abundances and whether they are incidental or true parasites. Examination of 75 specimens of these fishes from Puerto Rico recovered mostly local digenetic (endoparasites), nematodes, a leech (*Tracheliobdella lubrica*) and a few other ectoparasites. (Abstract ID 9495)

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EVOLUTION OF SHALLOW, HORIZONTAL SHEAR LAYERS WITH A HORIZONTAL DENSITY CONTRAST
Shallow coastal ocean flows frequently involve strong horizontal shear in combination with a horizontal density gradient. In the absence of the density contrast, the flow undergoes the classic Rayleigh instability leading to the roll-up of the shear layer into vertical vortices. The density contrast results in a transverse gravity-driven tilting of the interface resembling a lock-exchange. The evolution of rapid buoyancy-induced tilting of horizontal shear is explored with laboratory experiments performed in an open-channel flume with a splitter-plate entrance. Measurements of the downstream evolution are made with co-incident PV and LIF in horizontal planes at several vertical locations spanning the water column. The measurements show vertical vortex roll-up and tilting and subsequent emergence of horizontal Kelvin-Helmholtz billows on the interface that interact with the primary vortices. The characteristics of flow are discussed, including phase averaged and mean velocity, vorticity and density fields as a function of a scaling parameter that quantifies the relative effects of lateral shear and buoyancy adjustment. The experiments compare favorably with three-dimensional, implicit-LES, numerical model solutions for the experimental configuration and parameters. (Abstract ID 11944)

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GENETIC STRUCTURE IN SWARMS OF THE TROPICAL MYSID MYSIDILUM GRACILE (CRUSTACEA)

Sea temperatures are rising and it is predicted that in the next 20 years temperatures will increase by 1-2°C. Marine ecosystems, particularly reefs, are already being impacted by thermal change. The ability to adapt to these alterations in temperature depends on genetic variability present within populations. Zooplanktonic mysids are likely key species in trophic interactions within reefs, yet few studies have focused on genetic composition of their swarms. Here we determine the genetic structure of swarms found in offshore reefs throughout the Caribbean Sea. Mysids were collected from 14 swarms and preserved for genetic analysis. Based on preliminary COI sequences of 24 mysids from two swarms and three outgroups (Neomysis, Mysis, Hemiptychus), genetic distances among swarms ranged from 4-33%, while distances within swarms ranged from 0-25%. Mysids were distributed among three independently evolving clades according to Maximum Parsimony and Neighbor Joining analyses, with individuals from St. John forming two clades within a monophyletic group. These preliminary findings indicate that there is substantial genetic variation among and within mysid swarms, thus affording the capability to adapt to their changing environment. (Abstract ID 9807)

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CACING DYNAMICS IN PERMEABLE REEF SEDIMENTS: THE ROLE OF HYDRODYNAMICS AND BENTHIC METABOLISM

To investigate diel CaCO$_2$ dynamics in permeable coral reef sands, we measured porewater profiles and fluxes of oxygen, nutrients, pH, calciturbation, and alkalinity across the sediment-water interface (SWI) in sands of different permeability at Heron Reef, Australia. Background flushing rates were high, most likely due to infaunal burrow irrigation, but flux chamber stirring enhanced porewater exchange. Light and porewater advection fueled high rates of benthic primary production and calcification in surfite surfite sediments. In the light, benthic photosynthesis and calcification induced surface minima in calcium and alkalinity, peaks in pH and oxygen, and deeper oxygen penetration. Total oxygen uptake (TOU) in dune chambers was stimulated by porewater advection. Greater sediment oxygen consumption rates were observed in higher permeability sands. In the dark, alkalinity flux was not stimulated by increasing TOU because of a damping effect of porewater advection on metabolic carbonate dissolution efficiency. On a daily basis, carbonate undergoes net dissolution in Heron reef sands. However, porewater advection can reverse the CaCO$_2$ budget and promote CaCO$_2$ preservation under the most energetic conditions. (Abstract ID 9962)

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WEATHER-BAND FLUCTUATIONS IN THE WIND REDUCES THE ESTUARY-OCEAN EXCHANGE AND INCREASES ESTUARINE RESIDENCE TIME

Weather-band induced fluctuations in the winds decrease the salt exchange between the estuarine and the coastal ocean, which leads to the estuary becoming fresher and longer residence time in the estuary. The change in the salt exchange is primarily caused by changes in the salinity difference between the estuarine outflow and the oceanic inflow of the estuary and not by changes in the volume of water exchanged. Sediment-induced mixing in the estuary increases the salinity of the water leaving the estuary, while coastal upwelling and downwelling determine the oceanic salinity entering the estuary. The interaction between the estuary and the coastal ocean during fluctuating winds tends to decrease the salt exchange into the estuary causing the estuarine salinity to become fresher. This indicates an increased residence time in the estuary, suggesting that terrestrial and anthropogenic influences, such as nutrients and pollutants, can accumulate for longer periods. (Abstract ID 10527)

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CHANGES IN BACTERIAL COMMUNITY STRUCTURE AND FUNCTION UNDER PREDICTED OCEAN ACIDIFICATION SCENARIOS

Laboratory experiments were performed using flow-through systems in which the carbonate chemistry as well as the nutrient concentrations were manipulated, while controlling for the confounding effects of temperature and light. pCO$_2$ gradients from 400 to 4000 µatm were applied to microbial communities originating fromoxic hetetrotrophic sandy sediments, which were maintained in the flow-through systems. Shifts in bacterial community structure were determined by community fingerprinting (Automated Ribosomal Interrogative Spencer) assay and by 454 pyrosequencing of ribosomal genes. Functional changes were monitored as shifts in respiration rate and extracellular enzymatic activities, as well as community resilience measured as changes in beta diversity. Determining how community structure or functions are affected by CO$_2$ levels of predicted ocean acidification scenarios would help understand how microbes adapt to fluctuating carbonate system conditions. We will also further test whether elevated CO$_2$ levels in combination with different nutrient loads have a significant influence on microbial functions including biogeochemical activities and community resilience. (Abstract ID 11946)
The adaptive wavelet collocation method is applied to the shallow water model. This method solves the equations on temporally and spatially varying meshes, which allows a higher effective resolution to be obtained with less computational cost. The grid adaptation is achieved by using the ability of wavelet multiresolution analysis to identify and isolate localized dynamically dominant flow structures, e.g., vortices, and to track these structures on adaptive computational meshes. In addition to studying how the shallow water model behaves on non-uniform, time-varying grids, this work also sets out to improve the representation of continental topology through an extension of the Brinkman penalization method. This numerical technique works by altering the governing equations in such a way that no slip boundary conditions are enforced. When coupled with the adaptive wavelet collocation method, the flow near a complex boundary can be well defined. In addition, the bathymetry is represented in wavelet compressed form, thus allowing active control of the roughness, length scales, etc., plus efficient representation of the detailed bathymetry, with automatic refinement in regions of active interaction of bathymetry and flow structures. The applications presented here include wind-driven flow in a square basin, North Atlantic circulation, and a tsunami simulation. (Abstract ID 11580)

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EMERGENT COPEPOD COMMUNITIES IN AN ADAPTIVE TRAIT-BASED MODEL
We have a detailed mechanistic understanding of copepod population dynamics for many of the dominant taxa. However, important ecosystem shifts involve whole communities. Algorithms adopted from evolutionary computation provide one avenue for understanding community-level properties like biodiversity. We developed a copepod community model based on ecological tradeoffs in trait space. The model is generalized to represent a broad range of possible copepod taxa. We used this framework in an adaptive-computing context to examine the different communities that assemble under different temperature and food regimes across a latitudinal gradient. Emergent communities were characterized by analogues of species observed in nature. Biodiversity was highly dynamic across a wide range of temporal scales. (Abstract ID 11966)
EVOLUTION OF WATER MASSES' CHLOROFLUOROCARBON INVENTORIES FROM 1991 TO 2008 ALONG THE S83 WOCE HYDROGRAPHIC SECTION

Column inventories of two chlorofluorocarbons (CFC-11 and CFC-12) were calculated for multiple occupations (1991, 1995, 2001, 2008) of the WOCE Hydrographic Program S83 repeat section in the Southern Ocean. This meridional section extended from Tasmania (~44S) to the Antarctic shelf (~66S), between 139E and 146E. The column inventories increased ~40% for CFC-11 and ~50% for CFC-12 over the elapsed time and generally followed atmospheric trends in CFC concentrations. To investigate the rates and temporal variability of interior ocean ventilation, CFC column inventories for the major water masses (based upon their neutral densities) were calculated for each repeat occupation. In addition, the volumes of these water masses were computed using accompanying CTD data. Lower Circumpolar Deep Water (LCDW) column inventories of CFC-11 and CFC-12 increased nearly linearly, with ~50% increase in average concentrations of CFC-11 and CFC-12 over the elapsed time. Antarctic Bottom Waters (AABW) column inventories of both CFCs decreased ~17% between 2001 and 2008. A concurrent loss of ~12% volume of AABW results in average concentration decreases of ~7% (CFC-11) and ~5% (CFC-12). (Abstract ID 12423)

TEMPORAL AND SPATIAL ODOR PATTERNS SAMPLED BY LOBSTERS AND CRABS IN A TURBULENT PLUME

Olers are dispersed across aquatic habitats by turbulent water flow as filamentous, intermittent plumes. Many crustaceans take discrete samples of odors by flicking their olfactory antennae. We used planar laser-induced fluorescence to investigate how long antennules of spiny lobsters, Panulirus argus, and short antennules of blue crabs, Callinectes sapidus, sample fluctuating odor signals at different positions in a turbulent odor plume in a flume to determine if the patterns of concentrations captured can provide information about an animal's position relative to the odor source. Lobster antennules intercept odors during a greater percentage of flicks and encounter higher peak concentrations than do crab antennules, but because crabs flick at a higher frequency, the duration of odor-free gaps between encountered odor pulses are similar. Flicking antennules encounter longer time-gaps between odor encounters as the downstream distance to the odor source decreases, but shorter gaps along the plume centerline than near the edge. In contrast to flicking, almost all odor-free gaps were <50 ms at all positions in the plume if concentration was measured continuously at the same height as the antennules. (Abstract ID 11212)

THE EFFECTS OF CO2 LEAKAGE ON LIFE IN THE SEAFLOOR SEDIMENT: A LABORATORY MODEL

Since 1996, Statoil has continuously pumped CO2 into the subsurface storage site, the Utsira Formation, in the North Sea. By 2011 approximately 12 million tons CO2 are stored. To investigate possible consequences for life in seafloor sediments if a CO2-leakage should occur from the storage, we collected sediment cores from the area above the subsurface CO2-plume. The intact sediment cores were set up in a laboratory experiment where half of the cores were continuously exposed to CO2-acidified seawater of pH 6.4, while the remaining cores were exposed to normal seawater with pH 7.8 (control cores). During the experiment, pH was measured continuously, and O2 on a daily basis. During 1.5 months, both experimental and control cores were terminated and analysed after three different time intervals. At each termination, porewater was extracted for geochemical profiling, in addition to in-depth analyses of bacterial and archaeal communities, selected functional genes and sulfate reduction rates. Furthermore, virus, macrofauna and meiofauna were analysed. Preliminary results show clear differences between CO2-treatments and control cores, indicating an impact of elevated CO2-concentrations on the micro-, meio- and macrofauna of the sediment. Further analyses are currently ongoing. (Abstract ID 12699)

ASSASSESSING THE CONTRIBUTIONS OF SURFACE AND INTERNAL WAVE MOTIONS TO EDDY OXYGEN FLUXES MEASURED ON CONTINENTAL SHELVES

A unique problem in benthic eddy correlation (EC) studies of continental shelf environments is how to consider variable surface and internal wave motions that can dominate the turbulence-induced component of the measured covariance. Of major concern is the separation of wave frequency oscillations that may bias flux calculations (due to, for instance, a tilted or miss-aligned sensor) from those that contain meaningful flux contributions. When analyzing EC time-series collected on the Oregon Shelf, we have chosen to remove wave bias from the vertical velocity component by (1) using the ADV's pressure time-series to extract surface wave characteristics based on finite-depth linear wave theory, and (2) rotating the coordinate system to minimize the difference between the observed vertical velocity (at the wave frequencies) and the vertical velocity derived via wave theory from the pressure signal. These computations result in consistent burst by burst rotation angles when complimentary buoy data show that surface waves approached from a steady direction. Internal wave oscillations are also evident at low frequencies but require long-times series and linear detrending methods to adequately resolve. After wave biasing is removed, contributions to eddy fluxes at wave frequencies still often represent 15-40% of the total. We will illustrate assessing these contributions with data sets from water depths of 30-85 m. (Abstract ID 9191)
The use of bottom pressure recorders (BPR) to measure sea level change, ocean floor settling or geodetic processes requires extremely consistent and stable pressure readings. Proper long-term deployment of BPRs or other precision, untended pressure measurement instrumentation therefore, relies on understanding the drift rate and response characteristics of the pressure sensors. Sea-Bird Electronics routinely screens sensors for pressure-temperature response characteristics, offset and slope. The drift performance of the frequency acquisition and storage electronics is verified to be ±0.1 ppm per year; however, qualifying the pressure transducer is more challenging. Here we describe the testing protocols and present results in the characterization of the bulk drift of Digiquartz pressure sensors made by Paroscientific. This entails recording the output of the sensor relative to a reference sensor in a low thermal noise environment for 1 to 4 months. The data from one such test shows drift rates ranging from 0.75 patient per year at 3000psia per year. In the cadre of sensors under test differences of as much as a factor of 10 were observed in drift performance. (Abstract ID 12898)

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DRIFT MEASUREMENTS OF PRESSURE SENSORS

The distribution of aluminium in the upper 1000 m of subantarctic waters south of Australia was determined using reversed-phase high-performance-liquid-chromatography with fluorescence detection. The study focussed on three main process studies in sectors west, south and east of Tasmania. 0.75PSIA per year to 3.0PSIA per year. In the cadre of sensors under test differences of as much as a factor of 10 were observed in drift performance. (Abstract ID 12898)

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ALUMINIUM IN THE SUBANTARCTIC SOUTHERN OCEAN SOUTH OF AUSTRALIA: REGIONAL COMPARISONS DURING SUMMER

The distribution of aluminium in the upper 1000 m of subantarctic waters south of Australia was determined using reversed-phase high-performance-liquid-chromatography with fluorescence detection. The study focussed on three main process studies in sectors west, south and east of Tasmania during the SAZ-Sense expedition in austral summer 2007. Aluminium concentrations ranged (0.11-16 nM), showing distinct spatial variability and were highest at the surface east of Tasmania (due to higher delivery of dust and lateral transport of sub-tropical waters enriched with trace metals from shelf sediments), and lowest west of Tasmania (which was located in the Polar Front and more remote from continental sources). Surface water dAl correlated with the concentration of Al is aerosol samples collected during the voyage. The impact of meso-scale eddies formed as filaments of the East Australian Current to the SE of Tasmania are evident in the dAl data. The MADCOW model is used to calculate the dust deposition to the surface ocean in our study area and to compare with water column dFe observations. (Abstract ID 9395)
ADJOINT SENSITIVITY ANALYSIS APPLIED TO THE GLORYS 1/4° GLOBAL OCEAN REANALYSIS

Mercator-Ocean is a French ocean forecasting center. It also produces reanalysis. In order to improve the analysis and forecasting systems, different strategies are explored. All systems are based on weekly optimization of the ocean initial conditions. Here we study the sensitivity of the 1/4° global forecast to initial conditions and atmospheric forcing. The latter one is known to be an important error source for the ocean, not currently taken into account in our systems. We compute the observation misfit sensitivity in order to identify the most important ocean variables and areas to control. We focus on the SST observation misfit. The time period is restricted to the assimilation window, 7 days. We show that at ½° resolution, over few days, the vertical mixing dynamic dominates. Using the sensitivity fields, we explore the possibility of correcting the heat fluxes. For this study, we run the recently developed NEMOVAR code which includes the adjoint of the NEMO ocean model. (Abstract ID 10989)

RESPONSE OF BACTERIAL UPTAKE OF ORGANIC CARBON IN NITROGEN ENRICHED MESOCOSMS

The concept of microbial carbon pump (MCP) has been proposed to illustrate the microbial transformation of labile dissolved organic carbon (DOC) to refractory DOC. The MCP effects however can be influenced by other environmental factors such as nitrogen. In the present study, we examined additional nitrogen's effect on the uptake of organic carbon in in situ mesocosm experiments at Western Pacific and South China Sea. The results showed that, nitrogen enrichment could facilitate the uptake of organic carbon and enhance both bacterial respiration and bacterial production, the bacterial growth efficiency (BGE) increased with increasing nitrogen concentration and then decreased again to certain extents depending on different field conditions, while the DOC left in the ambient water usually decreased with increasing nitrogen concentration. We believe that excess nitrogen could stimulate the uptake of DOC in the environment and thus perform a negative effect on the preservation of DOC pool in the ocean. (Abstract ID 10969)

OCEAN-ATMOSPHERE-WAVE COUPLING EXTREME EVENT ANALYSIS, FORECAST AND EFFECT IN THE MEDITERRANEAN SEA IN MAY 2010

The coastal areas of the western Mediterranean Sea are one of the challenging places in ocean forecasting. This region is exposed to some storms events which occur during a few days. During these events, strong air-sea interactions are observed like ocean heat loss by heat fluxes and, especially in the coastal area, surface gravity waves which can have some catastrophic consequences on the coastal area. To better identify the significant air-sea interactions, we used the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modelling System, which is comprised of the Model Coupling Toolkit to exchange data fields between the ocean model ROMS, the atmosphere model WRF, the wave model SWAN, and the sediment capabilities of the Community Sediment Transport Model. A severe storm occurred in May 2010 over the western Mediterranean Sea. During this event, wind speed reached up to 25ms and generated surface gravity waves with a significant height of about 8 meters which caused several damages. Main results are in good agreement with the observations and highlight the importance of the air-sea interactions during a storm event over the Mediterranean Sea. (Abstract ID 11040)

CONSTRUCTION OF PROBABILISTIC EXPERT SYSTEM TO PREDICT SCOUR BURIAL

The extent to which sea mines located on the seafloor in ports and coastal regions are buried under the sediment has a significant effect on detection by current sensors. Therefore the ability to predict burial is of great importance to clearance planning by Naval forces and of interest to homeland defense. Since the dominant burial process in sandy sediments, was the focus of several ONR field experiments. Measurements from three field tests are used to validate a parameterized deterministic burial model. However, prediction of burial in an operational setting is complex, as mine locations, time history and local environmental parameters are not generally known with precision. A probabilistic expert system construct provides the means to account for these inherent uncertainties. In this study we develop a Bayesian network as a predictive tool, where the causal influences are estimated from a Monte-Carlo sampling of the parameterized model. Scour burial is highly dependent on the strength of bottom currents which vary with wind and wave forcing over shorter time scales (hours, days) than the time horizon of operational predictions (normally weeks to months). The conditional probability relationships in the Bayesian network are developed using time varying sequences drawn from the distributions representative of climatological conditions in the region of interest. We contrast two seasons at two coastal sites where field results are available for evaluation. (Abstract ID 9710)

REQUIREMENTS OF A MINIMAL MODEL FOR MESOSCALE OCEAN-SURFACE OIL SLICKS

Model oil slick predictions comparisons to the Gulf Coast data have enjoyed mixed success. Their lasting contribution, arguably, has been to generate a multitude of modeling and computational questions, as well as questions regarding the interpretation and assimilation of data, particularly on the mesoscales. A fundamental aspect to the success and interpretation of results based upon the assimilation of oil spill data that resides at the surface is an understanding of the evolution and dynamics of the oil that resides on the surface or near it. In this talk we propose a minimal model for surface oil and show preliminary results of controlled passive tracer and phenomenological oil slick outcomes on coarse as well as highly resolved nearshore/shelf flows. For flows that are well approximated by shallow-water wave/current models we also consider how results from models and observations are properly interpreted. (Abstract ID 9757)

MODELLING NITROGEN TURN-OVER BETWEEN FISH PREDATOR AND PREY USING CSIA OF AMINO ACIDS

The use of models for ecosystem based management has become widespread but a greatly improved understanding of variability in food webs and more accurate assessment of trophic status is essential for these models to reflect reality and anticipated change through exploitation and climate. Here, we utilise samples obtained from a feeding trial of Barramundi (an important commercial and recreational fish species in Australia) fed on a variety of diets for different periods of time. We investigated several aspects of stable isotope research pertinent to incorporation into ecological models, namely: 1. understand and measure trophic enrichment for individual amino acid nitrogen in higher trophic levels, 2. investigate the rate at which different amino acids are incorporated into muscle tissue and 3. effects of fish growth rate and muscle tissue turnover on stable isotope incorporation at the molecular level. This information is a critical advance in developing this isotope approach as a tool for the rapid and unbiased evaluation of trophic position for a wide variety of marine organisms and therefore for validation of output from trophic mass-balance ecosystem models (e.g. Atlantis). (Abstract ID 10976)
ARCTIC WATERS

Bio-optical relationships are known to diverge substantially in Arctic waters from those of lower-latitude regions. We utilize field measurements from the Chukchi and Beaufort Seas to examine relationships between optical backscattering and characteristics of the suspended particle assemblage. The particle backscattering coefficient at 550 nm, $b_{sc}$, varied six orders of magnitude, with the highest values occurring on the Mackenzie shelf. Backscattering was generally well-correlated with the mass concentration of particles, and to a lesser extent with other measures of concentration such as particulate organic carbon or chlorophyll. We interpret variability in the magnitude and spectral behavior of $b_{sc}$ with regards to changes in the particle size distribution and bulk composition of particles (organic to inorganic proportions).

High backscattering was associated with mineral-dominated assemblages that generally exhibit a steeper size distribution, while lowest backscattering was associated with organic-dominated assemblages with a greater contribution of large particles. We compare our results with those from other locations and discuss the implications of the differences to the utility of backscattering and other backscattering-dependent optical measurements for characterization of suspended particles. (Abstract ID 9630)

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OBJECTIVE DETERMINATION OF FEATURE RESOLUTION IN AN SST ANALYSIS

Ocean model SST fields are used as ‘true’ SST data and subsampled based on actual infrared and microwave satellite data coverage to simulate the effects of missing data. SST analyses constructed from the full and subsampled model SST fields are then compared as a function of spatial scales of variability using wavenumber auto- and cross-spectral analysis. The results show that high-resolution features are generated with and without data gaps. However, if only sparse high-resolution data are available, the high-resolution features in an SST analysis are just noise. Fractional coverage of the number of ocean grid points to data to the total number of grid points possible is useful a metric for assessment of when and where small-scale features in an SST analysis can be considered accurate. It is thus recommended that maps of fractional coverage be made available to users. If the fractional coverage is increased locally in space and time, the coherence is improved on the short scales between 25 and 50 km. This relationship is shown quantitatively for each region considered. (Abstract ID 9419)

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DISOLVED ORGANIC MATTER, AN IMPORTANT PHOSPHORUS SOURCE IN OLIGOTROPHIC GYRES

Phosphate concentrations are chronically low in the subtropical North Atlantic and limit phytoplankton growth. There is accumulating evidence to show that phytoplankton overcome phosphate-limitation by accessing phosphorus bound to dissolved organic matter (DOM). However, questions remain as to the source and liability of DOM. We present findings from the subtropical North Atlantic: Ocean during spring 2011, where we quantified dissolved organic phosphorus (DOP) and its exudation, lability and uptake. A strong east-west gradient exists in DOP concentrations. Radiocarbon tracer experiments demonstrate that DOP is exported in the productive Mauritania upwelling and probably advected westward towards the subtropical gyre. Along this east-west gradient, enzyme assays reveal a decrease in the labile fraction of DOP from its source region and coincided with an east-west increase in the rate of assimilation of the labile phosphorus towards the gyre interior. This targeted experiment supports the hypothesis and model findings that DOP is produced in regions of high productivity and is transferred into the neighbouring oligotrophic gyre. This lateral transfer of DOP could provide the necessary phosphorus to sustain export production over the subtropical gyres. (Abstract ID 9863)

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THE DEEP WESTERN BOUNDARY CURRENT AND THE CIRCULATION OF NEWLY FORMED DEEP WATER

The role of the Deep Western Boundary Current (DWBC) as a conduit for newly formed (young) deep water masses (Labrador Sea Water, LSW; and Denmark Strait Overflow Water, DSW) is examined by discussing the distribution of two parameters (age and fraction of young water) inferred from chlorofluorocarbon data measured between 1980 and 2005 in the Atlantic from 20°S to 65°N. Compared to previous studies, a much larger data set with an improved mapping procedure was used, allowing to resolve the pathways of deep water in more detail. (Abstract ID 9381)

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SEASONAL METABOLIC RATES IN RESTORED TEMPERATE SEAGRASS BEDS ON A MEADOW SCALE MEASURED WITH THE EDDY CORRELATION TECHNIQUE

Seagrass meadows provide numerous ecosystem services such as increasing water quality, providing habitats for organisms, and sequestering organic matter. Eddy correlation offers a unique way to measure oxygen metabolism at the meadow scale at high temporal resolution and under in situ conditions. Late summer oxygen fluxes were measured in a 10-year old meadow restored by seeding, and showed a highly dynamic system with light, current and temperature as key environmental controls. As the site has changed from bare to vegetated sediments, oxygen fluxes have increased significantly suggesting restored meadows are locations of high production as well as respiration. In comparison to a similar study completed 5 years earlier at the same site, 24-hour integrated metabolic rates suggest a shift from late summer slight net autotrophy or balanced metabolism to slight net heterotrophy. We suggest this is caused by higher respiration rates due to increases in organic matter in the sediments as seagrass meadows mature. This work continues to further assess seasonal and annual metabolic rates at the meadow scale. (Abstract ID 11163)

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MAGNITUDE-FREQUENCY RELATIONSHIPS BETWEEN RAINFALL AND EXTREME FRESHWATER DISCHARGE IN THE ALTERED YEONGSAN ESTUARY, KOREA

The intermittent freshwater discharge has become a critical factor that governs the biophysical processes of the Yeongsan Estuary where the estuary dam altered the development and maintenance of the brackish zone. The timing and quantity of freshwater discharge are mainly driven by extreme rainfall conditions in the river basin. We thus investigated the probability distribution function for the extreme freshwater discharge cases, and established magnitude-frequency relationships between basin-wide rainfall and extreme freshwater inflow. With a well-defined event separation algorithm, we found that extreme cases follow the Weibull distribution with k=1.4. The 3-day accumulated rainfall over 104 mm induced the peak freshwater discharge of extreme events 1 day after the rainfall events. Magnitude-frequency relationships are $D=1.111\times10^{1.677\times r_3-1.326T_d^{-0.683}}$ and $T_d=0.117\exp(0.0158r_3)$ where $T_d$ and $r_3$ are return periods of discharge and rainfall, respectively, $D$ is discharge, and $r_3$ is 3-day-accumulated rainfall. These relations provide the framework to evaluate the effects of freshwater discharge on estuarine flow structure, water quality, responses of ecosystems from the perspective of magnitude and frequency. (Abstract ID 11024)

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CONTROL OF THE OCEAN CIRCULATION BY BOUNDARIES AND TOPOGRAPHY

Coastal and bottom ocean boundaries inject fluid vorticity and stir potential vorticity (PV), greatly enhancing the scale-transfer of energy. Boundary-current separation, interior gyres and gyre-stability are affected. Together with other topographic/boundary effects, the control of general circulation by its boundaries presents a challenge to ocean predictability. Both small-scale turbulent/viscous generation and planetary potential vorticity (PV) dynamics are involved. For the simplest barotropic ocean, net entrophy (½ squared vorticity) is generated at rates $\frac{1}{k} \sin 9^\circ$ ds, with $k$ the kinetic energy density, the line integral around the boundary, arc length ds, and $\theta$ the angle of the coast from east. Energy at western boundaries involved. For the simplest barotropic ocean, net entrophy (½ squared vorticity) is generated
Enhanced mixing of North Adriatic Dense Water (NAdDW) occurs in a strong frontal region as this cold and fresh intermediate water enters the Southern Adriatic basin and meets warm and salty Modified Levantine Intermediate Water (MLIW) coming from the Ionian Sea. Hydrographic data from winter/spring 2009 were analyzed to compute source water fractions via a least-squares analysis method and combined with ADCP data to compute fluxes. Results show that NAdDW traveled in a dense thin layer (~5 m thick) between the 25 m and 100 m isobaths before crossing the Palagruža Sill, and extended to 140 m depth after the Sill, where it was mixed and diluted with MLIW and surface water. By the time it reached the mid-point of its journey in the southern basin (Bari region), the percentage of NADW in the water column was about 40-50% less than its original concentration. NADW and MLIW flux estimates along the slope were -0.05 and -0.01 Sv, respectively (southwardly direction) near the sill, while in the Bari region NADW fluxes along the slope reduced to -0.02 Sv and MLIW fluxes increased to -0.08 Sv. (Abstract ID 10380)

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PHYTOPLANKTON COMMUNITY SHIFTS AND INCREASING SURFACE TEMPERATURES IN LONG ISLAND SOUND SINCE 1952

Annual sea surface temperatures in Long Island Sound (LIS) have been warming since the 1950s at the rate of 0.04°C/yr. Temperatures increase highest in winter (Dec - Feb), and the most consistent during the Fall (Oct - Dec). In addition, annual surface Chl A in the Central Basin of LIS has been increasing since the 1990s, and a nonparametric Generalized Additive Model suggests higher winter temperatures best explain the increase. The annual ratio of dinoflagellates to diatoms has apparently increased an order of magnitude since the 1950s and Non-normal Generalized Additive Model suggests that flagellates contribute more chlorophyll at higher temperatures relative to diatoms. This paper will argue that higher temperatures and freshwater inputs associated with climate change, despite nutrient reduction via wastewater treatment, may explain the increased chlorophyll in the Central Basin of LIS. (Abstract ID 9778)

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MIXING IN THE WESTERN EQUATORIAL PACIFIC AND ITS MODULATION BY ENSO

Vertical mixing affects the vertical structure of the ocean and in the tropics, in particular, the interaction between the ocean and atmosphere. High vertical resolution measurements in the western equatorial Pacific reveal that the vertical shear in and above the thermocline is dominated by small vertical scale features that are strongly related to regions of active mixing. Theory and numerical experimentation suggest the sources for this small scale activity include wind-generated near-inertial waves and instabilities of the current system. A striking feature of the mixing is its interannual variability; it being considerably higher during La Nina conditions compared to El Nino conditions. The cause of the reduced mixing during El Nino is the eastward advection of fresher water from the west. The implication is that conventional GCMs are missing a significant source of mixing which is modulated by ENSO. (Abstract ID 9332)

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FIELD-BASED LABORATORIES IN OCEANOGRAPHY AND GEOLOGY DURING A STUDY ABROAD SEMESTER IN ITALY

During fall semester 2011, field-based laboratories were conducted for university-level Introductory Oceanography and Geology courses for a Study Abroad semester in central Italy. To enhance the students' learning in the classroom, we developed field-based laboratories. For the Oceanography course we measured temperature, salinity and suspended material through filtration along the coast of Italy, studied wave and beach processes and biota, and examined the results of slope instability and associated landslide that closed a coastal trail. A tour through the large Genoa aquarium allowed close observations of a wide variety of marine biota and environments. We examined the ruins of Pompeii and Herculaneum and witnessed the destruction caused by Vesuvius in 79 A.D. From the Plinian eruption caused by subduction of the Ionian Plate beneath the Etna Volcano. In an effort to study the effects of sea spray in the marine boundary layer, a numerical code has been developed in which the capability of tracking individual spray droplets has been added to an existing solv solver (see Sullivan, McWilliams, & Moeng, JFM, 2010). This solver can perform either the direct numerical simulation (DNS) or large eddy simulation (LES) of winds over a moving, three-dimensional wave field, and with the addition of Lagrangian spray particles can now approach unresolved questions regarding the transport, thermodynamics, and generation of sea spray. In this poster, we present the initial findings and validations of this code and in doing so demonstrate its applicability to the problem of sea spray. By examining near-surface spray concentration profiles and droplet spectra, these initial simulations provide insight into spray characteristics difficult to measure experimentally. Future research goals are also presented. (Abstract ID 11443)

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AFFECT OF Cd, Cu, AND Zn ON DIATOM PHOSPHORS BUDGETS

As dominant marine primary producers, diatoms mediate a significant fraction of the global phosphorus cycle. The recently recognized role that diatom polyphosphate bodies (PPBs) play in phosphorus cycling, the abundance of diatom frustules in the oceans, and the increased metal loading in the oceans due to anthropogenic activities beg the question of how metal loading affects diatom phosphorus budgets. Here we use SEM, ICP-MS, and colorimetric techniques to examine the effect of Cd, Cu, and Zn free metal concentrations on the cellular phosphorus budget of the coastal, marine diatom Thalassiosira pseudonana. In multiple culture experiments, elevated free metal concentrations resulted in decreased frustule PPB size and associated frustule deformities. At naturally occurring free metal concentrations, only Cu affected frustule PPB size: Cd and Zn had an effect only at metal concentrations encountered in areas highly affected by anthropogenic activities. Furthermore, PPBs became undetectable in the cell at higher metal concentrations. The observations presented here could lead to a more precise mechanistic understanding of global phosphorus cycling, while also detailing a fuller spectrum of effects of coastal industrial processes. (Abstract ID 12338)
IMPACT OF DIFFERENT DIAPICYNAL DIFFUSIVITY PARAMETERIZATION SCHEMES ON OXYGEN CONCENTRATIONS IN THE EAST PACIFIC OCEAN MINIMUM ZONES IN A GLOBAL OCEAN MODEL

This study aims to assess the impact of two commonly used diapycnal diffusivity schemes on the simulated dissolved oxygen concentrations in the east Pacific. For this the GFDL Modular Ocean Model (MOM4p1) is coupled to a biogeochemistry model (TOPAZ) and forced with CORE normal year data. The two background diffusivity schemes chosen for this study differ in their latitudinal dependence. Scheme (1) is almost constant in latitude with slightly reduced diffusivities around the equator. Scheme (2) uses an overall smaller diffusivity with high latitudinal variability. The simulated oxygen concentrations in both experiments are compared to World Ocean Atlas data. First results indicate that the overestimate in the extent and strength of the Pacific oxygen minimum zones under scheme (1) is slightly improved using scheme (2). This supports earlier studies that show similar improved results for other oceanic properties in this region. In addition to the sensitivity study the oxygen concentration in a present day control simulation, the study provides indications on the impact of reduced vertical diffusion due to higher stratification, which can be of interest for future climate conditions. (Abstract ID 9954)

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EVOLUTION OF THE OCEAN’S “BIOLOGICAL PUMP”

In today’s ocean, fixation of carbon at the surface by photosynthesizing organisms and subsequent particulate sinking creates a strong vertical transport that dominates the distribution of carbon, nutrients, and oxygen in the ocean (the “biological pump”). However, earlier in Earth history, the ocean carbon cycle may have been very different. Specifically: an ocean inventory of dissolved organic matter (DOM) orders of magnitude larger than exists today has been hypothesized, and which could potentially help explain a variety of coupled carbon isotopic and climatic excursions in the geological record. But what are the characteristics of this DOM reservoir and how could it build up in the first place? Here we test the assumption that under very low dissolved oxygen conditions, bacterial metabolism of labile organic matter would tend to proceed coupled to sulphate reduction but that less labile organic compounds, degraded rapidly under oxic conditions, would now not be bioavailable. We enable the eGENIE Earth system model with DOM fractions of varying degradability and explore both the steady state and dynamical implications of an ocean biological pump dominated by DOM. (Abstract ID 10959)

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TOWARD A CLIMATOLOGY OF LAKE SURFACE TEMPERATURE FROM AVHRR 1-KM FOR THE MAJOR PREALPINE WATER BODIES WITHIN SWISS GCOS

To estimate lake surface temperature (LST) from satellite data, we have developed an algorithm to derive LST from AVHRR (Advanced Very High Resolution Radiometer) data archived at the University of Bern. This study proposes an adjusted algorithm to derive LST from AVHRR. The Radiative Transfer for TOVS (RTTOVS) and European Centre for Medium Range Weather Forecasts (ECMWF) reanalysis data are used to improve the retrieved LST by correcting for atmospheric water vapor effects. A short time series over the past 10 years is presented and validated against in situ LST measurements from Lake Geneva and Lake Constance. In a future step, the successful method will be applied to our whole data archive covering 1989 to 2011, including smaller lakes as well. (Abstract ID 9885)

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THE DISTRIBUTION OF DISSOLVED IRON IN THE WESTERN ATLANTIC OCEAN

Iron (Fe) plays a key role in the regulation of primary production and dinitrogen fixation in large parts of the world oceans. Because there is an increasing urgency to understand the role of the oceans in global climate, it is paramount that we understand the biogeochemical cycle of bio-essential elements such as Fe. Despite this recognized importance there is still limited knowledge of the sources, sinks, chemistry and internal cycling of Fe. To fill this gap in our knowledge, the distribution and organic speciation of dissolved Fe (DFe) have been measured during three Dutch GEOTRACES cruises. Together, these cruises form a comprehensive, high resolution, full-depth section through the western Atlantic Ocean from Iceland to 90S. In this presentation we will evaluate the distribution of Fe and its speciation using many other parameters such as dissolved oxygen, fluorescence, the macronutrients phosphate, nitrate and silicate and trace elements like dissolved aluminium (DAI) and dissolved manganese (DMn), to understand the processes that determine the distribution of DFe. (Abstract ID 9708)

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TEMPORAL TRENDS IN BEGGING BEHAVIOR OF COMMON BOTTLENOSE DOLPHINS (TURPINOS TRUNCATUS) IN WATERS AROUND SAVANNAH, GEORGIA

The feeding of wild dolphins worldwide has created risks to both dolphins and humans. In previous studies, Savannah, Georgia had the highest rate of begging behavior by common bottlenose dolphins (Tursiops truncatus) of any published research. However, this research was conducted in the summer; to date, temporal trends of begging behavior have not been investigated year round. Thus, temporal trends in begging behavior were analyzed from 2009 - 2011. The percentage of days and sightings with begging were analyzed for monthly and weekly (i.e., weekdays vs. weekends) trends. The highest percentage of sightings and days with begging occurred during the months of January and September (28.57% and 25% of sightings, respectively and 100% and 100% of days, respectively); however, these months also had a low number of survey days. In addition, weekdays had a higher percentage of sightings with begging (25.93%) and days with begging (91.67%) than weekends (18.63%; 72.41%). These results were unexpected and may be due to small sample size in the non-summer months or temporal trends in prey fish availability or recreational boating activity. (Abstract ID 10113)

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THE ROLE OF TIDAL FLATS IN THE COASTAL HEAT BUDGET: SOURCE OR SINK?

Recent field measurements on the Skagit Bay tidal flats (Washington State, USA) suggest that the presence of the flats alters the heat budget of the bay. The flats heat rapidly during the midday low tides and release this heat back to the water column during the flood tide. A simple 2-D numerical model of water fluxes and heat transfer over a tidal flat was developed to examine the regional heat budget. The model results are consistent with both in situ and aerial field observations of temperature. Seasonal test cases demonstrate the effect of tidal and solar phases, which is significant in the Pacific Northwest. During the summer when lower water occurs during the midday, the flats store heat and act as a net source of heat to the water. Conversely, during the winter, when lower water occurs during the night, the flats cool more quickly than the surrounding water and act as a net heat sink to the water. The sediment-water heat fluxes represent about 20% of the total heat flux to the water column. (Abstract ID 11612)

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SPATIAL-TEMPORAL VARIABILITY OF NEARSHORE FECAL INDICATOR BACTERIA: THE RELATIVE IMPORTANCE OF FLUID DYNAMICS AND EXTRA-ENTERIC
BACTERIAL MORTALITY

Two major factors determine the spatial and temporal distributions of nearshore fecal indicator bacteria (FIB): local circulation and mixing patterns (fluid dynamics), and extra-enteric bacterial mortality. The relative contribution of these processes to nearshore FIB variability, however, is uncertain, largely because field programs with high resolution physical and bacterial measurements have been few. We present results from a 5-hour field program that took place in 2006 at California’s Huntington State Beach. Joint physical (waves and currents) and bacterial (E. coli and Enterococcus) observations were made during this study, and were used to parametrize individual based physical-biological models designed to identify dominant mechanisms controlling FIB variability. Seven models were developed, one containing only fluid dynamics (advection and diffusion), and six exploring different FIB mortality mechanisms. Our results indicate that fluid dynamics alone can explain surface FIB variability reasonably well, although rates of FIB loss tend to be underestimated. By including extra-enteric mortality in our FIB models we were able to significantly improve both our estimates of FIB variability and total FIB loss. Improvements were dependent upon the FIB mortality mechanism modeled. (Abstract ID 10515)

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THE USE OF DISSOLVED OXYGEN SENSORS ON PROFILING FLOATS: TECHNICAL CHALLENGES AND DATA QUALITY

Dissolved oxygen is the most basic biochemical property that can be measured in the ocean, with a long history and large archive of shipboard-based measurements based on Winkler titrations. There are now over 200 profiling floats deployed in the world ocean equipped with several varieties of dissolved oxygen sensors that are vastly increasing the volume of data in this archive. There are problems of calibration, drift, and reliability associated with these sensors that must be assessed and solved in order to maximize the usefulness of the data. We discuss here the data quality from several different sensor types, comparisons to the historical archive, and correction procedures that can improve the quality of the measurements. Ultimately it is desirable for oxygen data collected from profiling floats to be accurate to 1 micromole/kg over times of several years, and it appears not unreasonable that this goal can be attained in the near future. (Abstract ID 11537)

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OBSERVATIONS OF ANOMALOUS NEAR-SURFACE LOW-SALINITY PULSES OFF THE CENTRAL OREGON COAST

The Columbia River plume is a dominant feature of the Pacific Northwest coastal hydrography. In response to local winds, the plume flows northward over the shelf in fall and winter, and southward offshore in spring and summer, affecting the biochemical and physical properties of the shelf system. From mid-May through July 2011, extreme Columbia River discharge, associated with an anomalously high snowpack, ranged from 14,000-16,000 m$^3$/s, more than two standard deviations above the mean for this period. This freshwater discharge was detected 180 km south of the river mouth off Newport, OR, where salinity values of 22 were recorded. We present the spatial/temporal evolution of these low-salinity pulses during June and July 2011. Analysis of in situ data off of Newport collected from OSU autonomous underwater gliders, Ocean Observatories Initiative (NSF funded) and the Northwest Association of Networked Ocean Observing Systems (NANOOS; NOAA funded) moorings, as well as remotely sensed data, show that the onshore-offshore location of the plume front is not controlled by riverine discharge rates, but rather by Ekman dynamics, and that these freshwater pulses reach the coast. (Abstract ID 10465)

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MARINE EDUCATION THROUGH THE EYES OF AN ARTIST; TRANSLATING SCIENTIFIC DATA THROUGH NEW MEDIA

Addressing the issue of marine plastic pollution from an artist/educator’s perspective, a different way is offered to represent and communicate the hard scientific data currently the focus of many marine scientists, toxicologists, epidemiologists, and policy-makers. Ristuben’s current project deals with the use, over-use, and disposal of plastics, their toxicity, and their concentration in ocean ecosystems including the marine food chain, a multi-media performance/lecture format. Using personal and archival video and photography, and presenting the facts and data in an aesthetically compelling format results in a message with affect and power. The presentation is based on Ristuben’s extensive research and her personal story, including her voyage in July 2011 through the North Pacific Gyre with a science team led by Algalita Marine Research Foundation. (Abstract ID 9372)

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EFFECTS OF “HOST FACTOR” ON PRODUCTIVITY OF ZOOXANTHELLAE AND ZOOCHLORELLAE IN THE ANEMONE ANTHOPLEURA ELEGANS TSIMISSIMA

The anemone Anthopleura elegantissima can host distinct algal symbionts: zooxanthellae and zoochlorellae. Previous research with isolated zooxanthellae indicates that a chemical host factor increases the photosynthetic rate of the symbiont and the amount of photosynthetic products they release. However, it is unknown whether zoochlorellae also respond to host factor and how the two symbionts respond to host factors from anemones in different symbiotic states. Isolated algae from anemone hosts were transplanted to anemone tissues from zooxanthellae, zoochlorellae and symbiotic A. elegantissima. Photosynthetic rates and the release of photosynthetic products were measured using C. Carbon fixation rates for both symbionts increased in all anemone tissues relative to filtered seawater (FSW) controls. Carbon release from zooxanthellae increased in all anemone tissues relative to FSW, but carbon release was inhibited in zoochlorellae when placed in animal tissues. We saw no evidence of a host factor that increases release of photosynthetic from the symbionts, but we did see increased rates of photosynthesis in all treatments. This study contributes to understanding symbiotic associations, particularly in light of the challenges produced by climate change in corals. (Abstract ID 9767)

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CLOSURE IN VALIDATION AND CALIBRATION OF OCEAN COLOR SENSORS: OCEAN OPTICS SUMMER COURSE 2011

One of the main goals of the 2011 Ocean Optics Summer Course, entitled “Calibration and Validation for Ocean Color Remote Sensing” held at the Darling Marine Centre (Maine), was to train participants in obtaining accurate and precise high-quality data and achieving agreement among measurements from different instruments and/or methods. Inherent-optical properties (IOPs), radianetic measurements (AOPs) and discrete water samples taken simultaneously during two one-day cruises in the Gulf of Maine, presented an excellent opportunity to assess closure. Four different case-studies are presented to evaluate closure between instruments and methodologies. We compared (1) Remote sensing reflectances measured with radiometers, modeled with HYDROLIGHT, and extracted from the MODIS AQUA images, (2) semi-analytic inversion models to obtain IOPs from AOPs, (3) diffuse attenuation coefficients estimated from AOPs and IOPs and (4) Chlorophyll a concentration from fluorometry, absorption spectra and spectrophotometry. Results show good agreement amongst instruments and between in situ and modeled data. This study also shows how important it is to understand the limitations and benefits of measuring the same parameter with more than one instrument to consolidate results and understand uncertainties. (Abstract ID 12465)

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OCEAN OPTICS SUMMER COURSE: BUILDING A COMMUNITY OF OPTICAL OCEANOGRAPHERS
The 2011 Ocean Optics Summer Course held at the Darling Marine Centre (U. Maine) brought together a multicultural, international, interdisciplinary group of 20 students and six instructors. The three-week-long intensive course was funded by NASA in an ongoing effort to train new generations in calibration and validation techniques for ocean color remote sensing. Students were immersed in an intensive learning environment consisting of lectures, hands-on laboratories, collaborative reports and two cruises. The combination was effective for conveying state-of-the-art techniques, fundamental concepts of ocean optics, and good practices for data collection and processing. Course participants made two substantive contributions to the scientific community: 1) a detailed portfolio document, and 2) a formal submission of field data to the NASA SeaBAS database. The portfolio contains in-depth explanations on the instruments used, including set-up procedures, protocols for accurate measurements, and step-by-step descriptions for data processing. This type of short course has a deep impact on the participants' careers, developing teamwork and organizational skills, networking and international collaboration. (Abstract ID 11928)

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TRANSCRIPTIONAL RESPONSES OF DEEP WATER BACTERIA AND ARCHAEAE TO HYDROCARBON CONTAMINATION FROM THE DEEPWATER HORIZON SPILL
The Deepwater Horizon oil spill formed a deep subsurface plume of dissolved hydrocarbon gasses and diffuse oil droplets. This influx of labile carbon substrates stimulated the growth of boom-forming microorganisms with the capacity to degrade oil and gas. To understand how these organisms responded metabolically, we sequenced mRNA from four sites inside and outside the plume and used the resulting 78 million reads (~200 bp average length) to partially reconstruct the metabolisms of the responding microorganisms and assemble operons of abundant transcripts. Metabolic reconstruction revealed that methane was consumed by a unique group of microorganisms with highly divergent particulate methane monooxygenases, primarily using the ribulose monophosphate pathway for both carbon assimilation and energy production. The degradation of other hydrocarbons was carried out mainly by Gamma proteobacteria related to known oil degraders and organisms resembling sulfur-oxidizing bacteria, although the latter did not appear to be oxidizing sulfur. The diversity of the community transcript pool as well as the taxa producing them decreased sharply in response to increased hydrocarbon concentration and the concomitant oxygen depletion. (Abstract ID 11356)

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THE RELATIONSHIP BETWEEN WIND STRESS AND EKMAN CURRENTS IN THE ANTARCTIC CIRCUMPOLAR CURRENT
Ekman theory is a keystone of oceanography. The simple case of constant wind forcing and constant eddy viscosity is well understood. The resulting net transport corresponds well with observations. However, details such as the rates of rotation and velocity decay of observed Ekman spirals do not fit well with classical Ekman theory. This suggests that other factors such as wind-forcing frequency and stratification could be significant. We examine the dependence of Ekman spirals on the frequency of wind forcing using a spectral technique which involves the estimation of transfer functions using wind-stress autoco spectra and cross spectra between wind-stress and Ekman currents at a constant depth level to estimate transfer functions. By comparing transfer functions from observations with transfer functions derived for theoretical eddy viscosity profiles it is possible to infer properties of mixing within the Ekman layer. In this study we apply this technique to ocean velocity data from 8 EM-APEX profiling floats. The floats collected velocity, temperature and salinity data at 3-5 day resolution to 1600 dbar across the northern Kerguelen Plateau during 2008. (Abstract ID 9318)

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VARIABILITY OF THE SURFACE CURRENTS IN THE MID ATLANTIC BIGHT ON THE SCALE OF DAYS TO YEARS
The maturation of ocean observing systems now allows scientists and engineers the opportunity to measure the ocean in never before seen ways. The Mid Atlantic High Frequency radar network has been in operation for four years with fourteen long-range SeaSonde type HF radars providing surface current measurements once an hour on a continuous basis. The network spatial and temporal coverage allows for research on the impact and response of the Mid Atlantic Bight due to wind forcing, stratification and river inputs. Surface currents from the network during a four-year study were summarized into seasonal and annual means. These means were examined and compared between each other and with meteorological observations. The network was also able to capture the surface current response to the passage of Hurricane Irene in August 2011. Initial findings indicate that the inertial currents are stronger on the outer part of the shelf. These inertial currents took approximately five days to decay after the passage of the hurricane. (Abstract ID 12650)

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THE 2011 ATCHAFALAYA RIVER FLOOD AND A POSSIBLE ALTERED SYSTEM STATE FOR THE ATCHAFALAYA RIVER DELTA ESTRAY
In May 2011, record rainfall events in the Mississippi River basin resulted in over 23,000 m3/s of water passing through the Atchafalaya River into the Atchafalaya River Delta Estuary and the northern Gulf of Mexico. We examined how this extreme event altered carbon quality, nutrients, and sediment transport to the Gulf, as well as the effect of these biogeochemical changes on ecosystem respiration and the food web. We compared measurements made before, during and after (2, 6, 9, 20, and 30 weeks) peak discharge with 3 years of previous measurements. Specifically, we quantified how the flood altered riverine particulate and dissolved carbon and nutrient fluxes, POC age-structure and sediment transport and deposition rates and how these changes influenced water column and benthic respiration, nutrient uptake, and denitrification activity (dinitrogen:argon patterns). Initial results indicate benthic respiration and nutrient fluxes were lower post-flood and the location where sediments switched from a net sink to source for DIN shifted as the hydrograph receded. Extreme flood events can dramatically change biogeochemistry of the receiving estuary for time scales beyond that of the flood event. (Abstract ID 12782)

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POSSIBLE EFFECTS OF A PROPOSED GEOENGINEERING PROJECT ON THE OCCURRENCE OF SEASONAL DIATOM BLOOMS IN THE NORTH PACIFIC SUBTROPICAL GYRE
Some researchers have proposed a geoengineering project in the North Pacific Subtropical Gyre (NPSG) using pipes to enhance vertical mixing and carbon sequestration. It is unknown whether the proposed project will enhance or completely alter the large seasonal diatom blooms that occur in this region. While studying a diatom bloom in the NPSG in 2008, we conducted a simulated (mesocosm) mixing experiment in nearby waters located outside of the bloom, with three control treatments (20m water) and three mixing treatments (20m and 300m water). Although diatom biomass increased 5-fold in the mixing treatments, growth rates of the primary bloom-forming diatom Hemiaulus hauckii were identical in both control and mixing treatments (0.30 ± 0.012 day-1). Hemiaulus hauckii was one of the most abundant diatom species in the control treatments, and microscopic observations showed the presence of nitrogen-fixing cyanobionts, while the mixing treatments were dominated by an assemblage of fast-growing (> 1 day-1), thinly-silified solitary diatoms with no cyanobionts. Our study provides preliminary evidence that the proposed geoengineering project in the NPSG
could alter diatom community composition and biogeochemistry in these waters. (Abstract ID 12796)

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LOCALIZING SWARMS OF MINIATURE VEHICLES FOR STUDYING SUBMESOSCALE DYNAMICS: A STATUS REPORT

As part of a cross-disciplinary project to develop swarms of miniature vehicles to study submesoscale dynamics, we have performed localization experiments for vehicles that are passively recording in shallow water. Experiments consisted of creating a long baseline navigation system adjacent to Mission Bay, San Diego, by deploying 5 surface spar buoys, approximately 1.5 km apart, that transmitted precisely timed signals to a set of underwater recording hydrophones at known positions. Temperature profiles were also recorded. Positions of the underwater hydrophones, as computed numerically, were then compared to the known positions derived from GPS data. The numerical inversion technique used the differential arrival time between pairs of transmitters. This is necessary as the underwater vehicles are not capable of transponding. Results indicate that the vehicles can be localized with 5 – 10 meter scale resolution using a ray trace forward model in concert with a direct search algorithm. Increased positional resolution can then be obtained by combining multiple pings and applying tracking algorithms. (Abstract ID 11401)

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CRITICAL CONCERNS AND LATITUDES: TIDAL EFFECTS ON ICE SHELVES OF THE AMUNDSEN SEA

Although circulation in ocean cavities below ice shelves is primarily density driven and controlled by topography, tides play a role and their role is complex. The role of tides in the circulation under the ice shelves Amundsen Sea was examined using the Regional Oceanic Modeling System (ROMS). Tidal influence varied widely and was highly dependent on the position of the ice shelf front and or grounding line with respect to M2 semidiurnal critical latitude. Ice shelves near and equatorward of the critical latitude experienced an increase in melting of 3 m/yr attributable to tides compared to those poleward of the critical latitude. Mean currents had the capacity to shift the critical latitude up to 5o, essentially modifying it to an effective critical latitude, further complicating the dynamics. Along with the increase in melting, there was a corresponding increase in the baroclinicity of the velocity fields and an increase in mixing for ice shelves equatorward of critical latitude or effective critical latitude when a mean circulation was present. This has implications for other ice shelves within 5o of semidiurnal critical latitudes. (Abstract ID 10740)

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QUANTIFYING GLOBAL-SCALE DEPENDENCIES BETWEEN JELLYFISH AND CLIMATE FORCES: AN ANALYTICAL APPROACH USING THE JELLYFISH DATABASE INITIATIVE

Previous work on relationships between climate and jellyfish suggest variations in the El Niño Southern Oscillation and North Atlantic Oscillation frequently drive the occurrence and size of blooms. However, dependencies between jellyfish and climate are often complex across space and time and other large-scale climate phenomena such as the Atlantic Multidecadal Oscillation may be important. While several reviews of climate effects on jellyfish have been conducted, the paucity of long-term observations at a sufficient spatial and temporal breadth has precluded a quantitative, global-scale analysis. Development of the Jellyfish Database Initiative enables tests of climate effects on the occurrence and magnitude of blooms to be performed for the first time at this scale. A multi-step analytical approach was used to test hypotheses. Data sets were generated by combining canonical, categorical and presence/absence observations. Multivariate statistics and linear models were used to test relationships between variations in jelly abundance and bloom occurrence and climate forces in global temperature zones. These results will aid marine resource managers by allowing forecasts of the expected impact of blooms on food webs during various climate regimes. (Abstract ID 11594)

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DISTRIBUTION OF Pb-210 AND Po-210 IN THE WATER COLUMN OF THE ARCTIC OCEAN

The cycling of particulate matter and organic carbon in the upper ocean can be studied using naturally occurring particle-reactive radionuclides. Here we discuss the results on the distributions of Pb-210 and Po-210 in the water column of the Eurasian and the Makarov Basins of the Arctic Ocean. The distribution of both radionuclides throughout the water column showed significant differences in the spatial variability between the continental shelf and the open ocean. Concentrations in the Barents, Kara and Laptev Seas are governed by larger scavenging in the shelf environment. Aside from the role that primary production, riverine inputs and/or resuspension processes may play, we suggest that sea ice melting also enhances particle export and scavenging of both isotopes by the release of particles to the water. Po-210/Pb-210 ratios <1 in particles are hypothesized to be related to the presence of young, detrital particles in the water, derived from sea ice, which are more enriched in Pb-210 than in Po-210 due to the deposition of the Pb-210 atmospheric flux onto sea ice. (Abstract ID 11006)

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A METHOD TO DERIVE THREE-DIMENSIONAL TEMPERATURE AND SALINITY FIELDS FROM AVISO'S GEOSTROPHIC VELOCITIES IN THE BRAZIL CURRENT (22-28S)

We propose a simple method to get three-dimensional (3D) temperature and salinity fields in the Brazil Current (BC) off southeast Brazil (upper 500m; 225-285) from AVISO’s geostrophic velocities. We first used the dynamic topography fields to obtain a parameterized horizontal structure function for the geostrophic stream function. We also fitted a vertical structure function to a mean velocity vertical profile derived from in situ velocity measurements. Using the vertical structure function and the stream function field we computed the 3D density perturbation field. Considering a linear approximation to the T-S relationship and a linearized form of the equation of state, we associated these density perturbation field to temperature (T) and salinity (S) perturbation fields. To get full T and S fields, we summed up T and S perturbations to the climatology. The geostrophic velocity computation of the obtained fields showed that the perturbations added energy to the climatological BC, closely resembling the near-surface in situ data available for the area. Finally, we interpolatated these fields (upper 500m) and a background climatology, to get 3D fields (surface to the bottom). (Abstract ID 11502)

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STORMINESS CONTROLS ON SOUTHERN OCEAN BIOGEOCHEMISTRY AND ECOSYSTEMS

A common characteristic of IPCC AR4 models is a tendency towards increased storminess (by 20-30%) over the 21st century under climate change scenarios. Given that storms are known to play a role in sustaining mixed layer depth during summer, it is important to understand how such dynamical changes may project onto ocean biogeochemistry, and whether there is an expected feedback on the carbon cycle, under climate change. As a first step towards understanding, we have conducted a series of model perturbation studies where we have introduced changes in mixed layer depth in summer (in the absence of changes in the mean seasonal cycle of momentum and buoyancy forcing at the sea surface). The dynamical model used is NEMO, the biogeochemical model is PISCES, and the surface forcing is derived from the extended/interim ERA-40 reanalysis over 1958-2006. The model results indicate that large MLD in summer over the Southern Ocean drives a reduced uptake of carbon by SAMW. For carbon-cycle coupling, this sensitivity over the Southern Ocean to changes in vertical mixing in response to increased storminess may be interpreted as being a positive climate feedback of the same order as the Southern Ocean carbon saturation mechanisms presented by Le Quéré et al. (2007). Efforts are currently under way to identify the relative roles of biological and physical entrainment processes in driving the response of the model. (Abstract ID 12703)

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The genome of the marine nitrogen-fixing cyanobacterium *Trichodesmium* contains an ABC transporter for ferric iron and a ferrous iron transporter of the *Feo* family, raising the question of how iron is acquired from ferric citrate complexes by these organisms. This suggests that the utilization of ferric citrate complexes by *Trichodesmium* may not involve a reductive pathway, raising the question of how iron is acquired from ferric citrate in the absence of a conventional TorB-dependent uptake system. (Abstract ID 11372)

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**PHYTOPLANKTON DYNAMICS IN THE GULF OF MEXICO: WHAT TEN YEARS OF HOURLY OBSERVATIONS AT SEVEN LOCATIONS REVEALS**

The Gulf of Maine Moored Buoy Program (formerly GOMOOS) was initiated in July 2001. In addition to meteorological and hydrographic observations, a suite of optical sensors were deployed on seven of the buoys: two in estuaries, four on the shelf and one in the deep Jordan Basin. The determination of phytoplankton biomass from chlorophyll fluorescence presents several challenges: sensor calibration and characterization, dilution variations, and quantification of the natural variations induced by species composition, growth phase, photoacclimation. This unique data set provides a window into quantifying the dynamics of phytoplankton in a marginal sea. Spatio-temporal analysis suggests that there are two distinct modes of seasonal bloom development, highly linked to hydrologic forcing, and that there is a geographic trend to these modes. Blooms can be further decomposed into a series of miniblurs driven by local forcing but spatially coherence across the gulf. Finally, it is possible to quantify the connection between inland sounds and coastal waters to separate regional from local hydrographic forcing, which has significant implications for the development of the toxic blooms of Alexandrium fundyense. (Abstract ID 10027)

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**MODELING THE TEMPORAL AND SPATIAL OVERLAP BETWEEN ATLANTIC BLUEFIN TUNA SPAWNING HABITAT AND DEEPWATER HORIZON OIL SPILL IN SPRING 2010**

The potential effects of the Deepwater Horizon oil spill on the spawning success of Atlantic bluefin tuna (Thunnus thynnus) will depend on the extent that oil contaminated the spawning habitat of this large, economically and ecologically important internationally managed apex predator. The extent of the overlap has both spatial and temporal dimensions. AFT larvae data used for the models were derived from 20 years (1990-2010) of the NOAA NMFS SEAMAP ichthyoplankton cruises. Satellite data (sea surface temperature and derived chlorophyll + CDOM) and in situ environmental observations over these 20 years were used to create preferred models to explore relationships leading to the occurrence of bluefin tuna (AFT) larvae. Four environmental variables plus day of the year were combined into a three layer, multilayer perception neural network model which predicted the probability of occurrence of AFT larvae. Oil spill impacted the northern GOM during the spring spawning season of AFT. Although eggs and larvae were likely impacted by oil-contaminated waters in the eastern GOM, high abundances of larvae were located in suitable habitat prior to the spill and in the western GOM away from the influence of the spill. This suggests that only 10-12% of the 2010 spawning habitat for AFT was impacted by the Deepwater Horizon oil spill. (Abstract ID 9816)

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The exterior and interior of the massive sulfide. (Abstract ID 11303)

Finally, we present phylogenetic descriptions comparing the gene populations recovered from elevated rates in the interior as opposed to the exterior of the sulfide and a loss of activity above between the outer crust and interstitial material of a massive sulfide as well as across a range of temperatures (4-90°C) that are typical in such environments. In particular the data show elevated rates in the interior as opposed to the exterior of the sulfide and a loss of activity above 50°C. qPCR of dissimilatory sulfite reductase subunit A (dsrA) genes was employed to estimate the abundance of sulfite reducing organisms on the surface and within the sulfide structure. Finally, we present phylogenetic descriptions comparing the gene populations recovered from the exterior and interior of the massive sulfide. (Abstract ID 11303)

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SULFATE REDUCTION RATES FROM COMMUNITIES HOSTED WITHIN AND ON MASSIVE SULFIDE DEPOSITS.

Sulfur metabolism is central to the ecology of deep-sea hydrothermal vents. While much of the research focus has been on the oxidation of dissolved sulfur compounds and the geochemical consequences of such process in the local environment much less emphasis has been placed on the reduction of sulfur to fuel biogeochemical processes. Here we present data concerning the rates of sulfate reduction by epifaunal endolithic organisms from venting massive sulfides. We demonstrate broad differences in the rate of this metabolically important reaction between the outer crust and interstitial material of a massive sulfide as well as across a range of temperatures (4-90°C) that are typical in such environments. In particular the data show elevated rates in the interior as opposed to the exterior of the sulfide and a loss of activity above 50°C. qPCR of dissimilatory sulfite reductase subunit A (dsrA) genes was employed to estimate the abundance of sulfite reducing organisms on the surface and within the sulfide structure. Finally, we present phylogenetic descriptions comparing the gene populations recovered from the exterior and interior of the massive sulfide. (Abstract ID 11303)

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WAVE-DRIVEN HYDRODYNAMICS OF SPUR-AND-GROOVE FORMATIONS ON A CORAL REEF

Spur-and-groove formations are found across the fore reefs of many coral reefs worldwide, and are typically along-shore periodic ridges of active coral growth (spurs) separated by low areas or depressions of sediment and coral debris (grooves). Although these formations are known to primarily form in wave-dominated environments and be influenced by wave direction and power, their exact hydrodynamic function is not well understood. In addition, incoming oceanic flow and high exchange is well known to favor coral growth; while areas of high sediment concentration do not. Using a 2D, depth-averaged, phase-resolving nonlinear Boussinesq model (funwaveC) we present modeling results of both a simplified spur-and-groove system and a case study from southern Molokai, HI, under various hydrodynamic conditions. Based on the modeling results, we show that the spur-and-groove formations form a nearshore circulation pattern of onshore flow over the spurs and offshore flow over the grooves, favoring coral growth on the spurs. In addition, we show a higher wave-velocity distribution over the spurs that also favors coral growth on the spurs. (Abstract ID 10052)

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HYPOXIA: REFUGE OR DEAD ZONE FOR COPEPODS?

In coastal waters there are examples of copepods spending part of the day in hypoxic (oxygen < 2 mg L-1) bottom waters which serve as a refuge for predators. Other studies have shown that copepods avoid hypoxic waters and aggregate higher in the water column where greater light levels may make them more susceptible to predation. We will review the hydrographic conditions that occur with these copepod different behaviors, compare species differences and review different physiological adaptations that facilitate life in low oxygen environments for copepods. (Abstract ID 10536)

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AN ANALYSIS OF NSF OCEAN SCIENCES RESEARCH EXPERIENCE FOR UNDERGRADUATE SITE PROGRAMS FROM 2009 THROUGH 2011

The Research Experience for Undergraduate (REU) Program at the U.S. National Science Foundation (NSF) provides U.S. undergraduate students from any college or university the opportunity to conduct research at many different institutions and gain a better understanding of research career pathways. The Division of Ocean Sciences (OCE) REU Sites foster research opportunities in areas closely aligned with OCE’s research programs. The aim of this paper is to provide an overview of the Ocean Sciences REU Site programs run in 2009 through 2011. A survey requesting information on recruitment methods, student demographics, enrichment activities, and fields of research was sent to the Principal Investigators of each of the active OCE REU Sites. Over 94% of the surveys were returned with the requested information from about 19 to 26 sites each year. The admissions rate for REU Sites in ocean sciences varies from 6% to 9%, with the majority of participants being rising seniors and juniors. Some of the participants come from non-PhD granting institutions, and a large majority of the participants are women. Regarding ethnic diversity, the REU Sites reflect the difficulty of attracting diverse students into ocean sciences as a discipline; a large majority of participants are Caucasian. Furthermore, participants from minority-serving institutions and community colleges constitute a small percentage of those taking part in these research experiences. (Abstract ID 10873)

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AN ENERGICAL ALGORITHM FOR OCEAN WAVE RETRIEVALS FROM SCANSAR IMAGES UNDER TYPHON CONDITION

The synthetic aperture radar (SAR) imaging of ocean waves is a complicated process, involving a variety of wavenumber- and direction-dependent, partly nonlinear modulation mechanisms as well as effects of noise. Traditional wave retrieval techniques use linearized models or iterative optimization schemes to invert SAR image spectra into estimated ocean wave spectra. This can lead to questionable results, especially under high sea state conditions, where the imaging mechanism gets increasingly nonlinear. Furthermore, the inversion of image spectra requires an explicit visibility of wave signatures in the image, but some wide-swath ScanSAR images cannot resolve wavelengths below 100 or even 150 meters, and many images of hurricane and typhoon scenes do not even exhibit clear signatures of longer waves. To overcome these problems, we have developed a full-energical wave retrieval algorithm, which determines peak wavenumbers and directions from image spectra, but exploits the correlation between significant wave height (SWH) and mean image intensity to obtain SWH estimates.
independent of resolved wave patterns. We explain the proposed algorithm and present results obtained from C-band and X-band ScanSAR images of typhoons. (Abstract ID 10253)

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ORGANIC GEOCHEMICAL EVIDENCE FOR OIL SPILL IMPACTS ON FISH IN THE GULF OF MEXICO: COMPARATIVE AND QUANTITATIVE ANALYSES OF POLYCYCLIC AROMATIC HYDROCARBONS

Blowout of the Deepwater Horizon drill rig in the Gulf of Mexico (GoM) resulted in an extensive oil layer at the surface, dispersed micro-droplets throughout the water column, and sub-surface plumes. Novel observations of fish disease, including external ulcerative lesions, have been made in regions proximate to oil-impacted areas. In order to evaluate long-term impacts of the oil spill on upper trophic levels within the GoM, polycyclic aromatic hydrocarbons (PAHs) were measured in fish from the continental shelf, continental slope and deep sea, and were compared to PAHs from the Macondo-MC252 source. Quantification included 18 target unsubstituted PAHs and five target alkylated PAH homologues. Independent of fish species or body weight, concentration of PAHs in liver samples from epipelagic fish were high with only 10% from unsubstituted PAHs (mostly 2-3 ring PAHs dominated by naphthalene) and up to 90% from alkylated PAHs of petrogenic origin. A large portion of fish species or body weight, concentration of PAHs in liver samples from epipelagic fish were high with only 10% from unsubstituted PAHs (mostly 2-3 ring PAHs dominated by naphthalene) and up to 90% from alkylated PAHs of petrogenic origin. A large portion of PAHs were found dominated by alkylated benz(a)anthracene/chrysenes homologues. Results of this initial survey indicate that fish were exposed to petrogenic PAHs, possibly through ingestion of contaminated prey and/or direct environmental exposure. (Abstract ID 11692)

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WAVE-CURRENT INTERACTION NEAR A SST FRONT

We present an analysis and modeling of wave observations collected near Bodega Bay during the Hi-Res Experiment in June 2010. This study is focused on the interaction between waves and currents near a sea surface temperature (SST) front with strong visible signatures of enhanced wave breaking. The CIRIAS Twin Otter aircraft was equipped with the Airborne Topographic Mapper (ATM), a scanning LIDAR to measure the sea surface elevation, instruments to measure the atmospheric turbulent fluxes, as well as visible and infrared video imagery to provide information about the breaking waves and the SST, respectively. Airborne observations were collected under the foot print of a coastal high frequency radar array, which provided supporting surface current information for the modeling and interpretation of the wave observations. The data show that the SST front corresponds to a region with sharp gradients of surface currents and enhanced wave breaking. The measurements and modeling of the wavenumber wind-wave spectra give similar changes in spectral saturation, and directional spreading across the front. The results are discussed in the context of wave-current interactions and related air-sea fluxes. (Abstract ID 12057)

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EFFECTIVENESS OF A NON-PHYSICAL BARRIER ON ROUTE ENTRAINMENT OF MIGRATING JUVENILE SALMONIDS IN THE SACRAMENTO-SAN JOAQUIN RIVER DELTA

The Sacramento-San Joaquin River Delta is a large estuary that has been intensely altered by a complex bathymetry, a very large tidal range, and a marked seasonality of the oceanic, atmospheric, and biological processes. In this study, a detailed description of the seasonal cycle of the chlorophyll-a concentration, from the SeaWIFS ocean color sensor data, and the winds, from the QSCAT scatterometer data, is presented. An analysis of the relationship between these two variables and its link with other physical mechanisms, like mixing and upwelling, is made for different regions within the GC. (Abstract ID 11990)

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PERFORMANCE EVALUATION OF HYCOM GULF OF MEXICO MODEL

In 2009, a comprehensive field study began, aimed to investigate Loop Current circulation dynamics, eddy–shedding mechanisms, and forcing of lower-layer flows in the Gulf of Mexico. This study utilized a mapping array centered near 26°N 87°W, which consisted of 9 full-depth and 7 near-bottom moorings as well as 25 bottom-mounted pressure equipped inverted echo sounders. Moorings were deployed in April 2009 and data recovered via rotation or telemetry in July and November 2010. Measurements were compared to output from the 1/25th degree resolution Gulf of Mexico HYCOM model with data assimilation. Model–to-model comparison revealed high temperature correlations and moderate to high correlations for both zonal and meridional velocity, with array-averaged correlations in the thermocline of 0.81, 0.71, and 0.79, respectively. Time-averaged eddy kinetic energy (EKE) showed comparable, but higher, values of deep EKE in the mooring array. A case study of upper and lower layer flows during the separation of Loop Current Eddy Franklin showed similar features between model and mooring array. In particular, both indicate that deep cyclones are generated beneath the Loop Current during the separation process. (Abstract ID 9862)

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PLAYING THE SHELL GAME: ASSESSING DISTRIBUTIONS OF INTERTIDAL CALCIFYING SPECIES AND THEIR MINERALOGIES ALONG THE CALIFORNIA CURRENT LARGE MARINE ECOSYSTEM
Ocean acidification (OA) has emerged as a major threat to marine biodiversity, ecological functioning and ecosystem services. One prominent hypothesis is that OA will affect calcifying species more adversely than non-calcifiers. In addition, the crystalline form of calcium carbonate (e.g., aragonite, calcite) may also drive differential sensitivities among calcifiers. Both hypotheses suggest that there will be ecological winners and losers under future OA conditions. Few studies have attempted to place these hypotheses into ecological contexts. Using a 4-year dataset of intertidal biodiversity surveys at 49 sites spanning 16° in latitude along the US West, we have compiled the first understanding of the spatiotemporal and environmental distributions of calcifiers and their mineral forms along the California Current Large Marine Ecosystem. Our results indicate differences between mobile and sessile calcifiers in their primary calcium carbonate forms. We also found latitudinal trends in the distribution of sessile mineralogies. In the context of environment, decreased abundances of low-magnesium calcitic species are associated with increased temperature, increased upwelling and decreased primary productivity whereas abundances of high-magnesium calcitic and aragonitic organisms show the opposite trends. (Abstract ID 12452)

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MODERN VS. ANCIENT EVENT LAYERS ON THE WAIPAOA CONTINENTAL SHELF: CHARACTERISTICS, MODES OF INITIATION AND DEVELOPMENT THROUGH THE LATE QUERNARY

Analyses and comparison of 8 box cores (representing historical timescales) and 5 giant piston cores (~34 ka dated to 18ka) retrieved from the continental shelf adjacent to the small, high-yield Waipaoa River, New Zealand, during two MARGINS Source-to-Sink cruises provide high-resolution records of stochastic event sedimentation throughout the Late Quaternary. Short time-scale, event-layer producing perturbations, such as cyclones, extreme rainfall events, earthquakes and volcanic eruptions can punctuate continental shelf accumulation with large, potentially hyperpycnal, additions of terrestrial sediment with characteristic geochemical and textural signatures. Detailed physical properties analysis of event layers correlated to stable and radiocarbon dating fluctuations help determine several possible modes of initiation. For example, low bulk density events, interpreted to be oceanic floods, are correlated with characteristic depletions of C and significantly lighter than ambient 34S in box cores. Dramatic terrestrial 14C excursions are also found throughout the Holocene and occur associated with X-radiographically and geochemically in box cores, serving as a benchmark with which to compare other events. (Abstract ID 11379)

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BROADBAND ACOUSTICS ON THE VENUS OBSERVATORY IN SAANICH INLET

From a biological oceanographic perspective, long-term high-frequency observatory-based acoustic observations are rich with information on the depths and abundances of fish and zooplankton. The drawback is that with single-frequency data it is difficult to conclusively identify species or even functional groups as present at any given time. This can be done, but only with plenty of supporting data, generally acquired non-autonomously. Broadband acoustic data offers a means of distinguishing between different types of scatterers based on their scattering spectra. Clustering techniques, such as k-means, have shown some success in classifying biological scattering layers. Using two years (Mar: 2008 to Feb: 2010) of broadband (85-155 kHz) echosounder data collected on the VENUS observatory in Saanich Inlet, we address the following questions. Can scattering spectra be an effective descriptor for classification of scattering layers using k-means clustering techniques? Are data from a single broadband transducer sufficient? Can scattering spectra be an effective descriptor for classification of scattering layers using k-means clustering techniques? Are data from a single broadband transducer sufficient?

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UPWELLING OVER NORTH-WESTERN AUSTRALIA: COMPLEX INTERACTIONS BETWEEN THE SURFACE AND SUB-SURFACE CIRCULATION IN THE LEEUWIN CURRENT

The Leeuwin current is an atypical boundary current in the world ocean. Although located on the eastern boundary of the Indian Ocean and being under the influence of quasi-permanent southerly trade winds (upwelling favourable), it flows poleward due to a strong along-shore pressure gradient. The absence of persistent upwelling off the western coast of Australia has been attributed to the presence of this pressure gradient that drives onshore geostrophic flows and overcomes the offshore Ekman drift. However, observational evidence shows that episodic upwelling situations occur year-round, having significant biological impacts, including those on the fringing Ningaloo reef. Using several data sources (time-series of remote sensed, ship-based and climatological in-situ data, and model output), we study the complex physical interaction of the Leeuwin surface current, the associated undercurrent and a wind-driven coastal counter-current. A modified upwelling index was computed to take into account the opposing Ekman and geostrophic forces. We investigate the association of two counter currents, coastal and undercurrent, which might favour stronger upwelling. We conclude with a discussion of the biological implications of such mechanisms. (Abstract ID 10714)

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IMPACT OF CHANGES IN CLIMATE AND HYDROPOWER OPERATIONS ON HABITAT OPPORTUNITY AND SURVIVAL OF COLUMBIA RIVER JUVENILE CHINOOK SALMON

The estuary and plume play a significant role in the life cycle of Columbia River salmon. Basin management requires anticipated knowledge of the changes in fish habitat and survival that might occur as a result of climate change and of the re-negotiation of the US-Canada Columbia River Treaty (which regulates storage capacity in the hydropower system). To begin understanding these changes, we are conducting simulations of river-to-ocean circulation for future scenarios of climate and hydropower operation; climate scenarios derive from work of the Climate Impacts Group at University of Washington, and hydropower operation scenarios are built with advice from federal and tribal agencies. Simulation outputs are then processed through filters linking (a) salinity, temperature, water depth and velocity to favorable habitat opportunity for juvenile Chinook salmon; and (b) salinity intrusion length and plume characteristics to smolt-to-adult returns. Finally, future scenarios are compared among themselves and with contemporary conditions. Early results confirm the potential for substantive changes in the physics of estuary and the plume, resulting in changes in seasonal and inter-annual patterns of physical habitat opportunity and survival rates. (Abstract ID 12176)

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THE IMPACT OF THE ATLANTIC-ARCTIC EXCHANGE ON RISING OCEAN BOTTOM TEMPERATURES AND THE FATE OF GAS HYDRATES

Vast amounts of methane hydrates are potentially stored in sediments along the continental margins, owing their stability to low temperature – high pressure conditions. Global warming could destabilize these hydrates and cause a release of methane (CH4) into the water column and possibly the atmosphere. Since the Arctic has and will be warmed considerably, Arctic bottom water temperatures play a key role in the fate of gas hydrates. A hierarchy of ocean/
sea-ice models has been studied to understand the impact of warm inflowing Atlantic water and the exchange of the Atlantic with the Arctic Ocean on the modulation of bottom water temperatures on interannual to decadal timescales. The future evolution projected by a climate model was analyzed and confirmed strongest impact on shallow regions affected by Arctic inflow. The resulting warming is spatially inhomogeneous. Within the next 100 years, the warming affects 25% of shallow and mid-depth regions containing methane hydrates. Release of methane from melting hydrates in these areas could enhance ocean acidification and oxygen depletion in the water column. (Abstract ID 10977)

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MULTIBEAM MEASUREMENTS OF SEDIMENTATION IN A RETREATING TIDETIDEWATER GLACIER REGIME

The Kronebreen/Kongsvegen glacier complex consists of two convergent tidewater glaciers ending at a single terminus at the southeastern end of Kongsfjorden, Svalbard, Norway. Modern climate forcing has led to a recession of the terminus and an increase in sub- and supra-glacial fluxes of freshwater and sediment. Multibeam swath bathymetry data was collected aboard the Norwegian Mapping Authority R/V Hydrograf from 2004-2008 and used to characterize the glacial retreat and quantify recent sediment flux. These data, once imported into Caris software for post-processing and visualization, provided a georeferenced surface for deriving characteristics of recessionary moraines and scouring. We compared these data to known data on the retreat rate and position of the glacier terminus. Sediment deposition features were identified and, when compared with data from more recent soundings, indicated an increased rate of sediment flux in the fjord. (Abstract ID 11483)

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THE MYSTERIOUS DYNAMICS OF DISSOLVED ORGANIC CARBON IN THE ANCIENT CARBON CYCLE

There is no reason to expect that the oceans’ reservoir of dissolved organic carbon is intrinsically stable. Its voluminous size derives from its slow decay, which in turn depends not only on biological communities responsible for DOC production and consumption but also on the marine environment, all of which can change at long time scales. It follows that pale-DOC concentrations have almost surely evolved over time. But how and when such changes occurred, and how we would know, are open questions. Here I discuss how fluctuations in the isotopic composition of sedimentary carbonate and organic carbon provide clues. By focusing on specific dynamic characteristics of isotopic change, I show how changes in the size of the DOC reservoir can be inferred. Particular attention is given to large perturbations of the carbon cycle preceding the Cambrian explosion, which can be explained by the drawdown of an unusually large DOC reservoir. I discuss dynamical constraints implied by this interpretation and the extent to which we are satisfied by the available data. (Abstract ID 12602)

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INVESTIGATING THE COMBINED EFFECTS OF OCEAN ACIDIFICATION AND NUTRIENT LIMITATION ON THE PHYSIOLOGY OF THE COCCOLITHOPHORE EMILIANIA HUXLEYI

Growth and calcification of the marine coccolithophorid Emiliania huxleyi is affected by ocean acidification and macronutrient limitation. Many laboratory studies have examined the effect of these variables in isolation, but their interactive effect has received little attention. We examined the physiological performance of Emiliania huxleyi (strain NZHE2) in a biostat experiment where organisms were exposed to three CO2 levels (255, 527 and 1200 ppmv) under three nutrient conditions (nutrient replete, phosphate limited and nitrate limited). Growth rate, coccosphere volume, particulate inorganic carbon and organic carbon incorporation as well as nitrate and phosphate uptake [defined by alkaline phosphate and nitrate reductase activity] exhibited different responses to ocean acidification depending on the nutrient availability. We propose that the competitive ability for nutrient uptake of Emiliania huxleyi together with its calcification response will be altered in high-CO2 oceans. Multimodal studies are essential to our understanding of the ecological and biochemical role of E. huxleyi in future oceans, which will in turn influence population structure, bloom dynamics, and ultimately, the efficiency of the biological carbon pump. (Abstract ID 11301)

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USING HIGH-RESOLUTION OCEAN TIMESERIES DATA TO GIVE CONTEXT TO LONG TERM HYDROGRAPHIC SAMPLING OFF PORT HACKING, NSW, AUSTRALIA.

Through the development of the NSW node of the Australian Integrated Marine Observing System (NSW-IMOS), a mooring array consisting of 4 locations has been deployed off the coast of Sydney, Australia, providing more than 2 years of timeseries data on the Sydney shelf. Parameters measured include velocity and temperature, salinity, fluorescence, dissolved oxygen and turbidity at 5-11m resolution. This moored timeseries data complements the more than 70 years (since 1942) of physical sampling at the Port Hacking (Sydney, Australia) sites, in 50m and 100m water depths, by providing spatial and temporal context. In this paper we investigate the relationship between the monthly vertical CDT profiles and the high temporal resolution moored timeseries, specifically the sub-monthly variability in the data from the moored instruments. For the first time we have a timeseries of optical signals at two sites which can be used to give spatial and temporal context to the monthly biogeochemical and phytoplankton record from the physical samples. We assess the significance of sub monthly variability relative to the seasonal and annual signals. (Abstract ID 10182)

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THE ENERGETICS OF LARGE ISONCYNAL DISPLACEMENTS

Large vertical velocities in the ocean are mostly adiabatic and generate large isopycnal displacements. The work required to lower or raise an isopycnal is exchanged with the potential energy reservoir and more precisely with the available potential energy (APE). For small displacements, the APE is quadratic in the displacement but it is no longer true for large displacements. This causes downward movements to be energetically cheaper than upward movements. We explore this piece of physics by comparing two models, that differ by their APEs, in various mesoscale turbulent regimes driven by the baroclinic instability and aiming to reproduce the Southern Ocean turbulence. We report on the properties of the turbulence sensitive to this physics with a focus on the vertical velocity. (Abstract ID 9416)

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ND ISOTOPES IN THE WESTERN EQUATORIAL ATLANTIC WATER MASSES: AMAZON RIVER AND MARGIN CONTRIBUTIONS (AMANDES PROGRAMME). Neodymium isotopic composition (IC) and concentration analysis in seawater help to trace circulation and mixing trends [Lacan & Jeandel, 2004a; 2004b] and explore the role of continental margins in supplying and exchanging material with the oceans [Lacan and Jeandel, 2005; Arsouze et al. 2009]. The north Brazilian margin and Amazon estuary system may contribute significantly to the Atlantic Ocean chemical composition, due to its considerable supply in fresh water and sediments that are in contact with major water masses and currents. Neodymium IC of samples from the Amazon plume, in a profile at 7.7°N 40.7°E and along a north-south transect in the east Atlantic were previously published [Goldstein & Jacobsen, 1986; Pfeiogras & Wassberg, 1987; Rickli et al. 2009, 2010]. We present results of Neodymium IC obtained in the framework of the AMANDES project. Samples were collected in October 2007 and February/April 2008 along the salinity Gradient, on the continental shelf, and further offshore. Neodymium values ranged from −8.9±0.5 (Amazon endmember) to −13.8±0.3 (Mid NADW). Fine circulation trends were identified with ADCP transects and moorings and a tidal model [Le Bars et al., 2010]. Combined with physical oceanographic features, Nd isotopic observations allow us to quantify the margin and estuary contributions to the ocean and infer their pathways. (Abstract ID 10250)
CLIMATE VARIABILITY AND PHYTOPLANKTON IN THE PACIFIC OCEAN

The effect of climate variability on phytoplankton communities was assessed for the tropical and sub-tropical Pacific Ocean between 1998 and 2005 using an established biogeochemical assimilation model. The phytoplankton communities exhibited wide range of responses to climate variability, from radical shifts in the Equatorial Pacific, to changes of only a couple of phytoplankton groups in the North Central Pacific, to no significant changes in the South Pacific. In the Equatorial Pacific, climate variability dominated the variability of phytoplankton. Here, nitrate, chlorophyll and all but one of the 4 phytoplankton types (diatoms, cyanobacteria and coccolithophores) were strongly correlated (r<0.01) with the Multivariate El Niño Southern Oscillation Index (MEI). In the North Central Pacific, MEI and chlorophyll were significantly (p<0.01) correlated along with two of the phytoplankton groups (chlorophytes and coccolithophores). Ocean biology in the South Pacific was not significantly correlated with MEI. During La Niña events, diatoms increased and expanded westward along the cold tongue (correlation with MEI r<0.48), while cyanobacteria concentrations decreased significantly (r=0.78). El Niño produced the reverse pattern, with cyanobacteria populations increasing while diatoms plummeted. The diverse response of phytoplankton in the different major basins of the Pacific suggests the different roles climate variability can play in ocean biology. (Abstract ID 9317)

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BOUNDARY CONDITION UNCERTAINTY IN THE NRL RELOCATABLE OCEAN ENSEMBLE FORECAST SYSTEM

A relocatable regional ocean nowcast/forecast system has been developed to support rapid implementation of new regional domains. The new system is the basis for an ocean ensemble forecast and adaptive sampling capability. The analysis component is the Navy Coupled Ocean Data Assimilation (NCODA) system, which performs a 3D variational analysis using satellite SST, SSH, and ice concentration, plus in situ temperature, salinity, and currents. The forecast component is the Navy Coastal Ocean Model. The ensemble uses the ensemble transform technique with error variance estimates from NCODA. Perturbed surface forcing (or an atmospheric ensemble) may be used to represent errors in surface forcing. Two methods for generating perturbed boundary conditions have been developed to assess their contribution to the ensemble spread. The first uses a space-time deformation approach. The second follows an information theory technique, and uses a training dataset from the large-scale host to identify the ensemble spread. (Abstract ID 11953)

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USING OCEANIC pCO2 PERFORMANCE METRICS TO ASSESS THE DEPENDENCY OF FUTURE OCEANIC CO2 UPTAKE ON MODEL SKILL

Coupled climate carbon-cycle models (CmMs) are used as tools to set anthropogenic CO2 emission targets for the stabilization of future atmospheric CO2 levels. In CmMs climate change drives a reduction in global oceanic CO2 uptake and causes acceleration in the growth rate of atmospheric CO2. Yet, the processes dominating these changes vary both regionally and between the models. An ongoing systematic assessment of these simulated changes in the oceanic CO2 uptake is needed. We conduct a global evaluation of regional oceanic pCO2 simulated in the latest CmMs using both global observational data compilations and climatologies. We define a series of oceanic pCO2-based performance metrics to quantify model skill in simulating the well-characterised temporal scales in the pCO2 climatologies; the mean state and the annual cycle. The metrics are used to rank the performance of the CmMs and identify the aspects of model performance that are strongly linked to future trends in oceanic CO2 uptake. In regions where future oceanic CO2 uptake is sensitive to model performance, we investigate the key processes that cause the model-data differences. (Abstract ID 11245)

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PHENOLOGY OF SEA ICE AND OCEAN ALGAL BLOOMS IN THE ARCTIC

Arctic organisms are adapted to the strong seasonality of environmental forcing. A small timing mismatch between biological processes and environment could have a significant consequence for the entire food web. Climate warming is likely to induce early snow melt and ice retreat in the Arctic, thus causing timing variability (phenology) of primary production for both ice alga and phytoplankton. This study is focused on synthesizing the available observations and coupled ice-ocean-ecosystem model results to examine the spatial variability in primary production phenology in the Arctic, and to test existing conceptual models on region-dependent algal growth. The results allow us 1) to quantify the spatial variability in bloom phenology; 2) to identify the regions most susceptible to climate-related changes in mixing and light/nutrient availability; and 3) to infer the possible impact on zooplankton and higher trophic levels. The numerical experiments also provide insight on the mechanisms controlling the phenological shifts and assess the phenological responses under future climate-change scenarios. It is anticipated that the results from this study will lay the foundation for more comprehensive research in this important area. (Abstract ID 10294)

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KRILL LIPID DYNAMICS ALONG THE WESTERN ANTARCTIC PENINSULA

Polar zooplankton safeguard against the seasonality of food availability by converting and concentrating lipid-poor phytoplankton into large lipid deposits, which are then utilized by prey predators. Warning trends in the northern part of the western Antarctic Peninsula (WAP) have altered perennial sea-ice dynamics and the magnesium and community structure of the summer phytoplankton blooms, with potential implications for prey quality. We compared total, neutral and polar lipid content and nutrient (CN) ratios of macrozooplankton collected from the north and south of the WAP to assess whether regional warming is affecting zooplankton prey quality. Total lipid content of juvenile, mature male and mature female Euphausia superba were elevated in the southern part of the WAP where sea ice still persists, compared to the north. The neutral lipid fraction accounted for a lower percentage of the dry mass than polar fraction and both lipid fractions were elevated in the southern part of the WAP. Krill nutrient ratios showed no distinct trends. These results have implications for studies modeling trophic interactions and affects of climate change on prey quality along the WAP (Abstract ID 9709)

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OBSERVATIONS OF HIGH-FREQUENCY INTERNAL WAVES NEAR THE LUZON STRAIT USING UNDERWATER GLIDERS

Tidal flow through the Luzon Strait is known to produce large internal waves. The resulting waves that travel westward into the South China Sea are especially energetic, and grow steep though nonlinear processes as they propagate, while those that travel eastward into the Pacific are weaker. Here we present observations on both sides of the Luzon Strait using Spray underwater gliders. We focus on estimates of vertical velocity derived from measurements of pressure and vehicle orientation. Two approaches to the estimation of vertical velocity are presented. Our first approach involves a model of glider flight that is a balance between buoyancy and drag. A second, simpler approach is to high-pass observed vertical velocity under the assumption that changes in glider flight are low frequency compared to the internal waves we wish to observe. Comparison between these two approaches gives confidence that both are producing reasonable results. Gliders were used to make spatial surveys and to hold station for time series. Results support the notions of growth for westward propagating waves, and decay for eastward propagating waves. (Abstract ID 17101)

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INFLUENCE OF ATMOSPHERIC COLD AIR OUTBREAKS ON UPPER OCEAN THERMAL VARIABILITY OF THE FLORIDA STRAITS

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TOS/AGU/ASLO 2012 Ocean Sciences Meeting
This study investigates the response of the upper ocean thermal structure in the southern Florida Straits (FS) to cold-air outbreaks (CAOs), and the influence of the Loop Current (LC) position on the CAO impacts. Warm tropical water is transported to the FS through the Yucatan-Loop-Florida Current (YLCF). The residence time for YLCF water in the Gulf of Mexico depends on the variable northward penetration of the LC. It is hypothesized that during CAOs, the cooling of YLCF water before it enters the FS is sensitive to the northward extent of the LC. This connection between the LC position and the cooling of the YLCF surface waters is investigated using a 20-year satellite sea surface temperature data set and LC position determined from satellite altimetry. Thermal budgets are calculated in Eulerian and Lagrangian reference frames using data from a Hybrid Coordinate Ocean Model (HYCOM)1/25° Gulf of Mexico simulation. Outcomes of this work are of importance to understanding local fisheries of economic importance, as extreme cooling of FS water during CAOs can impact local fish species that are sensitive to thermal stresses. (Abstract ID 10560)

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NEAR - SURFACE TEMPERATURE STRATIFICATION IN DENSE SURFACE ALGAL BLOOMS AND WIND TRANSPORT.

Dense surface algal blooms are characterized by dense accumulations of light absorbing phytoplankton accumulating near the surface, in the case of dinoflagellates red tides the surface layer is approximately 1-3 m thick. We measured temperature, light attenuation and particle stratification with a free-rising CTD within and outside of dense patches of a red tide dominated by Lingulodinium in a coastal upwelling area off Baja California, Mexico. In situ observations showed that the surface bloom resided within the Near Surface Density Layer (NSDL) formed by near surface temperature stratification. The high light attenuation within the NSDL promoted the formation of the NSDL. Drifter buoys, previously compared to high-resolution current profiler, and placed within and below the NSDL suggested rapid wind transport of the NSDL layer. We propose that this transport together with the diel migration of dinoflagellates produces an overall transport of the bloom population towards the coast and that this transport is helping the dinoflagellates to maintain the high cell densities near the coast in a region of moderately high horizontal exchange. (Abstract ID 12000)

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PHENOLOGY AND PERSISTENCE OF CALANUS FINNACHRICUS UNDER CLIMATE FORCING IN THE GULF OF MAINE

The Gulf of Maine (GoM) lies at the southern edge of the subarctic range of the planktonic copepod, Calanus finnachricus. The species is nevertheless a fundamental component of the GoM ecosystem. We have developed a 1-D Individual Based Model of C. finnachricus in the northwest Atlantic that includes the dormancy phase of its life cycle. The model simulates demographic patterns of C. finnachricus in the Gulf of St. Lawrence, but predicts a bimodal diapause cycle (over summer and over winter) in the GoM due to low summer phytoplankton availability and warm temperatures at depth. This is not consistent with available data in the deep GoM, although a fall generation is observed in Maine coastal waters. We explore possible alternative explanations for this result, including evidence that coastal production may be the source of supply of late developmental stages to the deep overwintering stock. Understanding sources of supply of C. finnachricus in the GoM is critical to predictions of the species’ capacity to sustain its historically high abundance under climate forcing of water column temperatures and seasonal timing of primary production. (Abstract ID 11784)

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CHARACTERISTICS, LEVELS AND SOURCES OF LIPID TRACERS IN SEDIMENTS FROM THE SHATT AL-ARAB RIVER OF IRAQ AND THE NORTHERN PART OF THE ARABIAN GULF

Shallow surface sediment samples from the Shatt al-Arab River of Iraq and the northern coast of the Arabian Gulf were collected and analyzed to determine the characteristics, levels and sources of aliphatic lipid compounds. The sediment samples were collected using a Van Veen grab sampler, dried, extracted with a mixture of dichloromethane/methanol and then analyzed by gas chromatography-mass spectrometry (GC–MS). The lipids included n-alkanes (24.6+44.3 µg g–1), n-alkanols (23.6+25.9 µg g–1), and an unresolved complex mixture of steranes (15.6+28.4 µg g–1) biomarkers, phthalates (37.0+53.6 µg g–1), and an unresolved complex mixture studied region. Besides the wind-driven upwelling due to Ekman transport near coastal regions, the presence of the canyon enhances the upwelling of deep water from the adjacent oceanic region bringing the nutrients, which are injected into the bay, enhancing primary productivity.

The bathymetry of this submarine canyon has an average along axis slope of 6% within the studied region. The presence of the canyon enhances the upwelling of deep water from the adjacent oceanic region bringing the nutrients, which are injected into the bay, enhancing primary productivity. The average of the upper ocean thermal structure in the southern Florida Straits (FS) to cold-air outbreaks (CAOs), and the influence of the Loop Current (LC) position on the CAO impacts. Warm tropical water is transported to the FS through the Yucatan-Loop-Florida Current (YLCF). The residence time for YLCF water in the Gulf of Mexico depends on the variable northward penetration of the LC. It is hypothesized that during CAOs, the cooling of YLCF water before it enters the FS is sensitive to the northward extent of the LC. This connection between the LC position and the cooling of the YLCF surface waters is investigated using a 20-year satellite sea surface temperature data set and LC position determined from satellite altimetry. Thermal budgets are calculated in Eulerian and Lagrangian reference frames using data from a Hybrid Coordinate Ocean Model (HYCOM)1/25° Gulf of Mexico simulation. Outcomes of this work are of importance to understanding local fisheries of economic importance, as extreme cooling of FS water during CAOs can impact local fish species that are sensitive to thermal stresses. (Abstract ID 10560)

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NEAR - SURFACE TEMPERATURE STRATIFICATION IN DENSE SURFACE ALGAL BLOOMS AND WIND TRANSPORT.

Dense surface algal blooms are characterized by dense accumulations of light absorbing phytoplankton accumulating near the surface, in the case of dinoflagellates red tides the surface layer is approximately 1-3 m thick. We measured temperature, light attenuation and particle stratification with a free-rising CTD within and outside of dense patches of a red tide dominated by Lingulodinium in a coastal upwelling area off Baja California, Mexico. In situ observations showed that the surface bloom resided within the Near Surface Density Layer (NSDL) formed by near surface temperature stratification. The high light attenuation within the NSDL promoted the formation of the NSDL. Drifter buoys, previously compared to high-resolution current profiler, and placed within and below the NSDL suggested rapid wind transport of the NSDL layer. We propose that this transport together with the diel migration of dinoflagellates produces an overall transport of the bloom population towards the coast and that this transport is helping the dinoflagellates to maintain the high cell densities near the coast in a region of moderately high horizontal exchange. (Abstract ID 12000)
Patterns related to distance from advective pathways, water depth, and distance from the continental shelf are observable in the predicted abundance. We will continue our efforts concerning the data consolidation in order to examine decadal patterns in zooplankton abundance, and to explore various climate change scenarios. (Abstract ID 10709)

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CONTRASTING BIOGEOCHEMISTRY OF NITROGEN IN THE ATLANTIC AND PACIFIC OCEAN MINIMUM ZONES

ETNA and ETSP OMZs have strongly contrasting oxygen concentrations and N cycling processes. The same AAW water mass, for instance, has in the Pacific 81SN-DIN average value of 0.7 ± 0.8 % and in the Atlantic of 5.5 ± 0.6 %. This difference can be due to N-loss in the Pacific, increasing 81SN signal of the water mass, and/or nitrogen fixation in the Atlantic, decreasing the 81SN signal. Pacific surface waters are marked by strongly positive values for 81SN-N2O reflecting fractionation associated with subsurface N-loss and partial NO3- utilization. This contrasts with negative values in NO3- depleted surface waters of the Atlantic which are lower than can be explained by N supply via N2 fixation. We suggest the negative values reflect inputs of nitrate, possibly transient, associated with deposition of Saharan dust. Strong signals of N-loss processes in the subsurface Pacific OMZ are evident in the isotope data, which are compatible with a contribution of canonical denitrification to overall N-loss. However the apparent N isotopic fractionation factor observed is relatively low (11.4 ‰), suggesting an effect of influence from denitrification in sediments. Note that the fractionation effect from the complete set of stations (11.4 ± 0.3 ‰) lies reasonably close to an apparent global fractionation factor for OMZ denitrification of 12% which was calculated for a steady state 50:50 balance between water column and sedimentary denitrification (Altabet, 2007). (Abstract ID 9848)

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BOTTOM BOUNDARY LAYER SEPARATION IN A DENSITY FRONT GENERATED BY CANYON-TO-SHELF TRANSPORT

Bottom boundary layer (BBL) separation was detected in a front generated by upwelling of dense waters from Monterey Canyon onto the adjacent northern shelf of Monterey Bay. This event was closely observed in a time-series of high-resolution AUV vertical sections. BBL separation occurred above the central mud belt of the northern shelf. An intermediate nepheloid layer (INL) developed, intensified, and expanded rapidly, while anomalously cold, saline, low-oxygen water extended beneath it. Lateral compression occurred between the shelf of the canyon shelf break, consistent with internal tidal forcing. During the three days of INL observation, its suspended particulate matter sank into dense waters while maintaining a nearly constant particle size distribution in the range of 1 to 200 microns. Ecological consequences of such benthic-pelagic coupling events are considered. (Abstract ID 9436)

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RESEARCH WITH AUTONOMOUS UNDERWATER VEHICLES INFORMS EDUCATIONAL RESOURCE ABOUT HARMFUL ALGAL BLOOMS

Process studies employing autonomous underwater vehicles (AUVs) off central California have advanced the scientific understanding of harmful algal blooms (HABs), as well as the educational resources to explain them. These process studies gathered multidisciplinary observations from AUVs, moorings, ships, aircraft, and satellites. Moorred systems included autonomous robotic biochemistry systems for in situ detection of HAB species and toxins. Integrating the knowledge gained from a series of process studies, we developed a visualization of processes that influence bloom ecology in Monterey Bay, California. These processes act across the bay’s boundaries: the offshore boundary across which nutrient-rich upwelling filaments enter the bay; the canyon / shelf-break boundary across which nutrient-rich deep waters flow onto the continental shelf; the coastal boundary across which nutrients from agricultural land drainage enter the bay; and the shelf bottom boundary from which benthic-pelagic coupling can introduce nutrients, trace metals, and resting stages of bloom-forming species. This illustration was reconstructed in an educational podcast with a narration.
explaining bloom ecology in the region in language that is accessible to regional resource managers and the general public. (Abstract ID 9437)

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WHAT YOU SEE IS NOT WHAT YOU GET: RELATING DIATOM SPECIES COMPOSITION IN SURFACE WATERS TO CARBON FLUX DURING A SPRING BLOOM IN THE NORTH ATLANTIC

Mass sinking of cells following open ocean spring blooms serves as an important source of carbon to the ocean's interior. During the 2008 North Atlantic Bloom Experiment, we followed a Lagrangian surface float and compared microplankton community composition from surface and deep waters to determine how species composition influenced the quantity and quality of organic carbon arriving at depth. Diatoms numerically dominate all four deployments of PELAGRA floating sediment traps. Other microplankton were present but comprised <0.25% of trap material. Chaetoceros diadema resting spores were the most common diatoms, comprising 35-92% of cells and 8-64% of total POC flux in each sample. Diatoms also dominated surface waters. However, C. diadema represented just 1-4% of carbon in the upper 20m of the water column. The differing contribution of C. diadema to C-sink is likely related to formation of resting spores which sink rapidly, avoiding the dissolution and bacterial remineralization of slower sinking cells. Resting spores had high levels of variable fluorescence and germinated in on-deck incubations indicating the POC flux of resting spores was comprised of high quality organic carbon. (Abstract ID 11790)

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RESPONSES OF MARINE ECOSYSTEM TO TYPHOOON PASSAGES IN THE WESTERN SUBTROPICAL NORTH PACIFIC

Strong phytoplankton blooms are occasionally observed around a recurvature point of typhoon tracks in the western subtropical Pacific. These are noteworthy events in subtropical regions where both nutrient concentrations and biological production are persistently low. We investigated the response of phytoplankton to typhoon passage using a numerical model with/without biogeochemical processes. The model reproduced the observed patch-like phytoplankton bloom around a recurvature point of Typhoon Keith in 1997. The strong bloom is caused by the typhoon-centered upwelling of nutrient-rich water from below the euphotic layer, which supplies the nutrients required for phytoplankton growth, resulting in higher chlorophyll-a concentrations. The occurrence of phytoplankton blooms is determined by whether the sum of the mixed layer depth and total upward shift due to upwelling exceeds the nutrient depth, which is approximately 100 m in the western subtropical Northern Pacific. Biogeochemical processes then play essential roles in determining the response after the passage of typhoons in subtropical regions. Our results imply that weak, slow-moving typhoons, which occur more frequently than stronger typhoons, may strongly impact subtropical ecosystems. This study was recently published by Geophysical Research Letters (GRL). (Abstract ID 12884)

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IDENTIFYING LAGRANGIAN COHERENT STRUCTURES USING TRAJECTORY COMPLEXITY METHODS
To better understand and analyze a flow and its coherent structures we consider the individual particle trajectories in the flow and measure the way in which these trajectories sample the space - i.e. the complexity of the trajectories. We present two methods for capturing complexity of trajectories and show how we can then use this complexity information to identify coherent structures in the flow. We consider the methods in the context of both an analytical model and a more realistic flow (numerical model). (Abstract ID 12085)

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EDDY-INDUCED PARTICLE DISPERSION IN THE UPPER-OCEAN NORTH ATLANTIC

Eddy-induced particle dispersion is studied in the upper-ocean North Atlantic using a combination of altimetric sea surface heights, Lagrangian drifter data, and numerically-generated velocity fields. Our analysis demonstrates that transport is inhomogeneous and anisotropic. These effects were quantified by constructing the “spreading ellipses”. Spreading regimes were analyzed, and significant non-diffusive behavior was found, even at times scales longer than half a year: the influence of the mean advection was studied and diffusivity estimates in the presence of the mean currents were shown to differ significantly from the “eddy-only” values. In contrast, the influence of the Ekman velocity on the diffusivity estimates was found to be less significant. The analysis of numerical simulations further demonstrates that the material transport is dominated by eddies with large spatial scales, which can be resolved by altimetry. The anisotropy of dispersion has implications for parameterizing eddy-induced transport in non-eddy-resolving numerical models and is important for modeling distributions of heat, salinity and bio/geochemical tracers. (Abstract ID 9898)

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DIFFERENTIAL RESPONSE OF NATURAL PHYTOPLANKTON COMMUNITIES TO ENHANCED CARBON DIOXIDE (CO2) ALONG THE WESTERN ANTARCTIC PENINSULA

The Western Antarctic Peninsula (WAP) has undergone profound changes in the past decades: an unprecedented increase in atmospheric temperature and seawater heat content, and a decline in sea ice. Ocean acidification poses an additional threat, but the response of plankton communities to these changes remains largely unanswered. Through a series of perturbation experiments along the WAP, we examined the effects of enhanced CO2 on growth, productivity, and nutrient dynamics of large- and small-phytoplankton dominated communities. Their responses differed. The community consisting of large diatoms was weakly regulated by changes in CO2 and experienced a similar 10-fold increase in biomass and productivity in low (180 ppm), ambient (385 ppm), and high (750 ppm) CO2 conditions during the 14-day incubation. Small phytoplankton (cryophytes, small diatoms), however, did not grow efficiently under high CO2. Specifically, nanophytoplankton declined by 84% during the 12-day incubation. Small phytoplankton are becoming more prevalent in waters along the WAP due to increased temperatures and glacial melting. However, these communities may take a hit with ocean acidification, creating a ripple effect in food webs and biogeochemical cycling. (Abstract ID 10538)

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PROJECTED RESPONSE OF EASTERN PACIFIC LEATHERBACK TURTLES TO CLIMATE CHANGE: RECONCILING TERRESTRIAL VS. OCEANIC IMPACTS

Assessing the potential impacts of climate change on individual species and populations is essential for the stewardship of ecosystems and biodiversity. Critically endangered leatherback turtles in the eastern Pacific Ocean are excellent candidates for such an assessment because
their sensitivity to contemporary climate variability has been substantially studied. If incidental
fisheries mortality of eastern Pacific leatherback turtles is reduced or eliminated, the population
still faces the challenge of recovery in a rapidly changing climate. Here we combined IPCC-class
climate model projections and a leatherback population dynamics model to estimate a 7% per
decade decline in the Costa Rica nesting population over the 21st century. Whereas changes in
ocean circulation (amplitude of El Niño Southern Oscillation variability) had a small effect on
the population, the 3°C warming of the nesting beach was the primary driver of the decline via
reduced nest success (hatching success and hatching emergence rate). If future observations
show a long-term decline in leatherback nest success in Costa Rica, anthropogenic climate
mitigation of nests (e.g. shading, irrigation) may be able to negate the population decline.

(Abtract ID 11795)

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FROM ONSHORE TO OFFSHORE: USING AMINO ACIDS TO TRACE THE MARINE-
TERRESTRIAL EXCHANGE

Unravelling complex relationships between species to understand ecological patterns and
processes remains a very challenging aim for ecologists worldwide. There are many nearshore
ecological systems where terrestrial organisms have essentially a marine diet and vice-versa.
Traditional stable isotope analyses on bulk samples have shed considerable light on such
systems but can lack specificity. Stable isotopic analysis of individual amino acids (C3-A)A
provides the means of identifying nutrient sources, and allows inferences about the spatial and
temporal distribution of variability in nutrition. In this paper we apply this technique to unravel
the trophic relationship and nitrogen exchanges between a sand scarab Psophobus transversus
larvae and its guest: Lasiaplid mite (Acari: Mesostigmata). A new version of the N-acetylmethyl
ester (NACME) derivatization procedure is used. The δ15N values indicate an increase of 2-3.
3 trophic levels for the rate, implying a symbiosis relationship within this ecosystem. The next
stage is to apply the technique offshore to the understanding of the link between dissolved free
amino acids (DFAA) and phytoplankton. In particular the “dietary” preferences for nitrogen
source and its nutritive contribution to nitrogen metabolism. (Abstract ID 10850)

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THE SURFACE OCEAN CO
2 ATLAS (SOCAT): A NEW TOOL FOR ASSESSING
CHANGES IN THE OCEAN CARBON SINK

The number of annual surface CO
2 observations has been growing exponentially since the
1960s when the CO
2 increase was just beginning. The annual increase in the number of annual observations provides excellent opportunities to
look at the patterns of global and regional air-sea CO
2 fluxes in detail and to understand the
seasonal to inter-annual variations and the mechanisms controlling them. SOCAT is the result
of a four year effort by the international ocean carbon research community to assemble and
quality control more than 6.3 million surface water CO
2 measurements collected between 1968
and 2007 into a uniform format using methods that are transparent and fully documented.

Two SOCAT products are available: 1) a global, surface ocean CO
2 data set in a uniform format
which has undergone second level quality control and 2) a gridded product of monthly
mean surface water CO
2 with minimal temporal or spatial interpolation. We will briefly review
some of the rich information contained in SOCAT as well as some of the limitations in the data
set. (Abstract ID 12078)

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Tidak marsh outwelling of dissolved carbon and pCO2 to
the adjacent estuary and atmosphere. They trap algae and other suspended particulate matter, while exporting high molecular-weight, aromatic, humic-rich colored dissolved organic
matter (DOM) into the estuary through tidal flushing. However, less information has been
available on the role of tidal marshes in dissolved nitrogen and C:N dynamics. This information
is critical for understanding changes in DOM elemental composition during degradation
processes, transport, and mixing of dissolved compounds from different sources. It is also
needed for the development and evaluation of coupled physical/biogeochemical models in
estuarine ecosystems. To address this objective, we performed detailed and high-resolution
measurements of carbon and nitrogen components, including PO4, DOC, DIC, DON, TDN,
chlorophyll-α, and CDOM spectral absorption and fluorescence properties, in an eutrophic
sub-estuary of the Chesapeake Bay. Results from optical and chemical analyses highlight the
differences in processing and dynamics of humic- and protein-like components in DOM, and
the distinctive influences of watershed discharges, tidal marsh outwelling, and autochthonous
biological activity on estuarine biogeochemical and optical gradients. (Abstract ID 11282)

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THE ATMOSPHERIC WAKE OF MADEIRA ISLAND

The 57 km long and 22 km wide NW-SW oriented island of Madeira lies in the western Atlantic,
950 km SW from the southern tip of Portugal. Due to its size, terrain height, atmospheric
structure and winds upstream, wake formation in the downstream region of this mountaious island is frequent, in particular in summer when the most sustained winds below the trade wind inversion come from NE, the direction perpendicular to the island
topography. In situ and remote sensing measurements were obtained during the i-WAKE
airborne campaign (Aug-Sep 2010) in Madeira. SAFIRE’s ATR 42 research aircraft collected
data upstream and downstream of the island. Wake signals such as abrupt wind jumps at the
flanks of Madeira and warm cores of eddies are evident in the Sep 2, 2010 data analyzed herein.
High-resolution simulations using the WRF-ARW model were carried out to investigate the
wake structure. At the beginning of the analyzed period (1 – 3 Sep 2010), the atmosphere was
continuously stratified and changed into a shallow water regime with a strong inversion below
the mountaintop toward the end of this period. In both of these regimes the simulated wake
is unstable with continuous generation of wake vortices and eddy shedding. Sensitivity tests
suggest a strong dependence of eddy formation on the SST; the latter impacting the vertical
stratification of the atmosphere. (Abstract ID 12781)

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THE DISTINCTIVE INFLUENCES OF WATERSHED
DISCHARGES, TIDAL MARSH OUTWELLING, AND AT
MOCROMOLECULAR FLEXIBILITY: KEY TO SUCCESS IN THE SEA ICE
ENVIRONMENT?

This paper provides insight into the influence of the sea ice cycle on the macromolecular
composition of Southern Ocean diatoms. Assimilating huge quantities of carbon annually,
they fuel a highly productive ecosystem and generate a net CO2 sink. The annual formation
and decay of sea ice in the Southern Ocean means that microalgae experience dramatic
fluctuations in environmental conditions, including temperatures below -30°C and salinities
above 170. Knowledge of the ensuing biochemical responses of microalgae is currently lacking
while exporting high molecular-weight, aromatic, humic-rich colored dissolved organic
matter (DOM) into the estuary through tidal flushing. However, less information has been
available on the role of tidal marshes in dissolved nitrogen and C:N dynamics. This information
is critical for understanding changes in DOM elemental composition during degradation
processes, transport, and mixing of dissolved compounds from different sources. It is also
needed for the development and evaluation of coupled physical/biogeochemical models in
estuarine ecosystems. To address this objective, we performed detailed and high-resolution
measurements of carbon and nitrogen components, including PO4, DOC, DIC, DON, TDN,
chlorophyll-α, and CDOM spectral absorption and fluorescence properties, in an eutrophic
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the distinctive influences of watershed discharges, tidal marsh outwelling, and autochthonous
biological activity on estuarine biogeochemical and optical gradients. (Abstract ID 11282)

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950 km SW from the southern tip of Portugal. Due to its size, terrain height, atmospheric
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EFFECT OF OCEAN ACIDIFICATION ON GROWTH, CALCIFICATION AND REPRODUCTION OF CALCIFYING AND NON-CALCIFYING EPIBIONTS OF BROWN ALGAE.

Seaweeds are key species of the Baltic Sea benthic ecosystems. They are the substratum for, and interact intensively with, several fouling epibionts like byrophytans and tube worms. Most of the latter bear calcified structures and could be impacted by CO₂ induced ocean acidification. The present study tested the sensitivity of seaweed macroalgal communities to elevated pCO₂. Fragments of macroalgae Fucus serratus bearing the calcifiers Spirorbis spirorbis (Annelida) and Electra pilosa (Bryoza) and the non-calcifier Alcyonium hirtum (Bryoza) were maintained for 30 days under three pCO₂: natural 460 µatm and enriched 1200 and 3150 µatm. Our study showed a significant reduction of growth rates and reproduction of Spirorbis individuals at the highest pCO₂. Electra colonies showed significantly improved growth rates at 1200 µatm. The net dissolution of the overall epibiont community was significantly higher at 3150 µatm. No effect on Alcyonium colonies was observed. Those results prove a remarkable resistance of the algal macro-epibionts to the most elevated pCO₂ foreseen in year 2100 for Open Ocean (= 1000 µatm). Concerns remains with regards to possible higher pCO₂ in the future Baltic Sea. (Abstract ID 10312)

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OCEANIC DE-OXYGENATION AS EVIDENCED BY TIME SERIES DATA OFF BERMUDA.

Large scale ecological changes in the Earth’s history have been attributed to the spread of oceanic anoxia, with recent projections suggesting that dissolved oxygen may decrease by 4-7% by 2100. Observations of marine oxygen variability remain limited, however the Hydrostation S timeseries record of bottle data provides bieweely dissolved oxygen and apparent oxygen utilisation values between 1960 and 2010. Analysis of oxygen concentration data indicates varying long term trends throughout the water column, with Subtropical Mode Water at 500m displaying the greatest decrease of -0.19µmol kg⁻¹ yr⁻¹ (P<0.01). This trend decreases with depth to a statistically significant increase of 0.01µmol kg⁻¹ yr⁻¹ (P<0.01) at 1000m. However, North Atlantic Deep Water (NADW) revert to back to a significant trend (P<0.01) trend of deoxygenation with rates of -0.05 and -0.07µmol kg⁻¹ yr⁻¹ at 1200m and 2200m respectively. Apparent oxygen consumption displays opposing patterns, suggesting that these long term changes observed in oxygen concentration are possibly biologically mediated. We further investigate oxygen variability via field calibrated CTD data integrated over the surface mixed layer, Subtropical Mode Water, deep oxygen minimum zone and components of NADW. (Abstract ID 10697)

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CONSIDERATION OF VOID SPACE IN RIDGED SEA ICE AFFECTS ESTIMATES OF ICE THICKNESS AND ALGAL PRODUCTION.

Void spaces created during sea ice ridging and rafting may occupy up to 35% of ice volume. Voids occurring below the freeboard are filled with seawater, which adds significant latent heat and salt to the ice pack. Seawater-filled voids may also serve as ideal habitat for sea ice algae, however to our knowledge the impacts of void spaces on sea ice thickness distributions or algal production have not yet been considered. We used a three-dimensional biogeochemical model of Antarctic sea ice to investigate the impact of void space created during the ridging and rafting of sea ice. Modeled sea ice grows/rafts thermodynamically in the vertical dimension, while ice extent and ridging are estimated from satellite-derived sea ice concentration and motion. Model results show that including 30% void space during ridging produces sea ice that is 19% thicker and ice algal production that is 68% higher than in models without void spaces. Future studies of sea ice thickness and ice algal production may do well to consider the magnitude of sea ice ridging and impacts of void spaces. (Abstract ID 12870)

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ESTIMATING THE RELATIVE MAGNITUDES OF OCEAN ENERGY INPUT FROM SURFACE BUOYANCY AND WIND FORCING.

We explore the energy input from buoyancy and mechanical forcings, and the consequent dynamical effects upon the overturning circulation. We use an idealised, eddy-permitting, rotating, pole to pole ocean with a zonally reconnecting sill in the south and periodic boundary conditions. Heat fluxes and wind stresses representative of global climatology are used to define a reference configuration that is spun up to steady state. At equilibrium, energy input from buoyancy forcing in this model is the same order of magnitude as that of wind forcing. Scenarios with differing heat fluxes or wind stresses are also simulated; energy fluxes from buoyancy forcing and wind forcing into the ocean are calculated for each scenario and compared with those from the reference run for buoyancy forcing and wind forcing. All simulations of the box reach to have significant effects on energy fluxes into the system, total kinetic and available potential energy, overturning circulation, and on the zonal transport through the sills. Moreover, the two energy sources are coupled, in that variation in buoyancy forcing alters the energy fluxes from wind stress (and vice versa). (Abstract ID 10102)

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HYDRODYNAMICS AND WAVE-ENHANCED SEDIMENT TRANSPORT IN A BARRIER ISLAND-LAGOON-MARSH SYSTEM: A MODEL APPLICATION ON THE EASTERN SHORE OF VIRGINIA.

Sediment redistribution within shallow coastal bays in response to storms and sea-level rise strongly influences morphological and ecological evolution of these systems. Based on field observations and modeling, we investigate sediment transport processes in the Virginia Coast Reserve (VCR), which lacks a major fluvial source of sediment and is relatively unaffected by human activities. A three-dimensional coastal ocean model is used, which accounts for wave-current interaction and sediment transport. The model is validated with field observations of wind- and tide-induced water flow and surface waves within Hog Island Bay, centrally located within the VCR, during two several-month-long experiments (winds sometimes reaching 15 m/s). The resulting patterns of sediment transport are presented over event time scales for bays characterized by strongly varying bathymetry and coastline geometry. The results indicate that surface waves are an important control on sediment resuspension and redistribution. During high-tide phases, wave and current suspended sediment concentrations within the model domain are more than one-order of magnitude larger than those calculated when waves are neglected. Calculated patterns of sediment redistribution are compared with several-decade-long records of morphological change in the VCR. The implications for morphologic evolution and ecosystem response to climate and land-use changes are evaluated. (Abstract ID 9350)

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INVESTIGATION OF WAVE-SEA FLOOR INTERACTION, ATCHAFALAYA SHELF, LOUISIANA.

Recent studies (Jaramillo et al., 2008; Sheremet et al., 2011) investigated the coupling between hydrodynamics and muddy sea-floor on the Atchafalaya Shelf, and quantified the process (critical shear stress for erosion, bed and suspended sediment evolution- bottom stress relationship) for a small number of representative storms. In this study, we investigate the variability of this process for a larger population of storms, as well as for different observation locations. The observations collected during field experiments conducted in 2008 and 2010 on the Louisiana coast. The data set analyzed consists of observations of suspended sediment concentration and acoustic backscatter intensity (OBS-3 and 5, Campbell Sci., and PC-ADP, SonTek/TSI), collected for 6 weeks between 7-m to 4-m in 11 hibaths. The suspended sediment concentration profile is estimated based on the acoustic backscatter of the PC-ADP and calibrated using independent OBS observations within the first 50 cm above the bed. A unidimensional boundary layer model (Hsu et al., 2009), is used to reconstruct the vertical structure of the flow characteristics, and estimate parameters difficult to observe directly, such as bottom stresses. The results generalize previous estimates of bed yield stress, allow for building a statistical model for the bed-reworking cycle (liquefaction, erosion, fluid-mud formation and consolidation) and represent a first step toward a forecasting model for wave bed coupling in muddy environments. (Abstract ID 12218)

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OBSERVATIONS OF THE PENOBSCOAT RIVER PLUME.

This study of the Penobscot River plume in Penobscot Bay examines the temporal and spatial variability of the plume in a geographically complex bay on the coast of Maine. Hydrographic survey data and data from moored instruments are used to describe the plume during and after the spring freshet in both low and high discharge years. Moored data are used to show changes in sea surface salinity and temperature in response to semidiurnal tides, a wind event, and the advance of the season. Observations show that the plume is shallow and that plume salinity increases and temperature decreases in response to wind events. Wind direction seems to play a smaller role in plume circulation than found in a previous modeling study. These observations show that the plume tends to veer to the west side of the bay, resulting in lower surface salinity.
and higher temperatures there than on the east side. (Abstract ID 10386)

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TOWARDS LARGE-EDDY SIMULATIONS OF THE TURBULENT BOTTOM BOUNDARY LAYER UNDER A NONLINEAR INTERNAL WAVE OF DEPRESSION

We report our most recent results in the study of the three-dimensional bottom boundary layer (BBL) under a nonlinear internal wave (NIW) of depression using Large Eddy Simulations. We consider modelsee 1 waves in a frame of reference moving with the wave phase speed. The waves propagate in a two-layer continuous stratification and uniform-depth quiescent water. The flow solver relies on a quadrilateral spectral multidomain method on the along-wave/depth plane, which enables focusing, with high-resolution and high-accuracy, the computational domain in the near-bed wave-induced adverse pressure gradient region in the rear edge of the wave. In this region, a near-bed wake develops on account of global shear instability of separated NIW-induced BBL. The presentation will initially discuss the role of near-bed hydrostatic pressure gradient driven by the NIW-induced surface displacement. An assessment of the robustness of the boundary conditions applied to the near-bed focused computational domain will then be given, followed by preliminary 3-D results highlighting coherent structures in the NIW-induced near-bed wake. We will conclude with a discussion of the potential for relevant signatures in field observations. (Abstract ID 10064)

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INFLUENCE OF HIGHER TROPHIC LEVELS ON BLACK SEA PRODUCTIVITY

Seasonal variability of the Black-Sea ecosystem is studied with the combination of a three-dimensional physical-biogeochemical model and observations. The circulation model has spatial resolution capable of simulating both large-scale circulation in the basin and mesoscale eddies. The ecological model of the module includes two groups of phytoplankton, two groups of zooplankton, the opportunistic heterotrophic dinoflagellate Noctiluca scintillans, gelatinous carnivores ( Aurelia aurita, Mnemiopsis leidyi), bacteria, dissolved and suspended organic substances, nitrate, and ammonium. The northwestern shelf and the west coast of the Black Sea are characterized by the observed elevated productivity mainly because of the inflow of biogenic elements via river discharge. Model results suggest that although the temporary variability of nutrients are similar because of high biomass of the invasive ctenophore Mnemiopsis leidyi, longer periods of phytoplankton blooms occur in these coastal areas compared to the open basin. Three consecutive maxima of phytoplankton biomass (in winter, spring, and summer) occur in coastal waters and the extensive winter phytoplankton bloom is a new element in the annual cycle of the ecosystem. Model results indicate that variability in higher trophic level dynamics may also have implications for the carbon export out of the euphotic zone, which shows a decrease when Mnemiopsis leidyi is removed from the model. (Abstract ID 12384)

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STRONG OCEANIC CO2 VARIABILITY YET A NET AIR-SEA FLUX BALANCE – AN EVALUATION OF THE CONTROLS ON MIXED LAYER pCO2 IN THE GULF OF MAIN

The annual cycle of mixed layer carbon dioxide (CO2) is studied in the in the western Gulf of Maine using an extended time series of discrete and continuous carbonate system and hydrographic variables. These data are used to model the mean monthly variability of processes modulating the partial pressure of surface CO2 (pCO2). Compared to the open ocean, per area, most coastal systems can sequester or release large amounts of CO2 over an annual cycle. This Gulf of Maine region does both, yet despite large seasonal air-sea disequilibria of pCO2 this system is nearly in balance with respect to atmospheric CO2 over a 5-6 year period. This finding is attributable to the timing and magnitude of seasonal sea surface temperature (SST), net community productivity, delivery of freshened surface water and vertical entrainment of dissolved inorganic carbon (DIC). We find that seasonal SST variability and the annual spring bloom are the dominant factors controlling pCO2, but identify other key factors that play important roles in maintaining the annual CO2 balance. Advecive transport of low salinity water during the spring-summer period causes sub-atmospheric pCO2 values to persist well beyond the spring bloom period. Net community production of organic matter (NCP) during July to October is identified as the factor balancing high CO2 resulting from surface advective processes, vertical entrainment and thermal variability. (Abstract ID 9889)

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CHARACTERIZATION OF EXTRACELLULAR POLYMERIC SUBSTANCES (EPS) PRODUCED BY BENTHIC MICROALGAE UNDER DIFFERENT PHYSICAL REGIMES

Primary production in shallow coastal sediments can be dominated by benthic autotrophs and benthic microalgae (BMA) often contribute significantly to system production in these regions. A significant portion of photosynthetically-fixed carbon is exuded from BMA as extracellular
polymeric substances (EPS) but the specific function(s) and fate of EPS remain unclear. This study employed the use of isotopic tracers ($\delta^{13}$C and $\delta^{15}$N) and a novel experimental system, the perfusorator, to label sub-tidal sediment pore waters in situ and trace the label incorporation into organic and inorganic pools, including EPS. Rigid plastic covers were deployed over two of the perfusorators in order to examine differences in EPS production and composition under different light conditions. An acoustic Doppler velocimeter (ADV) and glass beads were used to quantify current speeds and directions and sediment turnover and mixing, respectively. We observed incorporation of $^{13}$C label into EPS pools during the labeling experiment. EPS mass, isotopic enrichment, and carbohydrate content and composition changed with respect to time and exposure to the physical environment. (Abstract ID 9880)

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THE SOUTHERN OCEAN THERMOCLINE VENTILATION: IMPACT ON ANTHROPOGENIC CARBON AND RESPONSE TO ATMOSPHERIC VARIABILITY

We use observations to show that the subduction of mode and intermediate water in the Southern Ocean occurs in specific locations where wind-driven Ekman transport, eddy fluxes and lateral induction drive water-mass and anthropogenic carbon across the mixed-layer base. Subduction shows strong regional variability dominated by regional variability of lateral induction, i.e. caused by variations in mixed layer depth along mean streamlines. Both the magnitude and location of the inferred transport are consistent with the observed interior distribution of anthropogenic carbon and potential vorticity. In addition, analysis of mixed-layer observations suggest a zonally asymmetric response of the Southern Ocean mixed-layer depth to the Southern Annular Mode. Anomalies of order of +/- 100 m caused by heat flux anomalies are found around the circumpolar depth. Our results suggest therefore possible impacts of atmospheric variability on mode water subduction through anomalies of the mixed-layer depth. (Abstract ID 11266)

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DISCOVERY OF LARGE AREAS OF ACTIVE HYDROTHERMAL DISCHARGE AND RECHARGE IN A MID-OCEAN RIDGE AXIAL VALLEY

Locations of warm hydrothermal fluids discharge at mid-ocean spreading centers are important for understanding a wide range of critical oceanic processes. Mapping the full distribution of recharge and discharge locations within the axial valley provides wider insight into the large scale features of hydrothermal circulation. To expand this scale, we deployed 180 conductive heat flow stations, in a 400 by 1000 m grid, within the Endeavour axial valley of the Juan de Fuca Ridge. Data were acquired using thermal blanket instruments which determined conductive heat flow in areas lacking substantial sediment cover. A dominant feature from this survey was a 200 meter wide zone of anomalously high heat flow extending across-strike over the entire axial valley floor. Approximately 81% of the axial valley sites were <50 mW/m2 suggests that recharge into the crustal reservoir is widespread over the axial valley floor, impacting ~50% of our survey area. The large areal extent of both high conductive heat flow and extensive re-charge zones suggest current models of oceanic crustal fluid circulation will need to be re-examined. (Abstract ID 12712)

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AXIAL CHANGE IN LATENT HEAT FLUX AND SEA SURFACE TEMPERATURE DURING CONTRASTING INDIAN MONSOON YEARS

Weekly Sea Surface Temperature (SST) and weekly generated Latent Heat Flux (LHF) show variations with TMI Brightness Temperature have been analyzed for twelve years. The SST and LHF are Weekly Sea Surface Temperature (SST) and weekly generated Latent Heat Flux (LHF) using TOS/AGU/ASLOAbstract Book TOS/AGU/ASLOAbstract Book

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TAXONOMICALLY LINKED VARIATIONS IN THE N/P RATIO OF MARINE PHYTOPLANKTON

The uptake ratios of nitrogen to phosphorus vary in surface ocean waters but the causes of the observed differences in space and time are poorly understood. Taxonomy appears to be a major factor and diatom blooms, particularly those in cold, polar waters are associated with N/P consumption ratios significantly below the canonical Redfield ratio (16), although the physiological basis for this is not clear. Iron-limited culture experiments with several diatoms indicate that cellular N/P ratio is associated with growth rate and is lowest for the fastest growing cells. We also report on the extent of diatom DNA damage in response to UVB exposure (as reflected by the generation of cyclobutane pyrimidine dimers) as a potential additional factor in altering diatom N/P ratios. The contrast between the low N/P consumption ratios characteristic of polar waters and the much greater ratios typical of cyanobacteria in sub-tropical gyres, suggests mixing between spatially and stoichiometrically distinct communities plays an important role in maintaining the nutrient levels in the modern ocean. (Abstract ID 12655)

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THE IMPACT OF ORGANIC LIGANDS ON THE TRANSFER OF TRACE METALS FROM HYDROTHERMAL VENTS INTO THE OCEAN

Deep-sea hydrothermal vents discharges fluids with extremely high metal concentrations into the oceans. Until recently, it was assumed that these high metal concentrations in the hot fluids are significantly depleted during mixing with ambient seawater by the precipitation as sulfide or oxide minerals, reducing their net fluxes from the hydrothermal systems into the open ocean to negligible values. However, the recent discovery of significant stabilization of dissolved copper and iron in the mixing zones of hydrothermal fluids with seawater by binding to organic molecules has urged a revision of trace metal fluxes from deep-sea hydrothermal vents. Here we demonstrate that the presence of organic ligands stabilizing dissolved trace metal species competes with metal precipitation and significantly increases the dissolved metal fluxes from hydrothermal systems. These fluxes may be considerably larger than previously assumed, i.e., up to 9% and 14% of the deep-ocean dissolved iron and copper budget can probably be assigned to hydrothermal sources[1]. [1] Sander, S.G. and Koschinsky, A., 2011. Nature Geoscience 4: 45-150. doi:10.1038/ngeo1088. (Abstract ID 9141)

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CHANGES IN LATITUDE - BACTERIVORY BY MIXOTROPHIC PROSTISTS IN THE ROSS AND BEAUFORT SEAS

Protists are traditionally described as either phototrophic or heterotrophic to define their contribution to nutrient and carbon flow in the microbial food web. In recent years increasing evidence indicated that many phototrophic protists also ingest particulate food and could have major impacts on their prey populations. We previously identified mixotrophs in every sample we examined during an austral spring cruise in the Ross Sea, Antarctica, where they comprised about 4%-34% of the chloroplastidic flagellates. Moreover, they were a major component of total bacitoxeres. These observations led us to hypothesize that mixotrophic nutrition is an important alternative microbial dietary strategy in polar marine environments. We have since found similar or greater proportions of mixotrophic nanoflagellates during summer in the Ross Sea (4%-33% of chloroplastidic flagellates) and in late-summer/early-autumn in the Arctic Ocean (4%-32%). In both polar environments, mixotrophs were often more abundant than heterotrophic nanoflagellates, nominally considered the major bacitoxeres in marine waters. In the Arctic, mixotrophic activity in picoeukaryotes, mostly resembling Microcystis sp., was an important component of total community bacitoxeres that was not detected in the Antarctic. (Abstract ID 10006)

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ANALYZING SST CHANGES IN RESPONSE TO EXTREME WEATHER

This work looks at characterizing SST analysis error related to the fastest growing dynamical instabilities associated with the generation of the oceanic response and cool wake to a severe weather event. This is done as a case study in a dynamical framework using best available
estimates of ocean and atmospheric states within a coupled limited-area model (CLAM) based on operational prediction systems at the Australian Bureau of Meteorology. We use an ensemble based breeding method to create dynamically coherent oceanic perturbations that are scaled to quantify analysis error growth and uncertainty of SST. We show that for different rescaling intervals we are able to resolve spatial structures of SST errors of the hour and errors of the week with a period (72 h). This work provides an illustration of nonlinear dynamically based correlation length and time scales that could be used to improve SST analysis under extreme conditions where satellite retrievals can be difficult. (Abstract ID 10895)

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SEDIMENT TRANSPORT PROCESSES AND DISPERSION OF BIODEPOSITS FROM A SHALLOW OYSTER AQUACULTURE SITE

Bivalve aquaculture relies on naturally occurring phytoplankton as a food source, thereby avoiding external nutrient inputs associated with fish farm aquaculture. However, high filtration rates and concentrated biomass of bivalves focus intense particle deposition on surrounding sediments, with potential adverse environmental impacts. We studied seasonal sediment transport processes responsible for dispersal of bio-deposits from the vicinity of an eastern oyster farm in the lower Choptank River, MD, USA. The farm is situated near the upwelling tip of a headland in approximately 1 m of water. Approximately 2 million 1-yr old oysters lead to up to 1 cm per day local sediment accretion in summer. We performed sediment and bathymetric surveys, deployed arrays of current meters, water gauges, and sediment traps, measured settling velocities and erosion, and modeled tidal flows and wind-waves. Results indicate that the site is sbb-dominated, tending to disperse bio-deposits towards the open estuary. However, tidal currents alone are not competent to transport the bio-deposits beyond the near-field of the farm. Episodic wave events likely provide additional energy needed for dispersal and minimization of local impacts. (Abstract ID 10657)

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AN IDEALIZED 3D NUMERICAL STUDY ON THE GENERATION OF LARGE COHERENT STRUCTURES DUE TO A TSUNAMI WAVE

When a tsunami wave propagates to the coast, the interactions of the waves, the shoreline and the coastal hard structures can cause the generation of large coherent structures (vortices). These coherent structures are shown to last for a long time through Boussinesq wave modeling (Son et al. 2011, Ocean Modelling, 38) and are believed to cause damages to vessels and coastal structures. Here, we investigate the generation, evolution and dissipation of these coherent structures using a 3D large-eddy simulation approach with a volume of fluid scheme for free-surface tracking. The model is validated with a flume experiment of solitary wave shoaling. To investigate the tsunami induced coherent structures, an idealized wave basin of 40x25x1.5 meters is simulated with grid resolution as fine as ~5 cm. A solitary wave is generated in the shallow water (2m). The vortex then interacts with the reflected wave and the jetty causing further migration and cascading. (Abstract ID 9640)

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SEDIMENT FLUXES IN PERMEABLE SEDIMENTS CALCULATED FROM TEMPERATURE-VERIFIED MODELING OF POSEWATER MOTION COMBINED WITH IN-SITU CHEMICAL MEASUREMENTS

A numerical model of wave-driven porewater motion in permeable sediments was developed by combining pressure-induced porewater advection (as derived by Shum) with Webster’s shear dispersion; the sediment-surface driving pressure is calculated from potential flow via second-order Stokes wave expansion and conformal mapping over ripples. Temperature, measured with a sediment-mounted miniature thermistor chain, was used to verify the model by using the sub-daily sediment temperature propagation to calculate advective transport to at least 20 cm into the sediment (i.e., over depths where advection dominates over diffusion). The model’s mapping of porewater motion allows the estimation of 1) seawater/porewater exchange by using the sub-daily sediment temperature propagation to calculate advective transport to at least 20 cm into the sediment, 2) porewater residence times, and, when combined with in-situ electrochemical profiling, 3) porewater chemical fluxes and sediment production/consumption rates. As a rough rule of thumb, the daily sediment ventilation depth approximates the sediment ripple wave length. We conclude that numerical modeling of permeable-sediment porewater motion is very feasible, that temperature is an effective tracer for upper-sediment porewater advection; and that the combination of modeling and in-situ measurements shows promise for the calculation of porewater fluxes and reaction rates in permeable sediments. (Abstract ID 9813)

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OXIDATION OF FE(II) IN THE PRESENCE OF INDIVIDUAL LIGANDS FROM PHAEODACTYLM TRICORNUTUM

The effect of organic ligands from the phytoplankton Phaeodactylum tricornutum in the oxidation rate of Fe(II) in seawater has been studied at two different pH values, 8 and 7.5. In the presence of oxalates, the Fe(II) oxidation rate, log k, showed a decrease from 3.31 M⁻¹ min⁻¹ to 2.81 M⁻¹ min⁻¹ at pH =8 and from 2.90 M⁻¹ min⁻¹ to 2.12 M⁻¹ min⁻¹ at pH = 7. The effect of individual organic ligands present in the medium has been studied focusing this study in the identification, characterization and quantification of polyphenols. The studies have been done both in the seawater and the seawater enriched with the phytoplankton oxalates. In the seawater extract, 9 of the 18 polyphenols analyzed were found, being the most abundant the catechin and sinapic acid. In the extracted of seawater enriched with the oxalates after eight days of culture growth 17 of the 18 polyphenols analyzed were determined being the most abundant the catechin, sinapic acid, quercitin and epicatechin. The quercetin was not found in any sample. (Abstract ID 11101)

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OBSERVATIONS AND MODELING OF THE MIXED LAYER AT STATION ALOHA

Mixed layer depth variations at Station ALOHA were estimated from Hawaii Ocean Time-series CTD profiles (1988-2011) and from the WHOTS mooring (2004-2011) using a density criterion. An improved version of the Price-Weller-Pinkel (PWP) 1-dimensional mixed layer model was forced with wind stress, heat and freshwater fluxes observed from the WHOTS buoy. The model captures the seasonal variation of mixing, but the mean MLD from PWP is shallower (28 m) than WHOTS (53 m). The model bias seems to arise from fewer deep mixing events in winter (though maximum depth is well captured) and from a generally shallower ML during summer. This bias may be attributed to daytime shoaling in the model that is more frequent and intense than observed. Strong, intermittent shears due to baroclinic tides and eddies are observed at ALOHA and are probably an important source of entrainment that is not modeled. 3-dimensional advection is important to close the ML heat and salt budget. Experiments with externally imposed Ekman pumping and large-scale horizontal advection are described. (Abstract ID 12587)

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DISSOLVED ORGANIC CARBON (DOC) DYNAMICS IN THE MEDITERRANEAN SEA

To date the contribution of the Mediterranean Sea (MS) to the global carbon budget is still under debate. Due to the extensive coast line and high population density, terrestrial inputs and anthropogenic pressures strongly influence the DOC cycle in the MS. The basin-scale DOC distribution and the fluxes at the straits can be evaluated thanks to the large data-set now available for the basin. This study will report a first estimation of the DOC budget together with information about the MS metabolic state. First estimates show that the MS contains about 2.2 10¹⁵ g DOC. The residence time of the water masses is 80-100 years and the DOC mineralization rates are very high in the intermediate and deep waters (2.2–14.4 µM Cyrl). As a consequence, the role of the MS in the global Carbon cycle may be more important than initially thought. The MS responds rapidly to environmental changes and may be a sensitive indicator of climate change with respect to the DOC cycle on a temporal scale shorter than in the Ocean. (Abstract ID 11939)

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TRAVELS ON BOARD THE R/V "URANIA" OUTREACH ACTIVITY WITH 10-12 YEARS OLD CHILDREN

We believe that public outreach is one of our duty toward the society. We organize activities in order to popularize the oceanography in the schools. The activities are mainly proposed to 10-12 years old children and they are organized in two meetings. The first is a playful lesson aimed to introduce the functioning of marine ecosystem, and to explain the work of the oceanographers. Starting from the ideas of the children and with some photos of phytoplankton, zooplankton, bacteria and fishes, we construct the marine ecosystems and the goods and services that the sea offers us. During the second meeting a film documentary about the life on board of the oceanographic vessel "Urania" is showed. The goal of this film is to describe the life on board, the personal relations between the team, the unexpected events, the choices of the oceanographers, in order to give an idea of the oceanographic research. (Abstract ID 11981)

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NITRIFICATION AND NITROUS OXIDE PRODUCTION IN THE EASTERN TROPICAL SOUTH PACIFIC: INSIGHTS FROM STABLE ISOTOPE RATIOS AND DIRECT RATE MEASUREMENTS

Oxygen deficient zones (ODZs) are important for N2O production in the ocean. Low oxygen concentrations underlying regions of high ammonium flux should support high rates of nitrification and high yields of N2O. Here we present measurements of the concentration and stable isotopic composition (δ15N, δ18O) and site preference (N2o) of nitrogen from a cruise in the Eastern Tropical South Pacific in 2010 along with direct rate measurements of nitrification and N2O production. N2O concentrations ranged from near equilibrium at the surface (6.6-7.8 nM) to 120 nM at the base of the euphotic zone, with evidence of N2O consumption at stations adjacent to the ODZ. Minima in N2O concentrations were associated with high δ15N-N2O (9.7 - 10.1 per mil) and high δ18O-N2O (82-80 per mil), while subsurface maximal N2O concentration had low δ15N(43-49 per mil) and δ18O (46-47 per mil). Site preference (δ15Nδ18O - δ15Nδ15N) ranged from 8.4 to 31.7 per mil and was correlated with δ18O-N2O. The highest nitrification rates (181 nM per day) were observed at the station with the highest subsurface N2O concentration. (Abstract ID 11910)

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FORCING MECHANISMS FOR THE COASTAL DYNAMICS OF THE UPPER GULF OF THAILAND

A realistic sigma-coordinate ocean circulation model has been used to study the forcing mechanisms and coastal dynamics of the upper Gulf of Thailand (UGoT). The upper Gulf is a low latitude shallow basin, about 100 by 100 km in size and an average depth of 15 m; it is strongly influenced by the seasonal monsoon winds. The model has horizontal resolution of approximately 1 km, 21 vertical sigma layers and forced by 8 tidal constituents, wind stress and surface heat fluxes. Sensitivity experiments are conducted to investigate the role of different forcing mechanisms, and to study the tidal, sub-tidal and seasonal dynamics. Model results are also compared with various observations. The influence of the wind stress on the shallow topography of the UGoT resulted in seasonal shifts between clockwise and counter-clockwise circulations during the southwest and northeast monsoons, respectively. Even with spatially constant surface forcing, narrow plumes of anomalously warm temperatures are transported along the Gulf by the seasonally shifting coastal currents. Satellite SST data generally agrees with the simulated spatial structure. (Abstract ID 9706)

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SIMULATING AND UNDERSTANDING THE ROLE OF TROPICAL ATLANTIC VARIABILITY IN THE CLIMATE SYSTEM

Second only to the El Nino-Southern Oscillation, the tropical Atlantic is a region characterized by significant air-sea interaction phenomena, including the meridional mode and the Atlantic Multidecadal Oscillation. Recent advances in high-resolution climate modeling and the increased availability of observations provide new opportunities to improve our understanding of tropical Atlantic variability. This talk will review some of the recent developments in simulating and understanding this variability, both in global climate models, as well as in more regional and mechanistic studies designed to elucidate mechanisms and test hypotheses. The role of the wind-evaporation-SST (WES) feedback and the role of subsurface oceanic processes will be discussed. A particular focus of the talk will be the persistent warm biases in the tropical Atlantic seen in global climate model simulations, in the equatorial Atlantic as well as in the upwelling regions of southeastern tropical Atlantic. Several hypotheses have been proposed to explain the origin of these biases, including deficient Amazon convection, oceanic barrier layers, inadequate model resolution etc. High-resolution coupled regional modeling studies can be used to test some of these hypotheses and preliminary results indicate that the Bjerknes feedback and subsurface advection may play an important role in amplifying the biases that are already present in uncoupled atmospheric model simulations. (Abstract ID 11439)

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MONSOON-DRIVEN UPWELLING EFFECT ON THE PHYTOPLANKTON BLOOMS
IN THE SOUTHEAST ASIA SEAS: AN EDDY-RESOLVING PHYSICAL-BIOLOGICAL MODEL STUDY

An eddy-resolving coupled physical-biological ocean model has been employed to investigate physical influences on the phytoplankton blooms in the South East Asia region during 2000-2007. The model captures the seasonal and interannual variability of chlorophyll distribution associated with the mesoscale eddies, ocean circulation and upwelling generated by the monsoon. During boreal winter, the high chlorophyll concentration in the northwest of Luzon is related to monsoon-driven upwelling and Kuroshio eddy. Monsoon-driven upwelling and current also control the high chlorophyll concentration in the east coast of Vietnam in boreal summer. The high chlorophyll region is linked to the variability of offshore current system. During boreal summer-fall, the phytoplankton blooms along the south coast of Java-Sumatra extend westward and offshore in the southeastern tropical Indian. The spreading of phytoplankton blooms in 2006 summer is the maximum. The southeasterly winds are stronger in 2006, and the coastal upwelling widely uplifts nutrient and the high chlorophyll is generated. The high chlorophyll in the south of Java coincides with the Indian Ocean Dipole event in 2006. (Abstract ID 10743)

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ROLE OF VERTICAL MIXING ORIGINATING FROM SMALL VERTICAL SCALE STRUCTURES WITHIN THE EQUATORIAL THERMOCLINE IN A COUPLED GENERAL CIRCULATION MODEL

Ocean background vertical diffusivity is known to influence the state of the equatorial ocean which affects the climate system, including the amplitude of ENSO. Recent measurements of ocean currents at high vertical resolution capture numerous small vertical scale structures (SVSs) within the equatorial thermocline which are not sufficiently resolved by coarse resolution ocean models. In this study, a coupled general circulation model has been used to investigate the effect of enhanced vertical diffusivity caused by the SVSs within and above the equatorial thermocline on the mean state and interannual variability of the tropical Pacific. It is found that vertical mixing caused by finescale features within the equatorial thermocline can strongly affect the mean state of the ocean leading to a warming of the cold tongue SST. We also find that the finescale features change the characteristics of ENSO such as the amplitude and skewness. (Abstract ID 10107)

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A ROLE OF LOCAL AIR-SEA INTERACTIONS INDUCED BY HIGH SST BAND ON THE HAWAIIAN LEE COUNTERCURRENT

The Hawaiian Lee Countercurrent (HLCC) is a narrow eastward current extending far westward from Hawaii. The satellite observations showed that atmospheric response with surface wind convergence and high cloud water appears over the HLCC with high sea surface temperature (SST). Using the coupled GCM that simulates well the atmospheric response to the high SST band, we suggest that the wind convergence further drives the HLCC with distinct acceleration in the south of the current axis. Both Ekman suction induced by positive wind curl along the wind convergence band and eastward Ekman surface flow induced by northerly wind in the south of the HLCC axis seem to play roles in the HLCC acceleration. When the HLCC speed is higher, the eastward SST band and wind convergence are more distinct. The HLCC acceleration via the local air-sea interactions over the high SST band could further enhance the HLCC variations with both seasonal and interannual time scales. (Abstract ID 10125)

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CLIMATIC FORCING AND PHYTOPLANKTON PHENOLOGY OVER THE SUBARCTIC NORTH PACIFIC FROM 1998 TO 2006, AS OBSERVED FROM OCEAN COLOR DATA

We investigated phenological changes in phytoplankton in the subarctic North Pacific and the relationship to climatic forcing variability from 1998 to 2006, using SeaWIFS data combined with climatological data. Original SeaWIFS data with 9-km spatial and daily temporal resolution were regridded to 2 x 2 degree and 10-day resolution within the range of 40°-60N and 140E–120W. The interannual variability in the timing, magnitude, and duration of phytoplankton blooms were derived by a Gaussian curve fitting technique. In addition, to investigate the geographic pattern of phytoplankton phenology, we classified the oceanic regions of the subarctic North Pacific into three groups based on K-means clustering: group A was distributed in the coastal regions of marginal seas, waters around the Kamchatka Peninsula, and along the Aleutian Islands; group B was mainly distributed offshore in western and central regions; and group C was in southeastern and central regions. The timing of spring blooms of group A was earlier in El Niño phase and later in La Niña phase, whereas the opposite pattern was seen in group B. (Abstract ID 10994)

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A NOVEL METHOD TO QUANTIFY GLOBAL AIR-Sea CO2 FLUXES AND SEASONAL Carbon/PH DYNAMICS VIA NEURAL NETWORK ANALYSIS OF MIXED-LAYER HYDROGRAPHIC CARBON DATA

Here we conduct an empirical analysis of surface total carbon dioxide and alkalinity bottle data using neural networks in order to provide an independent estimate of mixed layer carbon dynamics and global air-sea CO2 fluxes. Using the GLODAP, CARINA and CLIVAR discrete bottle datasets, the artificial neural network was first trained with mixed-layer hydrographic parameters (temperature, salinity, dissolved oxygen and nutrients) then multiple linear regressions were applied to data assigned to individual neurons, increasing the models predictive power and allowing statistical evaluation of parameter significance. To test the techniques ability to diagnose seasonal CO2 dynamics, we compare our estimates with the RAXS and HOTIS time series stations and conduct out of sample tests to ascertain global predictive capabilities. Once the model was optimised, the World Ocean Atlas climatologies were used to diagnose monthly ocean surface distributions of the carbon constituents and calculate the corresponding annual air-sea CO2 flux. Our independent technique shows similar sources and sinks of CO2 to those calculated from Takahashi et al [2009], whilst providing a first estimate of seasonal variability in DIC, ALK, pH and aragonite saturation state. (Abstract ID 10789)

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INTER- AND INTRA-ANNUAL VARIABILITY OF DIEL VERTICAL MIGRATION IN A COASTAL INLET

Variability in diel vertical migration of euphausiids in Saanich Inlet, British Columbia, is quantified using echosounder data collected by the Victoria Experimental Network Under the Sea (VENUS) coastal network. The continuous and high-resolution nature of our observations enabled examination of daily, seasonal, and interannual modulation of diel vertical migration in acoustic backscatter. A data ‘cube’ concept, where echosounder data can be imaged as a ‘cube’ in [time of day] x [depth] then applied to characterize its variability. Variability in migration timing relative to sunrise and sunset is observed on seasonal and shorter (<36- and 14-d periods) timescales, superimposed on seasonal changes in daylight length. Analysis reveals (i) delayed evening ascent coincides with early morning descent in winter, and (ii) early evening ascent coincides with delayed morning descent in shorter timescale. This study suggests the ability of euphausiids to adjust their migration timing and highlights the importance of high sampling resolution and long time-series record for determining the variability and complexity in diel vertical migration. (Abstract ID 11668)
INTRA-DECADAL CHANGES IN THE SALINITY AND ITS CONNECTION WITH SUBTROPICAL MODE WATER IN THE SOUTH ATLANTIC

We investigate salinity changes in the South Atlantic that could implicate in consequences to climate. According to Sato and Polito (2008), opposite trends in the salinity were observed on the Southwestern Atlantic, around 38oS. They speculate that the mass transported by the Brazil Current became saltier while the Malvinas Current contribution became fresher over the last decade. These opposite trends could imply on a weakening of the subtropical gyre due to flattening of the dynamic height slopes across the South Atlantic Current. The hypothesis is that intra-decadal changes in the air-sea interaction associated with the subtropical mode water formation are responsible for the observed trends. The analysis of salinity profiles from Argo data, World Ocean Database and models (GODAS and SODA) allows us to investigate its variability in the ocean interior. Additionally, the spatial and temporal variability of parameters measured from the AMSR-E microwave radiometer is essential to correlate the salinity trends with the hydrological cycle's variables at basin scale. The moisture fluxes (E-P) using satellite data show increasing (decreasing) trends right over the regions where the salinity increases (decreases). (Abstract ID 10636)

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at several light wavelengths with a sampling frequency of 1 kHz and a small collector of 2.5 mm in diameter, which is required to resolve the temporal and spatial scales of wave focusing events occurring at near-surface depths under sunny conditions. The Porcupine was deployed from R/P FLIP in the Santa Barbara Channel and south off Hawaii Islands as part of the ONR project “Radiance in a Dynamic Ocean”. Our results demonstrate large changes in the power spectra with increasing depth from less than 1 to 10 m. At the shallowest depths the dominant peak is located at frequencies between 1 and 3 Hz. With increasing depth the peak shifts toward lower frequencies and the spectra become sharper due to rapid dampening of high-frequency (> 1 Hz) components. The comparisons of power spectra for different light wavelengths, solar elevation, and wind speed are also presented. (Abstract ID 9359)

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PHYSICAL VARIABILITY ON THE SHEF OFF NSW AUSTRALIA: NEW INSIGHTS FROM THE NSW INTEGRATED MARINE OBSERVING SYSTEM

Within the framework of the Australian Integrated Marine Observation System, several moorings have been deployed along the NSW shelf. In particular, upstream of the EAC separation point at Coffs Harbour and off Sydney, mooring arrays have been continuously monitoring physical parameters including temperature and current velocities through the water column since 2009. Over 12 months of these concomitant datasets has been assessed, relative to remote sensing SST, SSH derived geostrophic velocities and wind observations. These unprecedented, high-resolution data are analyzed in order to identify the dominant shelf dynamics. The shelf circulation at 30oS is primarily dominated by the poleward East Australian Current variability. This strong boundary current intrudes onto the continental shelf in autumn, associated with warm, nutrient-poor water, but also drives some intense current-driven upwellings, with measurements revealing sudden cooling of the bottom temperature by up to 4 degrees. In contrast downstream of the separation point meso scale eddies and wind stresses play a role in the uplift and suppression of isotherms to a greater extent, resulting in a significant biogeochemical response, as identified from in situ observations. (Abstract ID 10066)

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HOW KING SCALLOPS RESPONSE TO OCEAN WARMING AND ACIDIFICATION

We studied synergistic effects of ocean warming and acidification (OWA) on king scallops (Pecten maximus, L.), an actively swimming calcifier. Metabolic activity and survival success were investigated on organismic level using oxygen measurements and force recordings during routine metabolism and swimming (escape response). P. maximus were sampled during winter from Stavanger (Norway) and incubated for 7-8 weeks at 4°C and 10°C, and at CO2 levels of 40 and 115 Pa, respectively. OA alone had only a marginal impact on routine metabolism and escape response of the scallops. However, we observed a significant reduction in both force production and in factorial aerobic scope (the quotient of exhausted exercise- to routine metabolism) under elevated temperature and high CO2 conditions. Exhausted animals at elevated temperature had significant less oxygen and more CO2 in their hemolymph compared to animals under routine conditions. Additions of OA alone had only a marginal impact on routine metabolism and escape response of the scallops. However, we observed a significant reduction in both force production and in factorial aerobic scope (the quotient of exhausted exercise- to routine metabolism) under elevated temperature and high CO2 conditions. Exhausted animals at elevated temperature had significant less oxygen and more CO2 in their hemolymph compared to animals under routine conditions. Additions of OA alone had only a marginal impact on routine metabolism and escape response of the scallops.
PERSISTENT MYSTERY PITS ON THE SEAFLOOR OF THE UPPER CONTINENTAL MARGIN

Observations are presented from rotary sonar imagery of persistent 0.5 m scale pits on the seafloor in 400 m depth on the upper continental margin. The observations were collected during the first 6 months of operation of the NEPTUNE Canada cabled ocean observing system. Pits were detected out to 10 m and even 50 m range, with a spatial density of O(1 m^-2). The same pits persisted over the full 6 month observation period. Core samples indicate pronounced downward fining of the seafloor sediments, from sand to mud. Spectra of near-bottom velocity from co-located ADCPs are dominated by the semi-diurnal tide. Contemporaneous CTD profiles in the area indicate that the bottom slope is likely critical for internal wave modes at the frequency of the semi-diurnal tide, and occurrences of pronounced bottom-intensified flow on this time scale are present in the ADCP records. Nonetheless, the critical stress for fine sediment erosion was exceeded less than 5% of the time. Why, then, do the pits not infill? And by what process(es) are the fine-grained particles winnowed out of the surficial sediments? (Abstract ID 12601)

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ELLIPTROCHLORIS MARINA AND SYMBIODINIUM MUSCATINEI-CO-HABITANTS IN ANTHOPLEURA XANTHOMARGINATA AND A. ELEGANTISSIMA
A. xanthomarginata and A. elegantissima harbor two endosymbionts; Elliptochloris marina (green chlorophyte) and Symbiodinium muscatinei (golden-brown dinoflagellate). They comprise 15-50% of the volume and protein biomass of their anemone host and determine distribution throughout the rocky intertidal shore. Information on the life cycle of these symbionts outside their host is scarce due to unsuccessful attempts to provide a culture media suitable for their survival. This study aims to culture E. marina and S. muscatinei by manipulating F/2 and ASP-8A media to determine optimal conditions preference of these symbionts. 16 x 100mm culture tubes were prepared for both symbionts (extracted from anemone tentacles) with F/2 and ASP-8A media and manipulated with the following treatments: animal tissue extract (salmon, anemone, mussel, and shrimp), nitrogen sources (urea, ammonium nitrate, and ammonium chloride), amino acids, casein, glucose, salmon oil, and autochthonous salmon tissue. E. marina responded better to ASP-8A media while S. muscatinei responded to F/2 media. Animal tissue extract and amino acids induced a positive population growth effect, which could suggest that these symbionts may have evolved to co-dependent on their host. (Abstract ID 9588)

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TRANSFER OF SUBGLACIAL WATER ACROSS THE GROUNDING LINE OF THE ROSS ICE SHELF: INDICATIONS FROM HELIUM ISOTOPE DATA

Measurements of helium isotopes collected at ocean stations occupied by the icebreakers Polar Sea in 1994 and Palmer in 2000 reveal He-4 concentrations in excess of the solubility equilibrium with the atmosphere in the deep Ice Shelf Water (ISW) plume observed near the Ross Ice Shelf (RIS) front at ca. 500 meter depth at ca. 180° longitude. The excess Helium is characterized by He-3/He-4 ratios of ca. 3.6±10^-7, i.e., below that of atmospheric air. Within analytical errors this ratio is identical to that determined by Jean-Baptiste et al. in the deep section of the Vestok ice core which consists of re-frozen lake water. From these observations we conclude that water from the hydrological system under the Antarctic Ice Shelf is transferred across the grounding line of the RIS and transported within the ISW plume to the calving front of the ice shelf. This helium isotope signature may be the first geochronological evidence in the Southern Ocean of water that has originated from landward of the grounding line of an Antarctic ice shelf, thus contributing to outflow plume properties, volume and related inferences. We discuss possible provenance and transport mechanisms of this observed subglacial water, as well as strategies to use isotope data for estimates of its transport rate in the ISW plume. The low He isotope ratio can also be used to trace the pathway of the ISW plume away from the RIS front towards the continental margin. (Abstract ID 11676)

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SENSITIVITY OF MODEL FORECAST TO GLIDER AND CODAR ASSIMILATION IN WESTERN NORTH ATLANTIC

Persistence of oceanographic structure is a key parameter for the spin-up of coupled ocean-atmosphere models. However, the impact of available observations on the initial condition of the ocean state is poorly understood in the context of a real-time forecast. In this study, we carry out a series of four experiments using the global GEM (Geophysical Fluid Dynamics Laboratory, Group for High-resolution Environment) ocean model with a resolution of 1/20° in a region of the western North Atlantic. The model is forced with NEMO (National Center for Atmospheric Research, Ocean Model) reanalysis, and assimilation is carried out using GLASS (Global Land Sea Surface) and CODAR (Coastal Ocean Dynamics and Assessment Program) data. The results show that the use of observations significantly improves the model's ability to capture the observed hydrographic properties and circulation patterns. The effect is most pronounced in the subpolar gyre and the Labrador Sea, where the model's ability to simulate the storage anomalies and the exchange with the subtropical ocean is enhanced. The results highlight the importance of incorporating observations into ocean model forecasts and the potential for improving the accuracy of climate and weather predictions. (Abstract ID 11127)
A recently implemented real-time ocean prediction system for the western North Atlantic based on the physical circulation model component of the Harvard Ocean Prediction System (HOPS) was used during an Observation Simulation Experiment (OSE) in November 2009. The modeling system, one of the three in MARACOOS, was built to capture the mesoscale dynamics of the Gulf Stream (GS), its meanders and rings, and its interaction with the shelf circulation. The feature-based initialization scheme was utilized for 4 short-term forecasts of varying lengths during the first two weeks of November 2009 in an ensemble mode with other forecasts to guide glider control. These forecasts are first compared against observed GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events. A reanalysis was then carried out by sequentially assimilating the data from three gliders (RU05, RU21 and RU23) and CODAR GS meandering and ring formation/absorption events.

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**PHYSICAL AND BIOLOGICAL CONTROLS OF NUTRIENT AND OXYGEN CYCLING IN THE SOUTH AFRICAN EASTERN BOUNDARY CURRENTS**

The Eastern Boundary Currents off southern Africa are related to two oxygen minimum areas of different nature, one in the Angola Gyre, another one in the Benguela Upwelling System. Both are linked by the Angola Current but are controlled by different physical processes and governed by different key species for the biogeochemical cycles. In the Angola Gyre nutrients are supplied to the euphotic zone by upwelling due to a typical wind stress curl, in the Benguela System we find both, upwelling from the wind stress curl and coastal upwelling modified by shelf wave s. The South Atlantic Central Water in the Angola Gyre is hypoxic but never anoxic whereas the bottom water in the Benguela becomes anoxic intermittently. We present a coupled 3d-biogeochemical model and to investigate transport and cycling of nutrients and oxygen. We will study physical controls of the oxygen conditions but also the capacity of organisms to modify and regulate oxygen conditions. The investigations are part of the GENUS (Geochemistry and Ecology of the Namibian Upwelling System) project. (Abstract ID 11238)

**USING THE SEDIMENT SOURCE-SINK CONCEPTUAL MODEL TO INTEGRATE OCEANS AND CONTINENTS IN THE LAND-GRAIN UNIVERSITY SCIENCE CURRICULUM**

Developing an educated society aware of the connections between human activities and impacts to ocean ecosystems requires university undergraduate science curricula connecting terrestrial to ocean systems. This is especially true in continental land-grant institutions that typically receive significant funding for degree programs in agricultural science focused on training students for careers in agriculture that indirectly impact ocean environments. Both are linked by the Angola Current but are controlled by different physical processes and governed by different key species for the biogeochemical cycles. In the Angola Gyre nutrients are supplied to the euphotic zone by upwelling due to a typical wind stress curl, in the Benguela System we find both, upwelling from the wind stress curl and coastal upwelling modified by shelf wave s. The South Atlantic Central Water in the Angola Gyre is hypoxic but never anoxic whereas the bottom water in the Benguela becomes anoxic intermittently. We present a coupled 3d-biogeochemical model and to investigate transport and cycling of nutrients and oxygen. We will study physical controls of the oxygen conditions but also the capacity of organisms to modify and regulate oxygen conditions. The investigations are part of the GENUS (Geochemistry and Ecology of the Namibian Upwelling System) project. (Abstract ID 11238)

**SPIN-DOWN AS A KEY TO THE RESPONSE OF THE MID-LATITUDE LOWER TROPOSPHERE TO SEA SURFACE TEMPERATURE FRONTS**

We investigate the response of the atmospheric Ekman layer in the vicinity of SST fronts using the high-resolution, operational ECMWF reanalysis. The response of the atmospheric Ekman layer includes the well known frontal adjustments due to the modulation of boundary layer stability and due to the imprints of SST on boundary-layer gradients of temperature and pressure. We find that the Ekman pumping induced spin-down and its secondary circulation displaces the stable stratification outside of the Ekman layer and renders the surface wind stress curl small through the associated thermal wind. The spin-down converts the frontal responses of stability to an adjustment of pressure and couples these processes. (Abstract ID 10308)

**FORMATION OF ANTARCTIC INTERMEDIATE WATER IN THE SOUTH ATLANTIC**

Antarctic Intermediate Water (AAIW) is one of the most prominent intermediate water masses of the southern hemisphere where it can be identified by its low salinity and potential vorticity. Formed north of the Antarctic Polar Front Zone AAIW deepens to depths greater 1000m on its way northwards. The focus of the present study is on the AAIW portion formed in the South Atlantic sector. The aim is to calculate inventories from anthropogenic tracers and formation rates of AAIW from historical tracer data which encompass the time period till 2004. The considered data set includes hydrographic measurements from the past two decades, chlorofluorocarbons (CFCs), as well as T/S profiles stemming from the Argo float program. By studying horizontal maps of water mass properties we present first results revealing the horizontal propagation of AAIW and associated variability. Based on historical measurements first tracer inventories and formation rate estimates are presented for the South Atlantic. (Abstract ID 9007)

**CURRICULUM OCEANS AND CONTINENTS IN THE LAND-GRANT UNIVERSITY SCIENCE**

By studying horizontal maps of water mass properties we present first results revealing the horizontal propagation of AAIW and associated variability. Based on historical measurements first tracer inventories and formation rate estimates are presented for the South Atlantic. (Abstract ID 9007)

**THREATS TO OCEAN ECOSYSTEMS FROM CHEMICALS OF DIRECT AND INDIRECT HUMAN ORIGIN**

The impacts of direct and indirect human activities on ocean ecosystems are globally important. The focus of the present study is on the AAIW portion formed in the South Atlantic sector. The aim is to calculate inventories from anthropogenic tracers and formation rates of AAIW from historical tracer data which encompass the time period till 2004. The considered data set includes hydrographic measurements from the past two decades, chlorofluorocarbons (CFCs), as well as T/S profiles stemming from the Argo float program. By studying horizontal maps of water mass properties we present first results revealing the horizontal propagation of AAIW and associated variability. Based on historical measurements first tracer inventories and formation rate estimates are presented for the South Atlantic. (Abstract ID 9007)
GROSS GROWTH EFFICIENCY OF MIXOTROPHIC AND HETEROTROPHIC CILIATES: RELATIVE CONTRIBUTION OF GRAZING AND PHOTOSYNTHESIS

Ciliates serve as an important link between microbial primary producers and higher trophic levels. Mixotrophic ciliates obtain carbon from both grazing and photosynthesis. We do not have a complete understanding of the extent of the contribution of heterotrophy and autotrophy to the growth of many mixotrophic ciliates; or of how the gross growth efficiency (GGE) of mixotrophs compares to that of heterotrophs. Here we measured the growth and grazing rates of the obligate mixotrophic ciliate Strombidium rassoulzadegani and the heterotrophic ciliate Strombidium spp. and compared GGEs. In low-light conditions, Strombidium spp. was used as a tracer to determine to what extent, if any, inorganic carbon contributed to the total carbon uptake. At most algal food concentrations used as a tracer to determine to what extent, if any, inorganic carbon contributed to the total carbon uptake.

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When algal food concentrations were low (30 to 100ngC/ml) we observed a range of GGEs ranging from 40% to 60% that increased with food concentration to a maximum. After accounting for Strombidium spp.'s photosynthesis, GGE for ingested carbon ranged from 40% to 60%. (Abstract ID 11659)

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GLOBAL SPATIAL AND TEMPORAL PATTERNS OF INCREASED NITROGEN LIMITATION ACROSS THE PERMAN-TRIASSIC BOUNDARY

This study compiles sedimentary organic nitrogen isotope records from a number of disparate, geographically separated marine environments spanning the Permian-Triassic Boundary. A widespread trend toward lower δ15N in the latest Permian indicates an increased role of nitrogen fixation, suggesting increased N limitation in many ecosystems, which may have peaked in marine food web and delayed the recovery from mass extinction. Extremely low δ15N values, ≤0.0, suggest that primary productivity was dominated by cyanobacteria during the extinction interval, both in the Tethys Ocean and the offshore Panthalassic. A substantial latest-Permian increase in continental eustasy due to warming, acidification, and the loss of vegetation may have increased phosphate inventories at the same time that increased anoxia was favoring nitrogen loss through denitrification and coastal upwelling currents were weakening, leading to NP ratios below Redfieldian values, and necessitating increased nitrogen fixation. Regions of delayed nitrogen cycle recovery may indicate upwelling regions especially sensitive to warming and the consequent weakening of overturning circulation. (Abstract ID 12863)

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PHYTOPLANKTON DYNAMICS AND BOTTOM WATER OXYGEN DURING AN EXCEPTIONAL BLOOM IN THE SUMMER OF 2011

During the summer of 2011 an exceptional phytoplankton bloom occurred off the New Jersey coast, which was monitored using the ocean observatory provided by the U.S. Integrated Ocean Observing System (IOOS), NOAA National Marine Fisheries, and the Environmental Protection Agency. The bloom was studied using satellites, HF radar, Webb Slocom gliders and a ROMS model. Chlorophyll concentrations were over an order of magnitude larger than the decadal mean of ocean color data and the bloom was initiated by a week of sustained upwelling wind and was maintained by intermittent winds that lasted until the passage of Hurricane Irene. The high concentrations of phytoplankton resulted in the supersaturated oxygen values in the surface waters; however the flux of organic matter resulted in oxygen saturation values of <60% in the coastal bottom waters, which was sufficient to stress benthic communities in the MB. The passage of Hurricane Irene increased the oxygen saturation at depth by close to 20%, but was not sufficient to terminate the bloom. Bloom senescence occurred only after upwelling winds were ended several weeks after Irene. (Abstract ID 11440)

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WHAT HAS COSEE NOW MEANT TO OUR RESEARCH AND OUTREACH EFFORTS?

The Centers for Ocean Sciences Education Excellence (COSEE) Networked Ocean World (NOW) has provided resource to utilize real time data (RTD) in their broader impact efforts. Reviewing past efforts, we show how COSEE NOW has improved all three criteria that we are judged for academic promotion, research, education and service. Using resources from COSEE Networked Ocean World, we have been able to improve our ability to incorporate RTD into our narratives, better gauge and frame material appropriate for the audience, develop more effective teaching practices, and have been provided a suite of different resources that have greatly expanded our broader outreach efforts. Some of the resources that have been helpful include pod-casts, audio slide shows, community blog spots, and a portal to a library of effective online resources. We will review our experience of using real-time data and will comment of what tools we see as becoming increasingly important to our lab in the coming years. (Abstract ID 11457)

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STATISTICAL RECONSTRUCTION AND ANALYSIS OF CHLOROPHYLL CONCENTRATIONS USING PHYSICAL PROXY DATA

While seasonal patterns of phytoplankton blooms are well known, long term patterns are not as well understood. Documenting low frequency changes requires long time-series of phytoplankton biomass measurements, yet the best-resolved, large-scale, continuous biological variable (satellite-derived surface chlorophyll concentration) is only 14 years long. Transparency data have been used to infer declining phytoplankton biomass abundance over most ocean basins during the past century, but in situ data sets have limited spatial extent and have yielded conflicting results. Canonical correlation analysis (CCA) has successfully reconstructed physical variables: sea surface temperatures and meteorological fields. Now CCA is applied to extend ocean color chlorophyll concentration back to 1958 using physical proxy data because phytoplankton abundance is primarily controlled and predicted by physical forcing. The chlorophyll reconstructions are validated against in situ and remotely sensed chlorophyll. Variability within the chlorophyll reconstruction data set is analyzed in relation to climatic signals to test the hypothesis that low frequency oscillations are reflected in phytoplankton biomass patterns over the past 50 years. (Abstract ID 11588)

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CRYSTAL FABRICS AND ELEMENT IMPURITIES IN SHELLS OF ARCTICA ISLANDICA – IMPLICATIONS FOR PALEOCLOCIMATE RECONSTRUCTIONS

Sr/Ca, Mg/Ca and Ba/Ca values are heterogeneously distributed in shells of Arctica islandica. These patterns are largely associated with crystal fabrics or the processes controlling them. The outer shell layer (OSL; homogeneous and irregular simple prismatic crystal fabric (CF)) contained element/Ca values up to 62% higher than the middle shell layer (MSL; crossed-acicular, crossed-lamellar, fine crossed-lamellar and irregular simple prismatic CF). A gradual decrease in Sr/Ca and Mg/Ca values was observed from the outer portions of the OSL toward the OSL/MSL transition zone. This chemical shift was accompanied by a gradual transition from homogeneous crystal fabrics into crossed-lamellar/acicular CF. Near annual growth lines (irregular simple prisms), i.e., during periods of slow growth, Sr and Mg seemed to be deposited in equilibrium with the ambient environment because the Sr/Ca and Mg/Ca values approached values typical for seawater. During the remainder of the growing season, Sr/Ca and Mg/Ca remained far below values expected for thermodynamic equilibrium. Ba/Ca peaks, however, occurred erratically at different times of the year without any noticeable changes in CF. Likely, the environmental information contained in these peaks was less severely filtered by vital effects than in Sr and Mg. The findings of the present study can help to develop new techniques with which extract environmental signals from the metal-to-calcium ratios of bivalve shells. (Abstract ID 12298)

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EL-NINO’S ROLE ON Klamath River Chinook Salmon Abundances

Variability in Klamath River Chinook salmon abundances is compared to ocean conditions to infer the relationships driving salmon productivity. Salmon’s first year at sea in the California Current Large Marine Ecosystem (CCLME) is hypothesized to be the most critical period in the salmon’s life and ultimately has consequences on the number of salmon returns to the Klamath. Through cohort reconstruction, age-specific abundances of Klamath River Chinook salmon is available. The cohort time series is compared to oceanic conditions at various lags. Results show that salmon abundance increases dramatically in years when salmon are born during El-Niño conditions. High cohort numbers align with warm near-shore sea surface temperatures, which are present during El-Niño years. Because river discharge and precipitation records show no noticeable pattern with the cohort time series, it appears that ocean conditions, in large part, determine the abundance numbers. We surmise that El-Niño conditions in the CCLME results in salmon predator and competitor declines, which offer the salmon favorable oceanic conditions once they enter the ocean the year after the El-Niño.
MEASUREMENTS IN THE NORTHWESTERN MEDITERRANEAN SEA

The influence of motions at the submesoscale on the spreading of drifter clusters has been investigated in two sets of experiments performed in the Ligurian Sea (Northwestern Mediterranean Sea) following two different experimental strategies. The first set of experiments (MREA 2007-2008) involved the deployment of drifter clusters in the center of the main cyclonic gyre, with initial radii of about 1 km (an order of magnitude below the typical deformation radius of 10-20 km). The results are suggestive of non-local dynamics at the submesoscale, characterized by exponential dispersion at the initial time and a constant maximum Finite Size Lyapunov Exponent in the range 1-10 km, with typical values of order 1/day. The second set of experiments, instead, targeted a coastal area characterized by surface fronts generated by river outflows. A deployment scheme that allows multi-scale measurements from 100 m to 1 km was used. Significantly different results are obtained, characterized by more than an order of magnitude higher dispersion and suggestive of local dynamics in the submesoscale range. (Abstract ID 9904)

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SEASONAL FLUCTUATION AND ESTUARINE REMOVAL OF RIVERINE IRON FLUXES TO THE GULF OF ALASKA

Iron(Fe) is thought to be a limiting nutrient for phytoplankton populations in much of the north Pacific and the Gulf of Alaska (GoA) in particular. The amount of freshwater entering the GoA from montane watersheds of coastal and interior Alaskan catchments is comparable to the discharge of the Mississippi River, ~50% of which is associated with glacial meltwater. As such, the riverine flux of Fe to the GoA is an important source of this micronutrient that will evolve as regional glacial ice loss continues. While it is clear that riverine iron loads are an important nutrient source to the GoA, relatively little is known about the chemical nature and behavior of iron in glacierized river systems and estuaries. Here we present geochemical data from the Copper River watershed and estuary, the largest single point source of freshwater to the GoA. Through examination of this data in the context of an evolving Alaskan landscape, we can speculate that continued ice loss and land cover change in the GoA watershed will influence both the flux and chemical nature of riverine-derived nutrient loads. (Abstract ID 11364)

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BIOGEOCHEMICAL AND PHYSICAL CONDITIONS IN THE GULF OF MEXICO DURING THE 2011 MISSISSIPPI RIVER FLOODING EVENT

We present an oceanographic dataset which characterizes the physical and biogeochemical conditions at six sites along the northern Gulf of Mexico (GOM) coast approximately one year after the Deepwater Horizon oil spill and during the 2011 Mississippi River flooding event. Temperature and salinity profiles collected aboard the SSV Cormorant suggest significant water column stratification. Nutrient concentrations increased by approximately one-third from the previous year. Increased nutrient inputs from the Mississippi River likely altered nutrient signatures, resulting in non-Redfield N:P ratios in the surface ocean. Dissolved oxygen profiles showed decreasing concentrations with depth, which were very close to hypoxic levels at some sites. These data were collected during developing record hypoxic conditions in the GOM and give insight into potential impacts that recent anthropogenic and natural stressors have had on the marine ecosystems. Water samples were also taken for nitrogen and oxygen isotope analyses to evaluate nitrogen cycle dynamics as well as the microbial production of nitrous oxide, a greenhouse gas which is poorly constrained but may be responding to increased inputs of fixed nitrogen. (Abstract ID 11861)

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AN ASSESSMENT OF MID-ATLANTIC STREAMFLOW AND ITS RELATIONSHIP TO THE NORTH ATLANTIC OSCILLATION AND THE PACIFIC NORTH-AMERICAN TELECONNECTON PATTERN

A discussion of the impacts of the North Atlantic Oscillation (NAO) and Pacific Northern American teleconnection pattern (PNA) on precipitation and temperature in the northeast United States is presented and is followed by an analysis of their impact on mid-Atlantic streamflow. Both the NAO and PNA affect atmospheric flow regimes and as a result affect both precipitation and temperature patterns in the northeast U.S. Negative temperature anomalies are associated with a positive PNA phase, contrasting with positive temperature anomalies during negative PNA phase. In contrast to the PNA, a positive (negative) NAO mode is marked by positive (negative) temperature anomalies in the northeastern U.S. The correlation between the PNA and precipitation in the northeast United States is weak but still significant. Like precipitation, streamflow also depends on the phase of the PNA and the NAO. The correlation between streamflow and the PNA was found to peak at ~6 for Susquehanna River in April. Values for the other months ranged between -3 and 3. Correlations for the Hudson and Delaware were found to range from -3 to 3. Monthly correlations were also found between the NAO index and streamflow with values ranging between -3 and 3 for all three rivers. The mean monthly streamflow varied as much as 50% for the Susquehanna River and as much as 20% for the Delaware and the Hudson River among the four different flow regimes. (Abstract ID 11661)

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BIOGEOCHEMISTRY AND CARBON ISOTOPE DETERMINATION OF NATURAL AND ANTHROPOGENIC VOLATILE HALOCARBONS IN SEAWATER

A new method with two-dimensional gas- chromatography and isotope ratio combustion mass-spectrometry was developed to analyze volatile halogenated organic compounds (VOCs) in surface water and the atmosphere. High resolution chromatography is required to measure reliable isotopic values of single natural (bromofrom) and anthropogenic (chloroform) VOCs in complex mixtures. Isotope determinations are a new tool to understand the biogeochemical behavior of halocarbons in the marine environment. The bromofrom production in Baltic Sea and North Atlantic surface waters was related to the biological productivity with a strong seasonality. Isotope determination can be used to distinguish between different characteristic organisms, like cyanobacteria, macroalgae and phytoplankton. Anthropogenic or natural sources of halocarbons are detectable by different carbon isotope values. For chloroform an isotope fractionation between atmosphere and surface seawater was visible. Concentrations of VOCs in water samples are typically in the pmol/L to nmol/L range. (Abstract ID 11190)

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VENTILATION PATHWAYS OF WATERS INTO THE PACIFIC AND ATLANTIC OXYGEN MINIMUM ZONES FROM HIGH RESOLUTION NESTED MODELS

The Oxygen Minimum Zones (OMZs) in the eastern portions of the tropical Atlantic and Pacific Oceans are observed to expand and strengthen over the last decades. Among the possible causes for the decrease in oxygen is a diminished supply due to a weakening of ocean transports from the ventilated subtropical oceans, associated either with changes in the shallow Subtropical-Tropical Cells or in the equatorial zonal current systems. Decadal variations or longer-term trends in these circulations would not only be caused by local wind stress, but also affected by remote factors such as changes in the Atlantic Meridional Overturning Circulation. Here we investigate the ventilation processes and pathways feeding the OMZs, and their variability on interannual to multi-decadal time scales by high-resolution (1/10°) ocean model simulations for the last 60 years. Lagrangian trajectory analyses in conjunction with passive tracer simulations allow to identify source regions, pathways, and “ages” of waters ventilating the OMZs. Transport time series suggest significant changes on (multi-)decadal time scales especially in the Pacific Ocean, reflecting strong impacts of climate modes like ENSO and the Pacific Decadal Oscillation. (Abstract ID 10967)
Spectral energy dissipation in broad-band wave fields

Breaking surface waves are an important mechanism for energy dissipation in the ocean. A key quantity in a wave field is the normalized distribution of total breaking crest lengths per unit area as a function of speed and direction, \( A_c(b) \), introduced by Phillips (1985). The first moment of \( A_c \) is equivalent to the breaking rate at a point, \( R \), and the fifth moment relates to the total energy dissipation rate, \( E \). We estimate \( A_c \) for broad-band waves in the Strait of Juan de Fuca, WA. We use a Fourier-based approach on video images of breaking crests to calculate \( A_c(b) \), previously applied under narrow-band wave conditions by Thomson et al. (2009). We improve the wave crest detection criteria and noise filtering, and we implement directionality in the Fourier method. We validate our methods using synthetic data where crest length, speed, and direction are known. We compare results from the field with in situ measurements of energy dissipation. Preliminary results demonstrate the viability of calculating \( A_c(b) \), and thus spectral energy dissipation, in complex wave fields. (Abstract ID 9971)

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ecosystems. Alternatively, the venting may derive from the dissociation of methane hydrate or release of underlying free gas with decrease of pressure and increase of temperature beneath the upper continental slope. (Abstract ID 9523)

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OBSERVATIONS OF WIND-DRIVEN VENTILATION AND VERTICAL OXYGEN FLUX IN CHESAPEAKE BAY

An extensive field effort conducted during the summer of 2011 provides a detailed view of the response of dissolved oxygen in Chesapeake Bay to wind-driven forcing. Four moorings provided highly resolved measurements of currents, temperature, salinity and dissolved oxygen at one estuarine cross-section. The in-situ measurements were complemented by ship-based measurement of turbulent mixing. These data document how the rotational response to along-channel wind forcing plays a key role in controlling the direct vertical mixing of dissolved oxygen, as well as the advective ventilation of hypoxic bottom waters. While near bottom waters remained hypoxic throughout the majority of the summer, wind forcing significantly altered the total areal extent of hypoxic water throughout the summer. Bottom waters became oxygenated during the passage of Hurricane Irene in late August, providing a dramatic example of wind-driven ventilation. (Abstract ID 10997)

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VISUAL ECOPHYSIOLOGY OF TAUPOG (TAUTOG ONITIS)

Tautog (Tautoga onitis) is a coastal temperate reef-associated species. Optical micro- and macro-habitats experienced by this species vary widely because of seasonal migration patterns, and daily movements. There are unavoidable tradeoffs between sensitivity and resolution in the evolution of visual systems. However, the functional properties and the ability of visual system reef-associated coastal fishes to cope with environmental variability have not received much attention. We used whole-animal cornel electrotetroretinography (ERG) to examine the response of tautog visual systems to light stimuli varying in wavelength (spectral sensitivity), intensity (luminous sensitivity), and temporal properties (flicker fusion frequency, FFF), as well as circadian changes in these responses. Tautog demonstrated fairly high sensitivity to dim light and moderate speeds of vision (i.e., FFF), consistent with our observations of visual function in other temperate reef-associated fishes. The broad spectral sensitivities of the species are consistent with seasonal migration patterns from shallow green-yellow coastal waters in cooler months to deeper blue-green coastal waters in warmer months. Collectively the functional properties of the tautog visual system thus correlate well with the photoclimate and light riches they inhabit. (Abstract ID 9650)

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OCEAN NETWORKS CANADA OBSERVATORY: ENCOURAGING NATIONAL AND INTERNATIONAL MARINE EDUCATION

Ocean Networks Canada (ONC) Observatory, comprised of VENUS and NEPTUNE Canada cabled networks, supports transformative science in coastal and deep sea ecosystems. It enables interactive experiments focused on ocean health, energy resources, natural hazards, and marine conservation for international research collaborations. Undersea data is collected in real-time, including continuous ocean property data, video footage and acoustic clips. Scientists, educators, students and the general public worldwide have access to the data online through websites, social media and ONC’s Oceans 20 real-time-data tools. To effectively engage our broad audiences, ONC’s strategy is to form partnerships and collaborate with like-minded organizations to distribute marine science and technology knowledge in a “ripple-effect.” ONC has successfully partnered with well-recognized organizations, collaborating on workshops, student symposiums, public engagement and university initiatives. Increasing global ocean literacy through international collaboration with scientists, educators and organizations is imperative. ONC foresees fostering further international collaboration through videoconferencing, data comparison, and possibly building its website into an ocean science education portal. (Abstract ID 10700)

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DEVELOPMENT OF AN ESTUARINE TURBIDITY MAXIMUM WATCH: FROM PROCESS UNDERSTANDING TO OPERATIONAL IMPLEMENTATION

The Columbia River estuarine turbidity maximum (ETM) is an important part of the estuarine “bioreactor” that modulates river to ocean exchanges. The Center for Coastal Observation & Prediction (COP) maintains endurance observation stations strategically located throughout the estuary (http://www.stctcmop.org/saturn). These stations are used to study physical and biogeochemical processes associated with biological “hotspots” in the estuary, with the ETM as a primary target. Most sensors monitor continuously, but some (e.g. for microbial communities) operate on episodic, feature driven sampling protocols. To support adaptive sampling, we analyze our growing data record to build an ETM Watch, which detects the onset and will ultimately predict both timing and intensity of ETMs as a function of river forcing, tide phase and upwelling regime. The Watch builds on the strength of historical, and growing, vertically-resolved time series of multiple variables from water levels and velocities to salinity and turbidity. We describe (a) the existing data record, (b) our understanding of ETM processes for different forcing conditions, (c) methods used to detect and predict ETMs and (d) preliminary assessment of the skill of the Watch. (Abstract ID 12183)

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THE ROLE OF COASTAL OCEAN DYNAMICS IN THE INITIATION AND TRANSPORT OF HARMFUL ALGAL BLOOMS IN SOUTHERN CALIFORNIA

A 2010 observational study was completed in the central Southern California Bight to better understand the spring seasonal variation in phytoplankton blooms related to many factors including nutrients from upwelling events, rivers, effluent plumes, and other coastal processes. Multi-month Webb Slocon glider deployments combined with MBARI environmental sample processors (ESP), and ocean color data provide a multidimensional view of the development and evolution of harmful algal blooms (HABs). Results from the glider and ESP observations show that open blooms of toxic Pseudo-nitzschia sp. developed offshore and subsurface prior to their manifestation in the surface layer and/or near the coast. By sampling tissue from barnacles attached to the gliders during the deployment we have observed that low levels of domoic acid, indicative of the presence of Pseudo-nitzschia, are present throughout much of the year and in most areas where the gliders were deployed. A significant outbreak and surface manifestation of the blooms appears to coincide with periods of upwelling, or other processes that cause shallowing and surfacing of the pycnocline and subsurface chlorophyll maximum. (Abstract ID 12578)

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DISTRIBUTION OF TRACE ELEMENTS IN THE EASTERN TROPICAL SOUTH PACIFIC

The geographical and depth distributions of biologically and non-biologically active trace elements (Ag, Cd, Co, Cu, Fe, Mo, Ni, Pb, V) in the Eastern Tropical South Pacific were measured during the 2010 Austral summer. Samples were collected along two latitudinal transects off the coasts of Peru and Chile at 10° and 20° South, respectively. This region is characterized by an intense oxygen minimum zone (OMZ), which is strongest in the northern transect and greatly reduced in the southern transect. Trace metal distributions were determined with respect to major water masses as well as in relation to the OMZ. An understanding of trace nutrient availability is fundamental, because trace nutrients are not only an important component of carbon cycling, but they may be a significant regulator of nitrogen fixation and denitrification in this region and globally. Analysis of the distribution of non-biologically active trace elements along and across isopycnals was used to determine nutrient sources to the OMZ and provided insight into the influence of dissolved oxygen on the availability of trace nutrients. (Abstract ID 12770)

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IRON LIMITATION AND TRACE METAL DISTRIBUTIONS IN SHELF WATERS OF THE WESTERN ANTARCTIC PENINSULA

The West Antarctic Peninsula (WAP) shelf is bordered by iron-limited waters of the open ACC
but hosts high summertime productivity. Climate warming along the WAP is the most rapid on the planet, with possible effects on fluxes of micro-nutrients from the continent to the adjacent shelf waters. For the first time in the Palmer LTER program, seawater samples were collected in Jan 2010 for determination of dissolved and particulate iron (Fe) as well nickel (Ni), zinc (Zn), manganese (Mn), copper (Cu), and cobalt (Co). Dissolved iron concentrations in outer shelf surface waters were as low as ~0.1 nM, comparable open ACC levels, but increased to ~0.9 nM inshore, suggesting lateral inputs from continental run-off or shallow sediments. Inshore offshore gradients of dissolved Fe and Mn in surface waters of the northern WAP indicate preferential uptake and removal of Fe to low constant values by mid-shelf, while Mn decreases across the shelf. This northern WAP outer shelf region is characterized by strong silicate drawdown, very little nitrate drawdown, and generally low Fe/NOx, suggesting Fe removal by a preceding diatom bloom. Surface water dissolved metal concentrations ranged: Zn 1.5-11 nM, Ni 5.7-7.8 nM, Cu 0.8-1.8 nM, Mn 0.1-2.7 nM and Co 17-67 pM, with no indication of limitation by any of these metals. Results will be discussed in the context of the potential role of micro-nutrients in controlling the distribution, timing, and rates of primary production in this region. (Abstract ID 12417)

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ENERGETIC PLASTICITY UNDERLIES A VARIABLE RESPONSE TO OCEAN ACIDIFICATION IN THE PTEROPOD, LIMACINA HELICINA ANTARCTICA

Anthropogenic carbon dioxide (CO2) diffuses into the ocean causing a reduction in pH. This “ocean acidification” may have a deleterious impact on energetic processes, including calcification, growth, and metabolism in marine organisms. Here we show that elevated carbon dioxide (hypercapnia) can suppress metabolism, measured as oxygen consumption, in L. helicina (forma antarctica) by ~20%. However, we further demonstrate metabolic plasticity in response to regional phytoplankton concentration and that the response to CO2 is dependent on the baseline level of metabolism. Reduced regional chl a levels suppress metabolism and mask the effect of ocean acidification. We hypothesize that this effect is not merely a result of gut clearance and specific dynamic action, but rather represents a sustained metabolic response to regional conditions. Thus, pteropod populations may be compromised by climate change, both directly via CO2-induced metabolic suppression, and indirectly via quantitative and qualitative changes to the phytoplankton community. Without the context provided by our long-term observations (four seasons) and a multifaceted laboratory analysis of the parameters affecting energetics, the complex response of polar pteropods to ocean acidification may be masked or misinterpreted. (Abstract ID 10040)

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PROCESSING OF DISSOLVED ORGANIC MATTER IN PERMEABLE SEDIMENTS OF THE COASTAL NORTH SEA

Although biogeochemical processes in permeable intertidal coastal sediments have been studied extensively, little is known about the production and consumption of dissolved organic matter (DOM), an important ecological parameter. In order to link the thousands of molecules that comprise the DOM pool to biogeochemical processes we applied a non-targeted multi-tracer approach using ultrahigh-resolution Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR-MS). Pore waters were sampled seasonally down to several meters depth at transects covering the intertidal zones of a sand flat with seawater circulation and a beach where meteotropic water mixes with seawater. The results show that in the tidal flat, sedimentary organic matter is being mobilized by high microbial activity. Within the beach, the quality of DOM depends on the extent of fresh and sea water input. A large similarity of molecular formulae in pore water vs seawater samples suggests a significant proportion of less-reactive DOM that may be persistent enough to be exported to the coastal ocean. We also find exclusive removal of compounds, suggesting that the investigated permeable sediments are selective sinks for terrestrial and marine DOM. (Abstract ID 11153)

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NEW ESTIMATES OF MULTIDECADAL THERMAHOLINE VARIABILITY IN BARENTS AND NORDIC SEAS FROM WORLD OCEAN DATABASE

World Ocean Database (WOD) is one of the largest publicly available ocean databases that can facilitate an adequate estimate of multidecadal variability in many regions of the World Ocean, including the northern North Atlantic and Eastern Arctic Seas. In recent years, WOD was substantially updated in those two regions and provides a better opportunity to revisit previous estimates of the multidecadal variability of temperature and salinity in the Barents Sea. We discuss the new WOD inventory and its recent growth in the Nordic and Barents Seas and show new estimates of multidecadal variability in those seas based on the updated record. Analysis of multidecadal ocean variability in the Nordic and Barents Seas indicates non-homogeneity of the long-term records and complex relationship between the long-term ocean variability in the two regions. Substantial warming in the Barents Sea that had been occurring over the past decade has slowed down, although there are still uncertainties of whether a new acceleration or a further slowdown may occur in the next decade. (Abstract ID 9619)

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DISCUSSION OF DESIGNING OCEAN, COASTAL, AND GREAT LAKES OBSERVING SYSTEMS TO ADDRESS SOCIETAL ISSUES

An integrated system of Federal and non-Federal ocean observing capabilities is needed to improve our understanding of weather, climate and ocean conditions, to forecast key environmental processes and to strengthen ocean management decision-making at all levels. The US Integrated Ocean Observing System is being established to meet this need. In 2011, each of the 11 US IOOS regions developed a ten-year build out plan. The plans are based on stakeholder requirements. They describe the products to be delivered to meet user needs and the models, data management and observations necessary to generate the products. From these 11 regional plans, a national synthesis was developed that demonstrates the regional contribution to national priorities. Each panel member will discuss the value of this national plan from their unique perspective. (Abstract ID 11925)

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DONWSCALING OF CLIMATE CHANGE AIB SCENARIO PROJECTION ON NORTH ATLANTIC OCEAN – ATMOSPHERE SYSTEM

The prediction of anthropogenic climate change on the northwest European shelves is a challenge for modeling. We present a novel approach to investigate the interactions between the North Atlantic Ocean, the European shelves and the overlying atmosphere using a global ocean model with high horizontal resolution in this area coupled to a regional atmospheric model. The applied regionally coupled model comprises the regional atmosphere (REMO), the global ocean (MPI-OM) with up to 5 km horizontal resolution in the North Sea, the marine biogeochemistry (HAMOCC) and the hydrological discharge model (HD). The coupled domain includes Europe, the North Atlantic and part of the Arctic Ocean. The lateral atmospheric and the surface ocean boundary conditions outside the coupled domain were prescribed using data from an A1B scenario simulation with the global ECHAM5/MPIOM model. Numerical experiments covering the period 1920-2010 were carried out. Future changes in ocean and atmospheric circulation focusing on different regions of North Atlantic and North European shelves were analyzed. In addition to the climate warming, other processes like northward shift of the Gulf Stream position, Atlantic MOC weakening, decrease of biological production in North Sea region, regional sea level rise, extreme floods and changes in amplitude and phase of the seasonal cycle of river runoff were estimated. (Abstract ID 11067)

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m. These preliminary results indicated that this system represents a new, interdisciplinary tool for detection of multiple acoustic-tagged fish over monthly time scales, simultaneous with the collection of high-resolution biophysical oceanographic data from the fishes’ habitat. (Abstract ID 10673)

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Phytoplankton and dissolved iron distributions near the Shackleton Transverse Ridge/Elephant Island in the Late Austral Summer of 2004
To test the hypothesis that iron (Fe) promotes phytoplankton growth in the Drake Passage region of the Southern Ocean, phytoplankton were enumerated using flow cytometry, along with dissolved Fe by ICP-MS, at stations located from 59°S to 62°S, 59°W to 53°W and in the eastern Bransfield Strait in late austral summer 2004. Since phytoplankton cells vary widely in their carbon content, proportional to cell size, abundance was converted to biomass using particle light scatter. These data were divided into nano- and micro-phytoplankton fractions (<20 and >20 μm diameter cells, respectively). Biomass in the Antarctic Circumpolar Current on either side of the Shackleton Transverse Ridge was similar; however at stations where ACC and shelf-associated waters mixed, significantly higher phytoplankton biomass was found, due to a 2-fold higher proportion of micro-phytoplankton biomass in the mixed waters relative to other areas. In addition, a significant positive correlation between dFe and overall phytoplankton biomass and nano-phytoplankton biomass was found at stations with shallower (≤55 m) mixed layer depths. Thus, dFe and light play a dual role in regulating phytoplankton biomass in this area. (Abstract ID 11665)

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The role of in situ copper ligands in determining the bioavailability of copper to an oceanic phytoplankton community
Dissolved copper (Cu) speciation in oceanic surface waters is dominated by organic ligand complexion. Historically, it has been hypothesized that microorganisms produce strong ligands in order to bind and detoxify Cu. However, our recent fieldwork has demonstrated that Cu bound to in situ ligands in the subarctic NE Pacific Ocean is bioavailable to the native microorganism community, suggesting that these ligands may facilitate Cu acquisition. To elucidate the role of the in situ ligands in controlling Cu bioavailability, we performed a four-day bottle incubation with surface water collected in the NE subarctic Pacific. Total dissolved Cu (1.2 nmol L⁻¹) and the in situ Cu speciation (expected 2-3 fold excess [L]) were modified with additions of CuSO₄ (1.5 and 10 μM) and a strong Cu(II) ligand, Cyclam (5 and 30 μM), respectively. Cu/Cassimilator ratios increased proportionally with increases in total dissolved Cu compared to the unamended control. Conversely, Cu/Cassimilator ratios decreased proportionally with the Cyclam additions, indicating that Cu/Cyclam complexes are less bioavailable than in situ Cu ligand complexes. These results suggest that, unlike Cyclam, in situ Cu ligands may facilitate Cu acquisition. (Abstract ID 12649)

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On the role of in situ copper ligands in determining the bioavailability of copper to an oceanic phytoplankton community
Using an autonomous underwater vehicle
We tested the feasibility of using an innovative system for detecting acoustic-tagged fishes and examining the effects of the marine environment on tag detection. This fish tracking system consisted of hydrophone receivers mounted on an autonomous underwater vehicle, the Webb Sclocum glider. Acoustic tags were attached to a stationary buoy line at five different depths in Ankle Bay, Alaska and the glider made repeat transsects past the buoy. During these transsects, the glider also collected a high resolution suite of environmental measurements including temperature, salinity, pressure (depth), distance to bottom, chlorophyll fluorescence, turbidity, and dissolved organic matter fluorescence. The hydrophones mounted on the glider recorded up to 150 detections per tag in a single pass of the glider. Maximum detection range of the tags was approximately 600 m, although the vast majority of detections were recorded from <300 m. These preliminary results indicated that this system represents a new, interdisciplinary tool for detection of multiple acoustic-tagged fish over monthly time scales, simultaneous with the collection of high-resolution biophysical oceanographic data from the fishes' habitat. (Abstract ID 10673)

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OceanSITES: Sustained Platforms for Observing the Deep Ocean and Biogeochemical and Ecosystem Parameters
OceanSITES is the global network of sustained timeseries stations with a focus on the open ocean. Over 100 sites are now operating or planned, most using mooring technology. These existing platforms offer themselves for carrying out continuous and long-term observations in the deep and abyssal ocean. Options for taking advantage of this deep-ocean infrastructure will be presented. Many of the OceanSITES stations carry biogeochemical and ecosystem observations already. The contributions to a global carbon and ocean acidification observing network will be explained. Also a scheme has been developed to use OceanSITES to provide a backbone ecosystem observing system. Sensors for observing Essential Ecosystem Ocean Variables could be installed on many of the existing OceanSITES platforms. (Abstract ID 12797)

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Weekly to Yearly Shoreline Dynamics of an Intermediate Mesotidal Sandy Beach
In the present study, weekly, seasonal and yearly behavior of shoreline features is derived from field data using both simple and complex statistical analysis. Observations consist of a 3-year data set of daily rectified video images of a 2 km stretch of an open sandy beach situated on the South-West part of France. Video images are complemented by hourly estimated hydrodynamic data. The features which we focus on are a) surf zone width, b) number and positions of sandbars, c) wave height and flux d) tide. During the study period, the energetic offshore wave conditions presented seasonality patterns: higher energy and longer waves during winter periods with Hs=1.83 m and T=9.47 s and weaker and shorter wave conditions during summer with Hs=1.50 m and T=8.19 s. The annual mean spring tidal range was approximately 3.7 m and maximum tidal range reached 5m during spring tides. The inner bar experienced all four classes of the intermediate beach classification. The less dissipative states presented significant pronounced 3D patterns including well-developed rip and feeder channels. (Abstract ID 9463)

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An optical sensor deployed on board autonomous underwater vehicles (AUVs) for aquatic chemistry measurements
A compact AUV-deployable optical instrument utilizing fluorescence, absorbance, and turbidity measurements to identify and quantify contaminants and natural substances is described. For spectrophotometry, six LED excitation sources ranging from 260 to 405 nm are used. Turbidity measurements are made by measuring light scattering, and a broadband (185nm-1100nm) light source is provided for absorbance measurement. The sensor package includes the above optical systems, a flowcell, a single board computer with associated power control board, and an optional battery; packaged in a cylindrical pressure case of 200mm diameter and 300mm length. The package is sized appropriately for deployment on the MIT Sea Grant Reef Explorer vehicle. It has also been deployed on surface vehicles and is adaptable for fixed locations such as moored buoys or access points in a water supply network. Validation of the instrument includes (1) comparison with a commercial fluorescence spectrometer in measuring standards and field samples, (2) comparisons of measured fluorescence and absorbance characteristics with published data for several chemicals, and (3) field demonstration aboard an AUV. (Abstract ID 9903)
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EFFECT OF PHOSPHORUS FRACTIONS IN MAJOR TRIBUTARY, THE GEUMHO RIVER, TO THE EUTROPHICATION OF THE NAKDONG RIVER ESTUARY

The 5-D hydrodynamic model, EFDC and a water quality model WASP were applied in 334 km reach of the Nakdong River to predict the water quality changes due to in-stream hydraulic structures by the 4 major river restoration project in Korea. Water quality characteristics of the Nakdong River can be divided into: (1) relatively clean upper stream area, 2) Polluted midstream area due to introduction of pollutant from urban areas and 3) down stream area influenced by estuarine barrage. The Geumho River, the largest tributary to the Nakdong River that include pollutants from Deagu City, exerts the greatest impact to the water quality degradation of the Nakdong River. It was found that inorganic phosphorus fraction of the Geum River is 77% in average while the same fractions of the other tributaries to the Nakdong River is less than 50%. Since soluble reactive phosphorus affects the growth of phytoplankton, this fraction issue can be a very important issue in the prediction of eutrophication in the Nakdong River especially in down stream area and this paper will report this effect. (Abstract ID 10156)

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THE VARIATION OF ZOOPLANKTON COMMUNITY UNDER THE CONTROL OF DIRE GATES IN THE DAM CONSTRUCTED ESTUARY.

To investigate the influence of freshwater on the variation of estuarine zooplankton community under the condition of estuarine dike, we collected micro-zooplankton and meso-zooplankton samples during wet season (June and August 2010) in the Youngsang estuary, Korea. During wet season including typhoon raining event, the range of salinity was fluctuated from 3.5 to 27.5 psu by the large discharge of freshwater when the gates of dike were opened, whereas the ranges were 25.2 to 33.2 psu in the closed gates of dike. A total of 33 zooplankton taxa were identified from 29 marine and 4 freshwater taxa in the estuarine waters. Major group of marine form was copepod. Most freshwater taxa were cladocerans. The abundance of zooplankton was higher in the high salinity waters than in the lower salinity waters. In canonical correspondence analysis for examining the relationship among zooplankton, stations and environmental variables, zooplankton community in the upper part of estuary was distinguished from the other areas and was represented freshwater cladocerans and brackish copepods. Also this area was characterized by dramatically changed zooplankton community with high concentration of nutrient and low salinity. (Abstract ID 10941)

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A REANALYSIS OF OCEAN CLIMATE VARIATION USING ENKF IN THE NORTHWEST PACIFIC

This study introduces the reanalysis of marginal seas climate variability in the Northwestern Pacific. A model calculation produced by ROMS (Regional Ocean Modeling System) with the 10km resolution is continuously assimilated by various observations every 10 days from 1980 to 2009. For the reanalysis, the Ensemble Kalman Filter (EnKF) which is one of the most advanced sequential assimilation methods, was used. The reanalysis was produced by using surface forcing of the European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric reanalysis and open boundaries of Simple Ocean Data Assimilation (SODA) and Estimating the Circulation and Climate of the Ocean (ECCO). The observation set for this experiment includes the historical archive of hydrographic observations taken by ship and Argo floats and remotely sensed SST. The reanalysis show a significant improvement in SST and transports in the major straits among the marginal seas. The product will be useful for understanding of climate change in the marginal seas of the Northwest Pacific. The reanalysis shows a significant improvement compared with the parallel run without data assimilation. And this system corrects that these changes lead horizontal and vertical structures of currents and other variables in the system to more consistency with observational data. Furthermore, the results show that the effect of the assimilation depends on the characteristics of the marginal seas. (Abstract ID 10088)

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EXTREME WAVE AND WATER LEVEL EVENTS IN THE NE PACIFIC

In recent decades, buoy-measured significant wave heights in the NE Pacific have been increasing. While researchers have focused primarily on documenting wave height increases alone, it is the coincidence of extreme wave and high water level events that has the potential to exacerbate inundation and erosion along vulnerable coastlines. Here we analyze the joint probability of extreme wave heights and water levels at a number of closely located, in-situ observation stations along the west coast of North America. We compare two methodologies for estimating extreme total water levels (TWLs) and assess for stationarity. The reanalysis shows a significant improvement in TWLs and transports. The full simulation approach first fits extreme value distributions to wave height records and then computes the conditional dependence between tidal anomalies and wave heights. Multiple synthetic TWL time series are simulated in a Monte Carlo sense using the fitted distributions and associated dependencies between the relevant parameters. Documenting trends in extreme TWLs will aid in coastal planning and hazard preparedness efforts. (Abstract ID 10549)

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APPLICATION OF A 3-D VAR DATA ASSIMILATION SCHEME TO AN EDDY-RESOLVING WESTERN NORTH PACIFIC MODEL BASED ON ROMS

A three-dimensional variational data assimilation scheme has been developed and applied to an eddy-resolving Western North Pacific model based on Regional Ocean Modeling System. This scheme, which is founded on the MOVE system developed by the Japan Meteorological Research Institute, is characterized by the following three steps: (1) minimizing the nonlinear cost functions by using a pre-conditioning method, (2) analyzing temperature-salinity profiles by using vertical coupled EOF modes, and (3) assimilating the data analyzed into an ocean model, namely, making reliable reanalysis data by using the Incremental Analysis Update method. As the first step, we apply this scheme to the 1/10-degree ocean model covering the Western North Pacific. Satellite SSH/SSTs and in situ temperature-salinity data from GTSPP and WOD2009 are assimilated into the model. The present system properly reproduced the Kuroshio large meander event and the non-large meander event, and the Oyashio first intrusion from 2003 to 2006. The distribution of the mean eddy kinetic energy at the surface derived from Satellite altimeter is also in good agreement with the one from the system. (Abstract ID 10299)

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IMPROVING SEA SURFACE SALINITY RETRIEVAL OVER THE EAST CHINA SEA USING THE LAND SURFACE SIMULATION AND THE AQUARIUS RADIOMETER DATA

The northern East China Sea (ECS) occupies an area of 900 km x 500 km to the east of Shanghai, China, and is a fertile fishing ground. The observed surface salinity of the ECS changes by 3 and larger due to river runoff. Much smaller changes (an order of several tenths psu) are expected as a result of other causes of the river flow variations. The shallow ECS is not sampled by the Argo floats. This study aims at monitoring the ECS salinity change with the Aquarius data that offer the unique opportunities of continuous mapping. Due to the emission of the land surface, however, according to the current simulation study of the Aquarius retrieval, the error in the retrieved salinity for the Aquarius observation may exceed 0.2, 1.5, and tens of psu within about 500 km, 150 km, and 50 km from the coast, respectively. The error may be too large to monitor the salinity variability in the ECS. The emission from land is simulated and corrected for. The correction performs accurately in the simulation environment, as expected. According to the sensitivity analysis, the performance is hardly affected by the uncertainties in the antenna pattern, wind forcing of the ocean, and WOD2009. The structural uncertainty in the surface salinity data used during the simulation of the land emission. The actual Aquarius observation and in situ salinity records will be used to evaluate the accuracy of the method. (Abstract ID 10708)

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EPOCOT GLOBAL WARMING EVENTS DRIVEN BY VENTILATION OF OCEANIC DISSOLVED ORGANIC CARBON

‘Hyperthermals’ are intervals of rapid, pronounced global warming known from six episodes within the Palaeocene and Eocene Epochs (~65 to 34 million years (Myr) ago) — the most extreme of which was the ~170 thousand year (kyr) interval of 5 to 7 °C global warming during the Palaeocene-Eocene Thermal Maximum (PETM, 56 Myr ago). The PETM is widely attributed to massive release of greenhouse gases from buried sedimentary carbon reservoirs and other, comparatively modest hyperthermals have also been linked to the release of sedimentary carbon. Here we show that the comparatively modest hyperthermals are three times more numerous than previously documented, paced by the eccentricity of Earth’s orbit and have shorter durations (~40 kyr) and more rapid recovery phases than the PETM. These findings point to the operation of fundamentally different forcing and feedback mechanisms than for the PETM. Specifically, we interpret our records to indicate repeated, large-scale releases of dissolved organic carbon (DOC; approx. 1600 gigatonnes) from the ocean by ventilation (strengthened oxidation) of the ocean interior. A larger-than-modern Eocene DOC reservoir is supported by a variety of palaeoceanographic evidence. (Abstract ID 11169)

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STABLE CARBON ISOTOPIC COMPOSITION OF INTACT POLAR LIPIDS IN THE SARGASSO SEA

Patterns in the stable carbon isotopic composition of organic carbon have proven to be a useful tool for tracing carbon flow through marine ecosystems. In the western North Atlantic, it has been demonstrated that three intact polar lipids have source-specificity, one glycolipid and one betaine lipid produced dominantly by photoautotrophs and a phospholipid produced by heterotrophic bacteria (1). In this study, we present the stable carbon isotopic composition of fatty acid methyl esters (FAMEs) derived from individual phospholipids, glycolipids and betaine lipids collected at three depths in the Sargasso Sea. We determine whether the expected trophic level enrichment in 13C between primary production and heterotrophic production can be observed. Using the source-specific polar lipids as end-members, we determine the proportional contributions of polar lipids shown to have mixed sources. We also use the vertical gradient in 13C values of dissolved inorganic carbon to determine whether the photoautotrophic lipids found at depth are detrital or synthesized by deep photoautotrophic production near the base of the photic zone. (Abstract ID 12757)

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PHYTOPLANKTON BLOOM IN THE LUZON STRAIT BORDERING THE KUROSHIO DURING THE NORTHEAST MONSOON

A few studies have reported intensive phytoplankton bloom during the northeast monsoon season in the Luzon Strait and its vicinity (referred as the LZZS bloom), yet the primary mechanism is under debate. Here using both in situ and remote sensing data, especially MODIS phytoplankton absorption coefficient at 443 nm (Aph) as a preferable pigmentation index, the LZZS bloom was investigated for a case of January 2010 and climatological state. Blooming patches of Aph>0.02 m-1 overlaid on a background level of 0.01 m-1 were discernible for both situations. A twin-core structure of the bloom was then identified. The major core lies far offshore in the deep basin to the northwest of Luzon, with a maximum horizontal scale of ~250 km, and the other nearshore in the Babuyan Channel, with a maximum horizontal scale of ~100 km. Variations of climatological monthly mean Aph and an areal bloom index (ABI) indicate that the LZZS bloom as a whole persists during November-February, peaking in December. Further investigations suggest that the bloom is primarily induced by enhanced nutrient pumping from depth to the surface by various meso-scale processes attributed to the interaction of Kuroshio and its intrusion with the complex topography of the Luzon Strait and the circulation of the northeastern SCS, i.e. the Luzon Gyre. In addition, the nearshore bloom is enhanced by nutrient input from the Cagayan River. (Abstract ID 10184)

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CDOM DISTRIBUTION AND PHOTOACTIVITY IN NORTHERN GULF OF MEXICO SHELF WATERS DURING SUMMER 2011

CDOM distribution and photoactivity along the Louisiana and Texas coastal shelf in the northern Gulf of Mexico was examined during cruises in May and August 2011. The effects of the spring 2011 Mississippi River flooding was evident as CDOM:DOC ratios were much higher during May than August indicative of heavy terrestrial organic matter inputs. Elevated CDOM:DOC ratios were observed offshore of Atchafalaya Bay and the Breton-Chandeleur Sound complex indicating coastal wetlands are also an important CDOM source to shelf waters. Generally, CDOM levels were highest in surface waters and decreased with depth, but CDOM levels were occasionally higher near bottom than at mid-depth without concomitant DOC increases. Possible bottom water CDOM sources are microbial processing of settling phytoplankton cells, sedimentary fluxes, and benthic algal activity which was prevalent along the Texas shelf. We are currently using EEM-PARAFAC to distinguish these sources. Modeled CDOM photobleaching for northern Gulf waters indicate that 90% of the CDOM in the upper 1 m may photobleach during summer, with losses up to 20% possible down to 10 m depth. (Abstract ID 11623)

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PHYTOPLANKTON ABUNDANCE AS AN INDICATOR OF EXCHANGE OF SURF ZONE WITH OFFSHORE WATER AT A DISSIPATIVE AND REFLECTIVE SHORE AND LARGEST TRANSPORT AND SETTLEMENT

The surf zone may act as a barrier to shoreward larval transport; the more surf zone water is exchanged for offshore water the less of a barrier the surf zone will be. Exchange should be greater at more dissipative beaches. As a partial test of this hypothesis we compared phytoplankton abundances in surf zones of a more dissipative and reflective beach with that just offshore. At the more dissipative beach phytoplankton were far more abundant in rip currents than offshore, but over ridges the concentration was much less than offshore. Surf zone phytoplankton abundance was correlated with concentrations offshore suggesting that surf zone water was exchanged with offshore. At the reflective beach, the abundance of phytoplankton in the surf zone and at the rocky shore to either side of the beach was 1 to 2 orders of magnitude lower than offshore. Exchange of water appears lower than at the more dissipative beach. Phytoplankton abundance was very low just north of the beach and higher to the south. Barnacle settlement followed this pattern, very low north and 10 x higher south. (Abstract ID 12336)

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MODELLING THE MIXED LAYER SATURATIONS OF CFC-11, CFC-12, AND SF6

In situ measurements of transient tracers, such as chlorofluorocarbons (CFCs) and sulfur hexafluoride (SF6), that enter the ocean through air-sea gas exchange provide estimates of ocean interior ventilation ages and transit time distributions. In estimating ages, tracer concentrations are often assumed to be 100% saturated at the ventilation sites. However, in areas of rapid subduction, mixed layer deepening, or surface warming/cooling, surface waters may not have enough time to equilibrate with the atmosphere. To investigate these potential super-undersaturations of CFC-11, CFC-12, and SF6, we ran an offline advection–diffusion code using physical fields from a climatological run of the Hallberg Isopycnal Model. Taking into account solubility effects, transport, mixing, and mixed layer dynamics, we find ages in the North Pacific, North Atlantic, and Southern Ocean with significant mixed layer undersaturations ranging from 10-40%. We will present findings showing the sensitivity of these saturations to the nonlinearity of the atmospheric histories, mixed layer entrainment of older waters, and interannual variability (using 1967-2008 hindcast fields) as well as the effects of the air-sea gas disequilibria on age calculations in the ocean interior. (Abstract ID 10003)

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Tapping into multimedia is a sensibly wide to broaden the impact of your science. But in a world awash with on air and online media, how do you produce content that both holds up and stands out? I will present an array of science storytelling techniques, tips for how to partner with media producers and distributors, and ideas for different types of media products that can work well with your science. Drawing on examples form both within ocean science and beyond, this session will empower you to weave multimedia content into your next grant proposal, and then produce it. Low-hanging fruit has never tasted so good. (Abstract ID 10871)

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EFFECTS OF DISSOLVED ORGANIC MATTER ON MICROBIAL COMMUNITY GROWTH, SUCCESSION, AND GENE EXPRESSION
Microbial community processes and biogeochemical activities that mediate the turnover of marine dissolved organic matter (DOM) remain largely uncharacterized. We performed controlled experiments using seawater microcosms amended with two different sources of organic carbon: high-molecular-weight DOM freshly concentrated from natural seawater and phytoplankton-derived DOM from a pure culture of the photoautotroph Prochlorococcus marinus. Microbial community growth and gene expression was followed over a 36-hour period using a combination of flow cytometry and whole community DNA and RNA sequencing. These data revealed taxon specific microbial activity and growth in both treatments, relative to controls. Gene expression dynamics showed that each DOM addition caused rapid responses in the dominant community members, Prochlorococcus and Pelagibacter, and stimulated microbial succession that favored diverse heterotrophic bacterial groups, including Alteromonas, NOC/OM66, Rhodobacter sphaeroides and Flavobacteriia. Examination of the induced biochemical pathways suggested a community shift from nutrient acquisition and energy production in the control, to biosynthesis and cell growth in DOM treatment(s). These data underscore the importance of the integrated microbial community in the processing of DOM. (Abstract ID 12160)

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IS CLIMATE CHANGE CAUSING BOTTOM WATER HYPOXIA IN THE DELAWARE BAY?
Our research effort of the past three decades plus study of an excellent monitoring database maintained for 44 years indicates that “normally” the Delaware Bay did not experience bottom water hypoxia in the summer. Our study of an extreme discharge event from the summer of 2006 and the phenomenal discharges of 2014 may have caused a different situation. We present here a combination of inspiration estimates made in our laboratory with river discharge, salinity, and chlorophyll patterns from continuous measurements and ship-of-opportunity datasets. It appears that, although poorly monitored, bottom water hypoxia may be a new phenomenon in the Delaware Bay since the oxygen demand is sufficient for isolation to cause rapid utilization. A dramatic increase in very large river discharges in the past decade may be causing brief, but adequate, stratification for isolation. While stratification has always been a common occurrence in the winter-spring period, cold water temperatures limit oxygen utilization. Any stratification beyond a few tidal cycles in the warmer summer months gives sufficient isolation for significant oxygen depletion. (Abstract ID 10014)

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INTERNAL WAVES OVER A SHELF SEA BANK AND THE CONSEQUENCES FOR NUTRIENT SUPPLIES INTO THE SEASONAL THERMOCLINE
In summer new primary production in stratified shelf seas is located within the thermocline, sub-surface chlorophyll maximum (SCM). Production is limited by the rate at which nutrients are supplied from the deeper water into the thermocline. On the tidally-energetic NW European shelf over flat seabed we typically find a nutrient supply of 1 – 2 mmol m-2 d-1. Combining nutrient measurements with time series of turbulent dissipation rates over a large bank in the Celtic Sea shows that turbulent nutrient fluxes into the thermocline can reach 50 mmol m-2 d-1. This high flux is largely caused by high turbulent diffusivities arising from breaking internal leewaves at the bank. There is a marked spring-neap cycle to the mixing. The affects of this nutrient supply are likely to be felt downstream in the mean flow over the bank. A Lagrangian numerical model is used to identify the extent of these downstream effects. The results are interpreted in terms of the potential increase in shelf sea primary production that can be attributed to mixing over all of the banks identified in the Celtic Sea. (Abstract ID 9319)

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INFLUENCE OF MESOSCALE EDDIES ON ZOOPLANKTON FECAL PELLET FLUX IN THE DEEP SARGASSO SEA
Zooplankton fecal pellets are important part of the particle flux because they export carbon and other elements from the surface to deep ocean and serve as a nutrient source to deep ocean ecosystems. We measured fecal pellet flux and size distribution at 500m, 1500m and 3500m-depths in sediment trap samples collected by the Oceanic Flux Program time-series between Dec 2006–Nov 2007. During the study three mesoscale eddies passed through a cyclonic eddy in a bloom stage (C), a post-bloom-moode-water eddy (M) and an anticyclonic eddy (A). Variability in fecal pellet flux associated with eddies masked seasonal trends in flux or size distributions. The flux was enhanced during C and M, but not during A. Size distribution shifts indicated small zooplankton and immature stages were more abundant within C whereas larger zooplankton were present within M and A. Differences in size distribution and flux at the three different fecal pellet reprocessing within the water column. Fecal pellets contributed 3-16% (averaged 7%) of organic carbon flux, a minimum estimate as fragile particles likely disintegrate post-collection. (Abstract ID 12488)

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BIOLOGICAL PROCESSES AMPLIFY THE IMPACTS OF OCEAN ACIDIFICATION IN COASTAL ECOSYSTEMS
Ocean acidification is a major threat to marine ecosystems. Perturbation experiments have exposed organisms/ecosystems to predicted future CO2 conditions to assess their vulnerability to future changes in seawater chemistry. The projected changes to seawater CO2 are derived from measurements that are generally taken in open oceanic waters. However, often the species/ecosystems of interest are from shallow coastal zones. Using a shallow coral reef flat as a case study, we show that local biological processes can cause large changes to carbonate chemistry. We found natural respiration of organic material to increase reef seawater CO2 levels by up to 1000ppm each day. However, due to non-linear carbon chemistry, that same biological signal will be amplified 2-5 fold by the year 2100, with daily CO2 levels reaching up to 3200ppm under a business-as-usual scenario. This amplification process is not only relevant for coral reefs, but for all productive coastal ecosystems. Our work suggests a critical need to understand the magnitude of biological processes in coastal marine environments, without which, we will be potentially understimating the true extent of CO2 impacts in the future. (Abstract ID 10094)

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SUBMESOSCALE SURFACE CURRENT VARIABILITY ALONG THE FLORIDA CURRENT
For more than a decade, high frequency (HF) radar measurements of ocean surface currents from phased arrays have been sampling the energetic Florida Current (FC) and its eddy field. These measurements have revealed submesoscale ocean features with scales ranging from 3 to 10 km (deformation radius – 30 km) along the western flank of the FC. While the FC core has northward speeds exceeding 2 m s-1, these cyclonically rotating features had vorticities from 5 to 10 f, where f is the local Coriolis parameter. Using the HF radar in very-high resolution mode where measurements were acquired at 20-min intervals at a spatial resolution of 250 m, a highly coherent vortex was observed off of Ft. Lauderdale. The translation speed of this vortex was of = 30 cm s–1 with an approximate diameter of 3 km which was well resolved by the radar. During a 3-month period in 2005, an intense vortex of ~ 12 km in diameter was observed. We are examining the several years of data to document the kinematics of these features. (Abstract ID 11618)
NUMERICALLY ACCURATE TREATMENT OF BOTTOM DRAG IN OCEAN MODELS
WITH MODE AND TIME SPLITTING
While representation of bottom drag term is essential for coastal modeling, the basic mathematical dilemma of handling an implicit no-slip bottom boundary condition in a mode-split model (whether split-explicit or implicit-free-surface) is not satisfactorily solved within the oceanic modeling community, and, moreover, most current oceanic codes do not even allow this without a major algorithmic redesign. The mathematical essence of the problem is the splitting of two stiff operators—one is associated with the barotropic mode splitting, the other is due to the implicit no-slip boundary condition at the bottom – a situation reminiscent to the classical dilemma in incompressible flows, e.g., Dukowicz and Dvinsky, 1992. The use of vertical grid refinement toward the bottom -- a standard modeling practice motivated by the need to resolve turbulent bottom boundary layer -- further exacerbates the splitting dilemma resulting in poor convergence. This presentation overviews the current modeling practices and proposes self-consistent algorithms to address both the errors due to time splitting and handling of the discrete of no-slip bottom boundary condition in the turbulent case where regularization length (viscous sublayer) is only marginally resolved or not resolved at all. (Abstract ID 12341)

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SEDIMENT BUDGET FOR THE FAR SOUTHERN REACH OF SAN FRANCISCO BAY: IMPORTANCE OF HYDRODYNAMICS TO THE SUPPLY OF SEDIMENT AVAILABLE FOR HABITAT RESTORATION
The South Bay Salt Pond Restoration Project is restoring 6,000 hectares of former commercial salt-evaporation ponds to tidal marsh or managed wetlands in the southern reach of San Francisco Bay (SFB). Sections of the project area have subsided and, given current sea level, will require about 32 million cubic meters of sediment to sufficiently raise bed elevations for colonization of tidal marsh plants. We calculated daily sediment budgets for 2009 and 2010 for the area using sediment flux data from the two major tributaries to far south SFB and measured sediment flux data at the bayward margin of the reach (Dumbarton Bridge). The tributary sediment loads are important to filling the subsided space on a centennial time-scale, while the tidal load at the Dumbarton Bridge varies dramatically by season and year. Although the net sediment flux during 2009 and 2010 was into far south SFB, the direction of springtide sediment flux appears to be controlled by the salinity gradient between central SFB and far south SFB. Wet springtide conditions promote the flux of sediment out of the project area. (Abstract ID 12669)

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SOLUBILITY OF TRACE METALS FROM NORTH ATLANTIC AEROSOL DUSTS
Dust supply impacts global climate by altering atmospheric aerosol loading, and is a major source of trace elements and isotopes (TEIs) to the surface ocean. Only a fraction of the TEIs deposited to the surface ocean are soluble, and thus available for uptake by phytoplankton. As ~50% of global photosynthesis occurs in marine environments, understanding the factors that limit phytoplankton growth are of fundamental importance to our understanding of the global carbon cycle. Trace metal data (Al, Ti, V, Mn, Fe, Co, Ni, Cu, Zn, Cd, Pb) is presented from the 2010 and 2011 US GEOTRACES North Atlantic transects that show clear distinctions in the trace metal loading of the bulk aerosol and fractional solubility, which is linked to aerosol provenance. For instance, on average iron is 2 orders of magnitude more abundant in Saharan dusts (225 ng Fe m⁻² air), but less soluble than in those originating over Europe (164 ng Fe m⁻² air) or North America. This data demonstrates a link between aerosol trace metal solubility and down-wind factors which should be taken into account by biogeochemical models. (Abstract ID 10644)

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CHARACTERIZING PHYTOPLANKTON BLOOMS IN THE COASTAL OCEAN USING AUTONOMOUS OXYGEN-DERIVED NET COMMUNITY METABOLISM OBSERVATIONS
This study reports observations collected from a mooring in the Gulf of Maine where dissolved oxygen and other supporting data were measured at 10 min intervals over multiple months in the summer and fall of 2009. Exploiting the advent of reliable oxygen sensors for extended deployments, we developed a multi-depth dissolved oxygen measurement subsystem with six measurements at fixed depths within the euphotic zone. This allows a time and depth-resolved evaluation of net community metabolism via the time-rate of oxygen change along with assumptions and/or corrections regarding surface and advective fluxes. Numerous significant phytoplankton blooms occurred during the deployment and this work will describe attempts to characterize surface, subsurface, and column integrated NEM over the time scale of minutes to days. Comparison and contrast between a strong short red tide event and several full bloom events will be discussed. For current correlation and method comparisons, measurement of dissolved carbon dioxide and nitrogen were also made and will be used to look at the O2/N2 approach to NCP estimation. This study should benefit the likely application of such techniques on moored profilers as part of future enhanced ocean observing system efforts. (Abstract ID 9974)

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CONTRASTING ROLeS OF GELATINOUS AND CRUSTACEAN ZOOPLANKTON AS MEDIATORS OF CARBON PATHWAYS IN OLIGOTROPHIC FOOD WEBS
Recent studies provide contrasting views of roles played by gelatinous and crustacean zooplankton in open-ocean food webs and carbon export to the deep ocean. To better understand how zooplankton community structure relates to the biorevailability and transfer of carbon, we conducted field sampling and experiments during two process-oriented cruises in the Sargasso Sea. Zooplankton biomass and abundances were measured along productivity gradients in two eddies, and food webs were constructed using stable and radiotopes analyses. We also conducted species-specific incubations measuring grazing, defecation and excretion by zooplankton, including fragile gelatinous species collected using blue-water diving techniques. Zooplankton biomass was highest in regions of high productivity, with co-occurrence of large salp and ctenophore blooms with high copepod biomass during spring and summer. Isotopic data suggest oligotrophic food webs are complex with zooplankton occupying several trophic levels. Gelatinous zooplankton grazing and excretion rates were greater than for copepods. Given consequences of the ‘jelly carbon shunt’ for food webs and potential increased frequency of gelatinous zooplankton in this region, these results have implications for trophic dynamics and transfer efficiency of the biological pump. (Abstract ID 11480)

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LABORATORY STUDY OF TURBULENT BOUNDARY LAYER IN WIND OVER WATER WAVES
Wind energy and momentum transferred to water result in wave excitation and evolution, in turn affecting air flow over the water. For better understanding of the effect of the spatially evolving wave field on turbulent air flow over the water surface, experiments in a small scale facility that consists of a wind tunnel over a 5 m long wave tank were carried out. Pitot-tube measurements of air velocity profiles and air turbulence were used to obtain boundary layer properties of wind flow and vertical mixing processes provide a linkage between the dynamic and biochemical processes. The phase and amplitudes of the mean velocity profiles and the measured Reynolds shear stress distributions. The phase relations and the degree of coherence between the measured air flow parameters and the instantaneous water surface elevation were obtained by cross-spectral analysis as a function of fetch and wind speed. The friction velocities were calculated both from the mean velocity profiles and the measured Reynolds shear stress distributions. The phase relations and the degree of coherence between the measured air flow parameters and the instantaneous water surface elevation were obtained by cross-spectral analysis as a function of fetch and wind speed. (Abstract ID 9570)

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USING TRANSPORT TIMESCALES TO INTERPRET ESTUARINE EUTROPHICATION OF THE CHESAPEAKE BAY
Both the amount of the nutrients discharged into estuaries and the nutrient retention time contribute to the eutrophic conditions of estuaries, while estuarine gravitational circulation and stratification are the key dynamic factors controlling the onset of the development of hypoxia. The transport timescales for measuring nutrient retention, quantifying estuarine exchange flow and vertical mixing processes provide a linkage between the dynamic and biochemical processes. The concept of using timescales to provide insight into the nutrient retention and relationships between dynamics and bottom water DO are discussed. A transport time is used to quantify nutrient retention in a box model. Two timescales are introduced to diagnose the competition between mixing and gravitational circulation and their impact on the DO level.
in deep waters. Coupling with a biochemical timescale of oxygen consumption, the hypoxic conditions in deep waters may be successfully interpreted with the relative magnitudes among the timescales. The transport timescales are highly variable. The dynamic characteristics of the timescales were studied through 3D model simulations. The model results demonstrate that freshwater discharge is the dominant factor for long-term transport. The short-term wind forcing has a strong accumulative effect on the long-term mass transport and onset of the development of hypoxia in deep water in the Chesapeake Bay. (Abstract ID 12184)

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LONG-TERM VARIABILITY OF THE KUROSHIO TRANSPORT EAST OF TAIWAN AND THE CLIMATE IT CONVEYS

The Kuroshio Transport (KT) from 1993 to 2010 was established using satellite altimetry data through three methods: geostrophic relationship (GR), empirical relationship (ER) and transfer function (TF). The relationships were built on the observed KT from the World Ocean Circulation Experiment (WOCE) moored current meter array east of Taiwan (referred to as PCM-1) and its surrounding SSH difference. Modeled ten-year climatology run of the KT was used to verify the three methods and the associated characteristics in long-term applications. The GR cannot well capture high frequency variability less than four months. The KT established by ER has similar variation with smaller variance and is underestimated. The TF can establish signal from all available frequency domains. However, the results indicate the observational period of PCM-1 period may be too short to build a reliable TF. Both KT estimated by GR and TF were then used to analyze the long-term variability of the KT on PCM-1 section. We found that the annual-averaged KT is contributed by the northern branch of the North Equatorial Current (NEC), which is strongly influenced by the ENSO events. The anomaly of KT is dominated by the mesoscale eddies east of Taiwan, where the strength is suggested by the West Pacific (WP) pattern. The correlation analysis further confirms that the long-term KT on Section PCM-1 not only conveys the ENSO signal but also the WP teleconnection. (Abstract ID 9902)

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FLOODPLAIN INFLUENCES ON DISSOLVED ORGANIC MATTER COMPOSITION AND EXPORT FROM THE LOWER MISSISSIPPI-ATCHAFALAYA RIVER SYSTEM

Knowledge of composition and export of riverine dissolved organic matter (DOM) is essential for understanding biogeochemical cycling in river-influenced ocean margins. We compared the chemical composition of DOM in the Mississippi (MR) and Atchafalaya Rivers (AR). Our study revealed higher concentration of dissolved organic carbon (DOC) in the AR. Strong evidence of floodplain contributions to DOM was observed in the AR. Dissolved lignin in the AR was depleted in syringyl phenols, indicating contribution from gymnosperms (eucalyptus) in floodplains. This was confirmed by higher concentrations and carbon-normalized yields of dissolved lignin and chromophoric DOM in the AR. The yields were highest during maximal litter fall season when the depletion in syringyl phenols was greatest, further supporting floodplain contributions in the AR. Lower concentration of total dissolved nitrogen in the AR due to nitrogen removal in floodplains corroborated these findings. Long-term (1996-2010) average DOC export from the AR and MR (0.30 and 1.72 Tg yr⁻¹, respectively) was calculated. The two rivers discharged 0.7-1.0% of global riverine DOC. (Abstract ID 11652)

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NUMERICAL STUDY OF CIRCULATION AND PARTICLE MOVEMENTS IN THE GULF OF ST. LAWRENCE AND SCOTIAN SHELF

Circulation in the Gulf of St. Lawrence and Scotian Shelf (GSL-SS) of Atlantic Canada has significant temporal-spatial variability under the influence of various forcing functions such as wind, tides, and freshwater runoff. Better knowledge of dynamically-consistent, time-varying, 3D circulation is needed in order to examine the effect of physical conditions in the observed movement of marine animals in the GSL-SS region. As part of an integrated observational and modelling platform for OTN Canada, a nested-grid shell circulation model was developed for simulating the 3D circulation and hydrographic distributions over the study region. The model was modified from its previous version by including seasonally-varying freshwater runoff from major rivers in the GSL-SS region and using results produced by a coarse-resolution model of the northwestern Atlantic Ocean in specifying open boundary conditions. The nested-grid shell circulation model was used in examining the effect of freshwater runoff from the St. Lawrence River on circulation and hydrography in the GSL-SS. It was found that the estuarine plume over the northwestern GSL and the seaward flow over the western GSL are affected significantly by the change in the freshwater runoff from the St. Lawrence River. The Nova Scotia Current is also affected significantly by the river discharge from the St. Lawrence River and adjacent rivers. The movements of particles carried passively by the 3D model currents will also be discussed. (Abstract ID 9693)

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NEAR-BOTTOM PROFILES OF OPTICAL AND ACOUSTIC PROPERTIES OF SUSPENDED PARTICLES AND TURBULENCE

We have made profiles of water properties and suspended particles by moving an instrument package from 0.2 to 2.3 m above the bed. Profiles took 17 min: short compared with slowly varying tidal currents and wave conditions, but long enough to average out effects of turbulence and individual waves. We deployed the profiler at the Martha’s Vineyard Coastal Observatory (12 m depth) and collected real-time profiles with an accelerometer, a CTD with oxygen and turbidity sensors; and a holographic imaging camera. Data from a transmissometer, a velocimeter, a laser particle size, various optical backscattering sensors, and the intake for a pump-sampler that runs filtered and unfiltered water through an absorption/attenuation meter were also recorded. There was no temperature or salinity stratification in profiles made in the first two weeks. Turbidity was vertically uniform when currents were strong. Profiles were linear on log-log plots when currents were weak and waves were large, consistent with the Rouse equation but, when currents were weak and wave energy was decaying, turbidity decreased markedly with elevation, consistent with a sharp lutocline sometimes observed by divers. (Abstract ID 10007)

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AMINO ACID-SPECIFIC NITROGEN ISOTOPIC COMPOSITION OF DEEP-SEA CORALS: UNRAVELING PALEO-NITROGEN CYCLE INTERACTIONS

With their extraordinary lifespans, deep-sea proteinaceous corals promise high resolution marine biogeochemical records over centuries to millennia. We compared δ¹⁵N of individual amino acids (δ¹⁵N-AA) in corals from the central Pacific (Hawaii; Garudasp; vs. the California margin (Monterey Bay; CA; Keratosis sp.) along with their primary food source, recently exported particulate organic matter, obtained from nearby sediment traps. The δ¹⁵N-AA values fell into relatively depleted Source and relatively enriched Trophic groups, typical of all heterotrophic organisms. Specifically, δ¹⁵N-Phenylalanine (δ¹⁵N-Phe) closely matched expected δ¹⁵N of nitrogen at the base of the food web. At Hawaii, coral δ¹⁵N-Phe averaged 3.8‰, reflecting a record of the balance of biological nitrogen fixation and upwelling of deep water nitrate. At Monterey Bay, coral and sediment trap δ¹⁵N-Phe averaged 7.9‰, reflecting denitrification-enriched nitrate of the Eastern Tropical North Pacific. Differences in plankton and export productivity regimes were also suggested by δ¹⁵N-AA parameters for trophic level and total re-synthesis. Together, these results suggest that δ¹⁵N-AA in deep-sea corals represents a major new tool for reconstructing detailed chronologies of complex paleo-Nitrogen cycle interactions. (Abstract ID 12691)

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PROCESS FILTERING AND INPUT FILTERING IN MODELING OF SANDPIT-INDUCED MORPHOLOGICAL EVOLUTION

The fundamental challenge of morphological modeling is the requirement to describe complicated interconnected physical mechanisms (waves, flow, sediment) over long time periods. Simulations are required in both physical formulations, referred to as process filtering, and input parameters, referred to as input filtering. In this study, we use a fully parallelized TVD version of NearCoM (Nearshore Community Model) to investigate sandpit-induced morphological evolution in both near-field and far-field. The model integrates the wave model SWAN, Quasi-3D circulation model SHORECIRC and a sea bed evolution model which incorporates several sediment transport formulas for sediment transport by waves and currents together with a morphological factor approach. The model input is simplified using a pump-sampler that runs filtered and unfiltered water through an absorption/attenuation transmissometer, a laser particle sizer, various optical backscattering sensors, and the intake for a pump-sampler that runs filtered and unfiltered water through an absorption/attenuation meter were also recorded. There was no temperature or salinity stratification in profiles made in the first two weeks. Turbidity was vertically uniform when currents were strong. Profiles were linear on log-log plots when currents were weak and waves were large, consistent with the Rouse equation but, when currents were weak and wave energy was decaying, turbidity decreased markedly with elevation, consistent with a sharp lutocline sometimes observed by divers. (Abstract ID 10007)
TOS/AGU/ASLO 2012 Ocean Sciences Meeting

OUTFLOW WATER OBSERVED IN AUSTRAL SUMMER IN FRONT OF THE AMERY ICE SHELF, ANTARCTICA

Thermohaline feature and spatial distribution of outflow water from the cavity under Amery Ice Shelf (AIS) were described based on hydrographic data obtained by Chinese and Australian expeditions to Prydz Bay, Antarctica, during the austral summer. The relatively cold and fresh Ice Shelf Water (ISW) was found as several discrete water blocks in front of the AIS, with the depth range of 100-600 m, under the seasonal thermocline. Most of ISW was concentrated west of 73°E and a small amount of cold ISW always occurred at the west end of the AIS front. Additional analysis implied that ISW could spread north to the continental break along the east flank of the Fram Bank near 70.5°E. Supercooled Water (SCW) with temperatures below in-situ freezing point was identified from outflow water. The maximum supercooling was 0.16°C. The SCW had less variability in the vertical profiles compared to shelf water, which implies that supercooling might result from upwelling of outflow water outside just the AIS front. This upwelling illuminates a unique mid-depth convection of the polar ocean. (Abstract ID 10706)

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INFLUENCES OF TIDAL FRONTS ON COASTAL WINDS OVER AN INLAND SEA

A regional numerical model of the atmosphere was applied to an inland sea, the Seto Inland Sea in Japan, to study the influence of near-surface temperature (SST) variations, accompanied by a tidal front, on the coastal winds in summer when tidal fronts fully develop. After confirmation of the model performance, two sensitivity simulations, which used spatially uniform SST with the highest and lowest values over the study area, were performed. The control and sensitivity simulations show that the mean wind speeds were apparently reduced by the low SST and the SST gradient accompanying the tidal front. The comparison of the terms in the momentum equations in control and sensitivity simulations indicates that the change of the perturbation pressure gradient force with the SST gradient is the most important factor in the modification of near-surface winds with SST variations. When the air flows across a tidal front, the air cools over the low SST area and warms over the high SST area. Consequently, the surface perturbation pressure increase over the low SST area and decreases over the high SST area. This adjustment in surface perturbation pressure produces an additional pressure gradient force with direction from the low SST area to the high SST area that decelerates the surface wind in the area upwind of the tidal front and accelerates the surface wind downwind of the tidal front. (Abstract ID 11200)

SATELLITE VIEWS OF THE BOHAI SEA, YELLOW SEA, AND EAST CHINA SEA

A comprehensive study of water properties for the Bohai Sea (BS), Yellow Sea (YS), and East China Sea (ECS) was carried out with eight- to nine-year observations between 2002 and 2009 from the MODIS Aqua. Normalized water-leaving radiance spectra, chlorophyll-a concentration (Chl-a), diffuse attenuation coefficient at the wavelength of 490 nm (Kd(490)), total suspended matter (TSM), and sea surface temperature (SST) are used to quantify and characterize the physical, optical, biological, and biogeochemical properties and their variability in the BS, YS, and ECS regions. The BS, YS, and ECS feature highly turbid waters in the coastal regions and river estuaries with high Kd(490) over ~3 m-1 and TSM concentrations reach over ~50 g m-3. The optical, biological, and biogeochemical property features in these three seas show considerable seasonal variability. The dominant EOF mode for Kd(490) and TSM variability in the BS, YS, and ECS regions is the seasonal mode, which accounts for about two-thirds of the total variance. Phytoplankton bloom in the BS, YS, and ECS is also found to play a minor role in the Kd(490) variation. The first EOF mode in SST for the regions is seasonal and accounts for nearly 90% of the total SST variance. The major mechanisms that drive ocean color property variations in the BS, YS and ECS are the seasonal winds, ocean stratification, and sea surface thermodynamics due to the seasonal climate change as well as coastal bathymetry and seasonal phytoplankton blooms. (Abstract ID 9513)

VERTICAL AND HORIZONTAL HABITAT PREFERENCES OF POST-NESTING LEATHERBACK TURTLES IN THE SOUTH PACIFIC OCEAN

In this study, we analyzed the vertical and horizontal habitat preferences of 46 satellite-tagged female leatherback turtles (Platya Grande, Costa Rica; 2004-2007) in the South Pacific Ocean. Turtles exhibited short, shallow dives during their migration southward (mean depth = 45 m, mean duration = 23.6 min), followed by deeper, longer dives (mean depth = 567 m, mean duration = 126 min) in the South Pacific Gyre that probably indicated searching for prey. We integrated the horizontal movements with remotely-sensed oceanographic data to determine the turtles’ response to the environment, and applied this information to recommendations for conservation in the pelagic environment. A generalized additive mixed model applied to...
the daily turtle travel rates confirmed that slower travel rates occurred at cooler sea surface temperatures, higher chlorophyll-a concentration and stronger vertical Ekman upwelling, all of which are considered favorable foraging conditions. The southern terminus (35-37°S) of the leatherback tracks was also in an area of increased mesoscale activity that might act as a physical mechanism to aggregate their prey, gelatinous zooplankton. However this could also act as a thermal limit to their distribution. This characterization of leatherback habitat use could aid the development of management efforts within the South Pacific Ocean to reduce mortality of leatherback turtles from fisheries interactions. (Abstract ID 10780)

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INFLUENCES OF BIOFILM-ASSOCIATED CILIATES ON THE SETTLEMENT OF MARINE INVERTEBRATE LARVAE

Settlement of marine invertebrate larva is often a limiting step in recruitment. Various components of microbial biofilms on substrata have been shown to influence settlement, especially bacteria, diatoms, and their extracellular polymers and metabolites. Protozoa are ubiquitous in biofilms, yet their potential to influence larval settlement has been unknown. We determined the effects of a mixed-species assemblage of biofilm ciliates on settlement and survival of the larva of common, hard-substratum invertebrates. Ciliates reduced settlement by ca. 50% for a serpulid polychaete and a mussel, whereas they more than doubled settlement for a second serpulid. The first serpulid also had a 7-fold increase in post-settlement mortality. Settlement of a bryozoan was unaffected. None of these results could be explained by an effect of ciliates on the abundance of biofilm bacteria. The mechanisms might include direct interactions between larva and ciliates or indirect effects from an altered bacterial assemblage. These large and species-specific effects of ciliates on larval settlement could have considerable impacts on invertebrate recruitment rates and species assemblages, especially considering that biofilm ciliates are highly variable over time and space. (Abstract ID 9531)

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TRANSITION PROCESS FROM BREAKING LARGE-AMPLITUDE INTERNAL WAVES TO TURBULENCE

Intense diapycnal mixing is considered to be caused by breaking of large-amplitude internal waves in the regions of continental slopes and passes where the tidal flow is strong. The detailed mixing process after such wave breaking is not well known because of their strong nonlinearity and small spatiotemporal scales. We investigated the transition process from large-amplitude internal wave breaking to small scale turbulence, using a high-resolution two-dimensional nonhydrostatic model with a realistic topography in the Amchitka Pass, where breaking of large-amplitude unsteady lee waves was observed. The transition changes the density field dramatically following three stages. After breaking of large-amplitude internal waves start with small scale convection in regions of overturned isopycnals, deep convection occurs. Then Kelvin–Helmholtz (KH) waves are induced along the interface between the deep convection region and a downslope jet. Subsequently, Tollmien–Schlichting (TS) waves, which are two-dimensional instability waves in boundary layers, develop in the jet. The growth of TS waves, as well as the deep convection and the KH waves, enhances diapycnal mixing through the generation of vortices and their collapse. (Abstract ID 11096)

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COMPARISON OF INTERNAL TIDES IN A HIGH RESOLUTION GLOBAL OCEAN CIRCULATION MODEL WITH ALTIMETRIC ESTIMATES

Internal tides are generated in a global eddy-resolving ocean circulation model and compared with estimates obtained from along-track altimetric sea-surface heights. Both the model and observations show strong generation of internal tides at a limited number of regions with propagation of beams of energy for thousands of kilometers away from the sources. The model tidal amplitudes compare well with observations near the energetic tidal regions. Averaged over the energetic tidal regions, the model and observation amplitude estimates agree to approximately 18% for the 4 largest semi-diurnal constituents and 24% for the 4 largest diurnal constituents. The altimetric tidal amplitudes are contaminated by leakage from mesoscale motions in regions of high mesoscale eddy activity such as the Gulf Stream, Kuroshio and Antarctic Circumpolar Current. The stationarity of the simulated internal tide will also be presented and discussed. (Abstract ID 11467)

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THE 4-D STRUCTURE OF UPWELLING AND PEARL RIVER PLUME IN THE NORTHERN SOUTH CHINA SEA DURING SUMMER 2008 REVEALED BY A DATA ASSIMILATION MODEL

We analyze four-dimensional structures of upwelling and Pearl River plume in the northern South China Sea (NSCS) during the summer of 2008 based on an assimilative model with Ensemble Kalman Smoother method. It is found that the Pearl River plume axis extended eastward along with the surface current and swerved offshore twice near (116E, 22.6N) and (117.5E, 22.8N). Anomalously warm water is found in the upper layer, which could be attributed to the intensified stratification and suppressed vertical mixing caused by the freshwater of the plume capping the upwelling west of 116E. The varying winds from upwelling favorable to downwelling favorable could induce a low-salinity water lens at the center of the model domain. Upwelling initially occurred at 114.5E, to the east of the Pearl River Estuary, intensified eastward, and reached its maximum near Shantou (116.7E, 23.2N). Since current-induced upwelling appeared mainly in Shantou, it is found that even if the wind-induced upwelling was shut down in Shantou by downwelling favorable wind on July 4, the upwelling still existed in Shantou. Moreover, because the direction of large-scale current was in favor of upwelling in the NSCS that cannot be reversed by varying local winds over a short time period, the upwelling shutdown time is longer for both wind-induced and current-induced upwelling in Shantou than for mainly wind-induced upwelling in Shanwei. The steeper slope in Shanwei also shortens the upwelling shutdown time there. (Abstract ID 10993)

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ASSESSING CMIP5 SIMULATIONS OF SOUTHERN OCEAN CIRCULATION AND CARBON UPTAKE

We present an evaluation of the CMIP5 models and discuss the dynamical implications of the results. The analysis includes an evaluation of the tropospheric jet since its strength is influenced by variations to the composition of radiatively active gases in the atmosphere and to surface ocean/sea-ice conditions, and it impacts Southern Ocean properties including the Antarctic Circumpolar Current (ACC), the meridional overturning circulation (MOC) and carbon uptake. In recent decades, a trend toward a strengthening and a southward contraction of the tropospheric jet has been observed and identified as one of the strongest climate trends in the Southern Hemisphere but the oceanic response to this trend is still not well-understood. Our evaluation considers both historic and 21st century simulations of the CMIP5 models. We will present three key results: (i) an evaluation of the simulation the present-day state of the Southern Ocean circulation including comparisons with well-observed key components (mixed-layer depth, and the isopycnal and water-mass structures; mean and variable sea level and surface kinetic energy, ACC transport; and mean and eddy-induced MOC); (ii) an evaluation of how the Southern Ocean responds to tropospheric jet variability and trend; and (iii) an evaluation of the ocean circulation changes simulated by the models over the 21st century; and the consequences in terms of carbon budget. (Abstract ID 9549)

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JOINT STUDY AND MODELING OF BIOLUMINESCENCE AND PHYSICAL/BIO-OPTICAL PROPERTIES

Over the past decade, high-resolution measurements of coastal bioluminescence (light produced by a chemical reaction in an organism) were collected during field programs conducted in Monterey Bay, CA. About 70-90% of the bioluminescent signal (BL) in coastal
planktonic systems is due to dinoflagellates but bioluminescence is found in many types of organisms (from bacteria to fish). Some field programs were specifically focused on bioluminescence studies, when BL was measured with multiple platforms including UUs, profilers and ships. Concurrent measurements of physical, chemical and optical properties of the water, as well as enumerations of zooplankton and phytoplankton, were also obtained. In this presentation, we will illustrate how bioluminescence measurements in combination with other physical, bio-optical observations provide valuable new understanding about the spatial and temporal variability of planktonic communities during changing environmental conditions. Preliminary results of dynamic modeling of bioluminescence potential and physical, bio-optical properties during upwelling/relaxation events will be also presented. (Abstract ID 10355)

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DOES MIXING CONTROL ESTUARINE EXCHANGE FLOW?
The mechanical energy budget of an estuary is useful in investigating how estuarine processes interact. This budget includes forcing by tides and rivers, advection of energy, particularly potential energy (PE), and turbulence that is a sink of kinetic energy and a source of PE (the buoyancy flux). The exchange flow appears in a volume integrated energy budget as advection of PE through an open boundary at the estuary mouth. The exchange flow is related to this PE flux, but does not translate exactly; the exchange flow is part of the momentum budget, not the energy budget. Nevertheless it seems intuitively obvious that the rate of mixing should control the exchange flow, since the exchange flow relies on the creation of mixed water in the system. These ideas are quantified using a realistic numerical simulation of flow in the Puget Sound estuary-fjord system. (Abstract ID 12329)

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THE ROLE OF THE SLOPE CURRENTS IN SEASONAL OXYGEN VARIABILITY ON THE PACIFIC NORTHWEST CONTINENTAL SHELVES
Hyposic regions (< 1.5 µM) exist over the shelf and slope of Washington and Oregon. Recent observations show the importance of both source water chemistry as well local biogeochemical processes in determining seasonal hypoxia on continental shelves (Connolly et al., 2010). Using the external forcings and framework set up by the MoSSea (Modeling the Salish Sea) project, ROMS, and NCOM, realistic hindcasts of 2005, 2006, and 2007 are performed. Oxygen is modeled and coupled to the biogeochemical model from Banas et al. (2008). Data from the ECOHAB PNW-RISE database is used to ground-truth the model. Preliminary results from 2005 indicate fresh nutrients from the slope are introduced in the spring when the slope currents are primarily equatorward, and then, over the course of the upwelling season, the nutrient source becomes more recycled, coincident with the emergence of the polar undercurrent. As a result, oxygen concentrations in the spring source waters set the initial condition for hypoxia to develop as a result of biochemical interactions with organic matter and the sediments. The role of slope current variability will be discussed. (Abstract ID 12566)

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REGIONAL TO GLOBAL SCALE PHYTOPLANKTON DYNAMICS: THE SEAWIFS LEGACY
For the past 13 years, the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) mission provided the first consistent, synoptic observations of global ocean ecosystems. Traditionally, changes in the chlorophyll concentration (Chl) are used as a metric for phytoplankton abundance and its distribution largely reflects regional patterns in vertical nutrient transport. On regional to global scales, Chl covaries with sea surface temperature (SST) because SST tracks light and nutrient conditions. However the presence of colored dissolved organic matter (CDOM) also covaries with SST and its presence interferes with standard chlorophyll retrievals. Semi-analytical algorithms are used to partition ocean color signals into Chl, CDOM and particulate backscattering. Variations in the CDOM-corrected Chl are partitioned into changes due to biomass, which dominate the high latitude seas and upwelling regions, and photoacclimation of intracellular chlorophyll concentrations, which controls much of the tropical and subtropical oceans. The SeaWiFS record demonstrates the complexity of temporal trends in phytoplankton dynamics and illustrates limitations of assessing global phytoplankton abundances using standard Chl retrievals. Last, SeaWiFS provided guidance for future satellite missions aimed at making new discoveries of the ocean biosphere. (Abstract ID 9612)

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THE OPERATIONAL USE OF SCATTEROMETER OCEAN SURFACE VECTOR WINDS IN EXTREME WINTER OCEAN STORMS
Beginning with QuikSCAT, ocean surface vectors winds (OSVWs) from satellites have become a key source of data for NOAA Ocean Prediction Center forecasters to make warning and forecast decisions. ASCAT on Metop-A and starting in late 2011 OSCAT on India’s OceanSat-2 have helped fill the gap left by the loss of QuikSCAT. This paper will focus on extreme extratropical cyclones of hurricane-force intensity and discuss lessons learned from QuikSCAT concerning the evolution of extreme winds in ocean storms. The capabilities of ASCAT and OSCAT as aids to the warning process will be demonstrated. High resolution modeling results from the Weather Research Forecasting (WRF) model will illustrate the significance of cyclone frontal structure to the development of extreme winds. Lastly, examples of post-stationary Red Green Blue (RGB) Airmass products from the Meteosat Second Generation (MSG) – 9 satellite will be shown to illustrate some additional uses of GOES-R imagery. This product has the capability to highlight moist tropical airmasses from cold, dry airmasses that are associated with explosive extratropical cyclogenesis or extratropical transitions of tropical cyclones. (Abstract ID 11280)

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OPERATIONAL OCEANOGRAPHY AT THE NOAA OCEAN PREDICTION CENTER, A COMMUNITY APPROACH
The NOAA Ocean Prediction Center (OPC) is one of nine centers that make up the National Weather Services National Centers for Environmental Prediction (NCEP). Traditionally a marine weather forecast center, the OPC has worked to enhance oceanographic and ecological services through building partnerships, sharing resources and data, leveraging the NWS/NCEP 24/7 operational capabilities, and determining stakeholder needs. Four focus areas have been identified and are being addressed: ecological prediction, ocean analysis and prediction, coastal services through building partnerships, sharing resources and data, leveraging the NWS/NCEP 24/7 operational capabilities, and determining stakeholder needs. Four focus areas have been identified and are being addressed: ecological prediction, ocean analysis and prediction, coastal services through building partnerships, sharing resources and data, leveraging the NWS/NCEP 24/7 operational capabilities, and determining stakeholder needs. Four focus areas have been identified and are being addressed: ecological prediction, ocean analysis and prediction, coastal services through building partnerships, sharing resources and data, leveraging the NWS/NCEP 24/7 operational capabilities, and determining stakeholder needs.
DIVERSITY OF THE DOMINANT MARINE NANO- AND PICOEUKARYOTES - THE SINGLE CELL PERSPECTIVE FROM THE TARA OCEANS EXPEDITION

Marine eukaryotes smaller than 20 µm are highly diverse and not well described, yet they are involved in many key ecosystem functions in the ocean. Diversity surveys based on bulk DNA methods may have distorted our view of the community structure due to the over-representation by types with multiple copies of the SSU rRNA genes. High-throughput sequencing of the SSU rRNA genes from single sorted cells yields a more accurate picture of the diversity of the dominant unicellular eukaryotes. We present here our results from surface waters of the Mediterranean Sea and Indian Ocean, as part of the Tara Oceans Expedition, a circum-global oceanographic survey of plankton diversity. Photoautotrophs, identified by autofluorescence, are generally less diverse than heterotrophs, and dominated by Prysinophytes, Chlorophytes, and Prymnesiophytes. The heterotrophic cells have more unknown representatives. The heterotrophic marine stramenopiles of the MAST groups are ubiquitous and widely dominant. Single amplified genomes from these cells are a valuable resource for genomic sequencing and studies of the diversity and ecological functions of these important microorganisms.

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ASSESSMENT AND IMPACT OF CARBON VARIABILITY IN THE NORDIC SEAS

In areas where deep water formation occurs, such as the Nordic Seas, relatively rapid transmission of atmospheric CO2 to the deep ocean is expected. Together with the Arctic Ocean and the Barents Sea, it makes up a known as the northern limb of the Atlantic thermohaline circulation, estimated to give rise to significant preindustrial inter-hemispheric transport of inorganic carbon directed from the northern to the southern hemisphere. Therefore, it is important to study the carbon dynamics in the Nordic Seas as they are an integral part of the global carbon cycle. Observational studies report significant variations of the ocean CO2 sink in the Nordic Seas and suggest a reduction of the atmospheric CO2 uptake during the last two decades, especially in the Subpolar and Nordic Seas. We use a combination of remote sensing data analysis, numerical model experiments, and in situ data to assess the impact of carbon variability in the Nordic Seas. A 3D ice-ocean model is used to drive a 1D ecosystem/carbon model featuring multiple phytoplankton functional groups, which is applied to key biogeochemical provinces within the study region. Our results address the impact of different phytoplankton functional groups on the seasonal uptake of atmospheric CO2, the major physical and biological driving mechanisms for the seasonal, interannual, and decadal variations of surface ocean pCO2 and sea-air CO2 flux, and the impact of long-term predicted changes on ocean acidification. (Abstract ID 9402)

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This study presents in-situ measurements of waves collected for a period of approximately thirty days (March to April 2011), at two locations in Winyah Bay. Winyah Bay, South Carolina, is a 29 km long estuary that is partially mixed and subjected to semidiurnal tides. The two sites exhibited different wave heights in response to the change in meteorological conditions. The principle hypothesis is that within an estuarine environment different areas are exposed to different energy in terms of tidal currents and surface wave activity and therefore, certain areas will be better suited for sediment accumulation. An unstructured SWAN model has been set up for Winyah Bay to research these objectives. Preliminary model results have been determined for wave height for in-situ locations during the same time period. Additionally, a long-term meteorological analysis has been completed to find the range of wind speeds in Winyah Bay. This range will be applied to the validated SWAN model to determine the effect that the high wind speeds have on the estuary's wave. (Abstract ID 9726)

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SIMULATIONS AND OBSERVATIONS OF STRONG BAROCLINIC GENERATION AND NONLINEAR WAVES IN THE SOUTH CHINA SEA

Tidal flow through the Luzon Straits generates internal tides that propagate into the South China Sea as large-amplitude nonlinear internal waves. Simulations were performed on an idealized two-dimensional model and a more complex regional numerical model. The regional model is three-dimensional with horizontally uniform stratification and uses simplified hydrostatic and isopycnal physics (with concurrent computational efficiency) but realistic geometry. Although the model is relatively simple it shows predictive skill both in the near field region of internal tide generation, and in the far field where nonlinear waves are observed to shoal on the Chinese continental shelf. We will present detailed model comparisons with field measurements of wave arrival times, energy flux, turbulent dissipation, and mode-conversion. Combining observations with predictive model simulations allows us to reconstruct a more complete space-time description of the internal wave environment throughout the South China Sea and allows us to construct an energy budget of baroclinic generation, mode-conversion, flux divergence, and ultimately estimate bounds on the bulk “efficiency” of dissipation vs. wave radiation in the Luzon Strait. (Abstract ID 12452)

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USE OF A HIGH RESOLUTION MICROARRAY ASSAY AND INTEGRATED SUMSCORE DATA ANALYSIS TO ASSESS TAXONOMIC DIVERSITY OF PSEUDO-NITZSCHIA SPI (BACILLARIOPHYCEAE)

A microarray assay was developed for diversity assessment of microorganisms using the Combimatrix ElectraSense™ platform. 307 oligonucleotide probes, ranging from broadly specific to unique, were evaluated in a proof-of-concept study targeting the internal transcribed (the 'Integrated Sumscore Data Analysis' [ISDA]) to integrate hybridization signals from multiple probes. Integrated signals provided a 'sumscore' for each ribotype represented on the chip. The ISDA correctly identified all tested species and provided information for a very small and low-cost Lagrangian surface float, has been developed to measure 3-D free oxygen, with implications for atmospheric pCO2. (Abstract ID 10258)

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A hook for teaching how data are used in the real world

Despite legislative initiatives to bolster Science, Technology, Engineering, and Math (STEM) education, U.S. students, particularly those from the Gulf Coast, and their Mexican counterparts, continue to perform poorly on international assessments. To address the need for enhanced STEM education, the Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA) is working with its data partners to develop the skills needed to understand and appreciate the science and technology required to manage the living resources of the Gulf of Mexico, make informed voting decisions, power the future work force, and compete in a global economy. Incorporating data from AUVs and other platforms, the Deepwater Horizon Oil Spill is being used as a living example of the Scientific Process to demonstrate how STEM disciplines translate to science and technology applications that are relevant to their everyday lives. The project complements ongoing research focused on priority issues identified by the Gulf of Mexico Alliance, Gulf Coast Ecosystem Task Force, and the Gulf of Mexico Large Marine Ecosystem Project, supports ocean and environmental literacy initiatives, and aligns with state and federal education standards. (Abstract ID 12241)

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MODEL ROBUSTNESS IN ESTIMATING LARVAL TRANSPORT AND CONNECTIVITY IN THE COASTAL OCEAN

Ocean circulation models combined with Lagrangian particle tracking are now widely used for estimating larval transport and connectivity in the coastal ocean. This study quantifies how sensitive estimates of larval transport produced by these models are to three user-defined input parameters: the number of particles released, particle release depth, and particle advection time. Using 3D ROMS solutions and a particle tracking model of the Southern California Bight, we quantified the spatial distribution of particles using a two-dimensional density distribution (DD). DDs were created by integrating the number of particles over one grid cell, dividing by the number of particles released, and applying a 2D isotropic Gaussian filter. To achieve robust DDs, we found that a minimum number of particles is required and that below this threshold, the variations in the DDs increased rapidly. When DDs were created by releasing particles from different depths, differences between DDs grew linearly as the particles were released farther and farther apart. When the particle advection times were as little as three days apart, the differences in DDs ranged as high as 30%. (Abstract ID 11073)

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MEASUREMENT OF 3-D FREE SURFACE ACCELERATIONS OF PLUNGING BREAKERS IN THE SURF ZONE: A NOVEL LAGRANGIAN FLOAT AND COMPARISON TO GPUS MODEL DATA

The surf zone is a difficult environment in which to make in situ measurements of breaking waves, therefore, questions regarding 3-D dynamics of breaking waves remain open. FlowFidler, a very small and low-cost Lagrangian surface float, has been developed to measure 3-D free
surface accelerations of plunging breakers in the surf zone and enhance breaking wave models with field data validation. FlowRider’s sensor suite includes a 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer. A three-day field experiment at Waimanu Bay, Oahu, was conducted and free surface acceleration data collected in plunging breakers with wave heights ranging from 1.8 m to 3.6 m. Maximum acceleration values measured while the float traveled in plunging breakers exceed 8 g. Results from the field experiment have been compared to GIPUS4H free surface flow model results. A description of the instrument, data analysis results from the field experiment, and comparison to model results will be presented. Experimental success of the FlowRider demonstrates low-cost and expendable instruments using MEMS technology may be used in the oceanographic community to collect new scientific data on fundamental physical phenomena. (Abstract ID 12610)

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METAGENOMIC INSIGHTS INTO THE DOMINANT FE(II)-OXIDIZING ZETAPROTEOBACTERIA FROM A BIOMAT AT LOIHI, HAWAI’I

Zetaproteobacteria are among the most prevalent Fe(II)-oxidizing bacteria that proliferate at deep-sea hydrothermal vents, however, knowledge about their environmental significance is limited. None of the locally dominant or ubiquitous environmental operational taxonomic units (OTUs) have been isolated (Mcallister et al., 2011). We present the first metagenomic dataset featuring OTU1, which is the dominant Zetaproteobacterial strain at Lo’ihi, Hawai’i and one of two ubiquitous Zetaproteobacteria clades in the Pacific Ocean. Genome analysis reveals genetic potential for CO2 fixation and conversion to glycerol, Fe(II)-oxidation, hydrogen oxidation, and sulfide oxidation, despite inhabiting a sulfate-depleted environment. Several genes encode heat shock proteins, beta-lactamas, as well as resistance against arsenic and other heavy metals, which are abundant at this hydrothermal vent. Two-component signal transduction system genes, including PAS/PAC sensors and GGDEF domain genes, antioxidant genes, as well as polysaccharide biosynthesis, important for biofilm formation, are very abundant and may help positioning the cell at the oxic-anoxic interface to maintain cellular redox balance. Understanding the physiology, ecology, and genetics of dominant Zetaproteobacteria is important for understanding the cycling of iron and carbon at hydrothermal vents. (Abstract ID 12729)

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EVALUATION OF K-_EPSILON MODEL IN SIMULATIONS OF FULL DEPTH LANGMUIR CIRCULATION

In shallow coastal shelves, Langmuir circulation (LC) can engulf the water column acting as a secondary flow structure to the primary wind driven shear flow. Large-eddy simulation (LES) has revealed that the homogenizing action of LC induces a disruption of the classical bottom log layer in terms of mean velocity and turbulent kinetic energy (TKE) transport. We investigate the performance of the k-ε turbulence model in capturing the secondary LC structure and its associated log-layer disruption. In the constant coefficient k-ε model the eddy viscosity is taken as $C_k \epsilon^{1/2}$ where $k$ is TKE, $\epsilon$ is TKE dissipation rate and model coefficient $C$ is often set to 0.9. A priori analysis of the k-ε model based on LES-resolved fields suggests that $C$ is a depth dependent function in flows with full-depth LC. Consistent with this previous result, it will be shown that RANS (Reynolds-averaged Navier-Stokes simulation) with a dynamic formulation for coefficient $C$ is able to capture the secondary LC structure unlike RANS with the traditional constant coefficient model. (Abstract ID 12761)

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TUNDRA-DERIVED HUMICS AS A SOURCE OF NITROGEN AND CARBON TO COASTAL MICRIBIAL POPULATIONS

As temperatures rise, tundra runoff associated with increased permafrost melt reaches coastal Arctic microbial communities and has the potential to affect the competition between bacteria and phytoplankton. Humic acids from tundra melt ponds were isolated and used as a nutrient source in five-day bioassays conducted in spring and summer of 2011. Bacteria and phytoplankton responded positively to the tundra humic additions. In spring, bacterial production rates ($\mu$ [meq CO$_2$ per g] h$^{-1}$) peaked as early as March, while phytoplankton production rates ($\mu$ [meq CO$_2$ per g] h$^{-1}$) reached an order of magnitude higher when humics were added. There was no difference in chlorophyll a concentrations between the spring control and humics treatments, however, indicating that phytoplankton were supported by ambient nitrate. In the summer when nitrate concentrations were low, the greatest response, a 5-fold increase in chlorophyll a, was observed in the humic treatment after 60 hours of incubation. The delayed growth was likely supported by remineralized dissolved organic nitrogen (DON). DON accounted for over 90% of the nitrogen used in the summer humic bioassay. These data indicate that tundra runoff provides a source of carbon and nitrogen to Arctic coastal microbial communities. (Abstract ID 10421)

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TEMPORAL SEPARATION OF FIN WHALE CALLS ACROSS THE EASTERN NORTH PACIFIC

Fin whales produce a variety of low frequency, high intensity, short duration, frequency modulated sounds. The most commonly reported sound is the “20 Hz call”, which has been recorded worldwide. A higher frequency, “40 Hz call” has also been attributed to fin whales (Watkins 1981). The differences in temporal patterns between two fin whale call types are described from long-term passive acoustic data collected between 2005 and 2011 at three locations across the eastern North Pacific: the Bering Sea, off Southern California, and in Canal de Ballenas in the northern Gulf of California. Fin whale calls were detected at all sites year-round, during all periods with recordings. At all three locations, 40 Hz calls peaked in June, preceding a peak in 20 Hz calls by 3-5 months. The 40 Hz call likely has a foraging function and temporal separation between 40 Hz and 20 Hz calls may indicate the separation between predominately feeding behavior and other social interactions. (Abstract ID 10732)

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THE MICROBIOME OF MARINE DIATOMS: IS IT INFLUENCED BY ALGAL HOST PHYLOGENY?

Diatoms are the most prolific primary producers in the ocean and are very successful in forming algal blooms in the coastal and open ocean that allows for the sequestration of carbon in deep sediments; thus diatoms are major drivers of the global carbon cycling. Part of their ecological success is attributed to their unique evolutionary and physiological make-up as deduced from two representative diatom genomes sequenced to date. Genome sequences revealed the bacterial genes contribute up to 5% of their genome make-up, highlighting the close association of marine diatom with bacteria in the diatom’s evolutionary history. So far, few have looked at the diversity of epibiotic bacteria associating with different diatom species and hardly any have looked at these microscale interaction. To begin to dissect this intimate association, we started by assessing the diversity of epibiotic bacteria associating with 3 phylogenetically distant group of marine diatoms (radial centric, polar centric and pennate diatoms) using 454 next-generation sequencing. In our presentation, we will illustrate if diatom-bacteria association is influenced by algal host phylogeny, algal physiology or by random chance. (Abstract ID 12577)

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INFLUENCE OF INDIAN OCEAN DIPOLe ON OCEAN BIOLOGY IN THE EASTERN INDIAAN OCEAN

Indian Ocean Dipole (IOD) is well known to cause anomalously low sea surface temperature (SST) in the eastern Indian Ocean because of strong upwelling driven by anomalous wind. Changes on the ocean biology especially primary production (PP) are however still less studied. This study thus aims at assessing to what degree PP can be potentially enhanced by nutrient input from deep water due to strong upwelling during IOD. SeaWiFS ocean color and AVHRR SST data were used to estimate PP using modified-VGPM. During strong 1997 IOD, tongue-like low SST (<-1.0 °C) and high PP extended far westward to 60 °E, but spatially limited during weak 2006 IOD. Anomalously high PP during 1997 and 2006 IODs, respectively lasted for four and three months, with the magnitudes of 2.5 and 1.5 times as high as PP during weak IOD. Tongue-like low SST (<-1.0 °C) and high PP extended far westward to 60 °E, but spatially limited during weak 2006 IOD. Anomalously high PP during 1997 and 2006 IODs, respectively lasted for four and three months, with the magnitudes of 2.5 and 1.5 times as high as PP during weak IOD. Temporally and spatially integrating PP over the intense upwelling region (SST anomaly < -3 °C), 1997 and 2006 IODs roughly contributed to new production as much as 23 and 6 Gg Carbon, suggesting the importance of IOD climatic forcing on ocean biology. (Abstract ID 10752)

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CONSEQUENCES OF INCREASED TEMPERATURE AND OCEAN ACIDITY ON HETEROTROPHIC BACTERIOPLANKTON COMPOSITION AND METABOLISM

Oceans have absorbed approximately one third of all anthropogenic CO2 released into the atmosphere. By 2100, sea surface temperatures are expected to increase 4 °C, and atmospheric CO2 concentrations are predicted to triple. These compounding effects will undoubtedly have
significant consequences for biological processes in the oceans. Heterotrophic bacterioplankton play an important role in the marine carbon cycle and the oceans’ ability to sequester CO2. However, there is limited research on how these important microorganisms will respond to predicted increases in temperatures and pH. Our aim is to investigate the consequences of elevated temperature and pH on heterotrophic bacterioplankton composition and metabolism using manipulative experiments in which temperature, pH, and organic matter supply are altered. Terminal-restriction fragment length polymorphism (T-RFLP) will be used as a fingerprinting technique and a variety of assays for microbial growth and respiration will be implemented. This study will provide a foundation for future work in this relatively unexplored area of oceanographic and climate research, and help predict the response of microbial communities to climate change and the implications with respect to microbiologically-mediated biological processes in the oceans. (Abstract ID 9465)

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ON THE RESONANCE AND SHELF/OOPEN-OCEAN COUPLING OF THE GLOBAL DIURNAL TIDES

The resonance of diurnal tidal elevations is investigated with a realistic forward numerical forced-damped global tide model and three interpretive models: a simple coupled oscillator model, a one-dimensional shallow-water model, and a model comprised of a set of normal modes computed for realistic ocean geometries. Prior to performing the numerical experiments, the topographic wave drag was tuned for diurnal tides. This tuning incorporated comparisons to observed tidal kinetic energies and elevations. Simulations possessing idealized topography and geometry indicate that the presence of continents amplify tidal elevations by modes computed for realistic ocean geometries. Prior to performing the numerical ON THE RESONANCE AND SHELF/OOPEN-OCEAN COUPLING OF THE GLOBAL DIURNAL TIDES

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HIGH-FREQUENCY FLUCTUATIONS IN OPTICAL MEASUREMENTS REFLECT CHANGES IN PARTICLE SIZE DISTRIBUTION IN A BOTTOM NEPHELOID LAYER

Suspended particle size and concentration are key parameters for sediment transport models and predicting the performance of optical and acoustical detection systems within bottom nepheloid layers. These parameters are routinely estimated in situ using optical proxies such as attenuation, backscattering, and low-angle light scattering. Such measurements are topographically sensitive and can be used to infer perceived measurement quality and reduce “noise.” Ironically, the intensity of these fluctuations has been shown in both theoretical and laboratory studies to be linked to suspended particle size. First, we present measurements from a laboratory aggregation experiment where fluctuations of measured optical properties are clearly linked to changes in size of suspended particles over time. Second, we apply similar principles to field measurements of near-bottom optical properties and particle size. Results suggest that analysis of fluctuations can be used to infer changes in particle size within the bottom boundary layer. This unconventional approach has the advantage of being applicable to a wide range of sensor types and measurement platforms, leading to enhanced understanding of sediment dynamics over a wide range of temporal and spatial scales. (Abstract ID 11639)

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SPONGE DIVERSITY AND ACCLIMATION IN NATURALLY-ACIDIFIED MARINE CAVES

The limestone framework of many tropical coral reef communities is riddled with crevices and caves formed by dissolution during glacial periods. The dominant fauna of these caves are sponges, and their total biomass relative to cave volume can cause significant metabolic reductions in O2, with a corresponding increase in CO2, and decrease in pH. We assessed pH levels in seven caves throughout the Exuma archipelago (Bahamas), and examined changes in sponge diversity relative to pH stability. We also transplanted the facultative cave sponge Chondrilla nucula across an acidification gradient from pH 7.7 (= cave conditions) to pH 6.8 (= oceanic conditions). Our results indicate that sponges exhibit variable responses to the

Resuspended coastal sediments exposed to simulated sunlight typically release significant concentrations of dissolved organic carbon (DOC), organic nitrogen, and total dissolved Cu (TDCC). Release of TDCCs from photolyzed suspensions containing environmentally relevant suspended solids concentrations (38–400 mg/L) of fine-grained (10–20µm) sediment occurred in 9 of 12 samples exposed to 6 hours of light, relative to dark controls. TDCC concentrations were typically 30% larger in light vs. dark samples with net increases ranging from 0.5 to 10 nM; photorelease was correlated with Cu content of the sediments. Net DOC photorelease from diverse riverine and coastal sediments ranged from 20–180 µM in 6-h exposures. DOC photorelease was correlated with OC content of the sediments. Transects along river systems also indicate a correlation between DOC photorelease and long-chain n-alkane carbon preference index, suggesting that diagenetically unaltered OC is more photoreactive than relatively degraded organic matter. Photoxic fluxes of both TDCCs and DOC in the upper water column may be comparable, on an areal basis, to benthic and riverine fluxes and thus should be considered in biogeochemical mass balance models. (Abstract ID 11712)

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BAROCLINIC INSTABILITY AND TURBULENT MIXING IN THE OCEAN BOUNDARY LAYER

Interaction between mixed layer baroclinic eddies and small-scale turbulence is studied using a non-hydrostatic large-eddy simulation (LES) model for both unforced and wind/wave driven boundary layers. Free, unforced evolution of the flow from a standard initialization consisting of an 80 m deep mixed layer with a warm filament and two frontal interfaces in geostrophic balance, on a model domain roughly 5 km x 10 km x 120 m, with an isotropic 3-m grid. Results from unforced experiments of shear that shear generated in narrow frontal zones can support weak three-dimensional turbulence that is directly linked to the larger scale baroclinic waves. In cases with surface forcing, baroclinic instability is accelerated when the winds are in the same direction as the geostrophic flow. For winds opposing the geostrophic current, baroclinic instability is suppressed and the frontal zone lateral scale increases from enhanced mixed layer turbulence. Both cases can be interpreted in terms of the wind-driven Ekman current that either 1) advects cold water over warm, sharpening the front and enhancing baroclinic instability, or 2) advects warm water over cold, which is then mixed vertically by wind and wave forced Langmuir circulation, decreasing the frontal intensity. (Abstract ID 12248)

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naturally-acidified conditions of marine caves that are manifested in cave-specific patterns of diversity and invasiveness. While sponges don't face all the issues that calcified species encounter under acidic conditions, it is clear that the physiological challenges of dealing with an acidified future may have significant consequences for this important functional group as well. (Abstract ID 10006)

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ACCELERATED PARAMETER IDENTIFICATION IN 3D MARINE ECOSYSTEM MODELS

Parameter identification or data assimilation in time-dependent, spatially threedimensional models is a quite challenging task with respect to the computational effort and the choice of the appropriate optimization algorithm. We propose two methods - new in climate and ocean science - that allow for a significant acceleration of such kind of optimization runs. As an example, we study the simulation of marine ecosystems in an offline mode with precomputed ocean circulation data using Kr vítálek's transport matrix method. In the applications, a steady periodic solution is computed and parameters of the biogeochemical model are to be identified. The aim is to fit given synthetic or real observational data. One method - called surrogate-based optimization - replaces the original and computationally expensive model evaluation by a surrogate that is build upon an approximate solution and corrected afterwards. This method reduces the computational effort by up to 90 %. In the second method called one-shot approach, simulation steps are augmented by adjoint and parameter updates. An appropriately designed preconditioner ensures convergence of the method in an abstract setting. This approach also reduces the overall optimization steps significantly. We sketch the two methods and show examples for 3D marine ecosystem models. (Abstract ID 10962)

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PARTICULATE IRON, ALUMINUM, AND MANGANESE IN THE PACIFIC EQUATORIAL UNDERCURRENT AND LOW LATITUDE WESTERN BOUNDARY CURRENT SOURCES

Samples from the equatorial Pacific and from the coastal margin of New Guinea and New Ireland were analyzed for total particulate Fe, Al and Mn. Leachable and refractory Fe, Al and Mn were calculated. There were large zonal gradients for all three particulate metals near the depth of the Pacific equatorial undercurrent. The PFe and PAl concentrations were much higher along the coast of Papua New Guinea and New Ireland. There were significant correlations between Fe and PAl. The leachable particulate fraction increased from Al < Fe < Mn. The primary source of PFe and PAl appeared to be material of riverine origin. To understand how a particulate iron maximum could be maintained at a constant depth across the equatorial Pacific we used a simple model where the advective input of leachable particulate iron (LPFe) was balanced by iron loss due to remineralization and loss due to particle sinking. Using a sinking rate for 1-μm sized particles of 0.086 m d^{-1}, the remineralization rate necessary to produce the observed gradient would be 0.006 d^{-1}. (Abstract ID 10169)

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COMMUNITY ATMOSPHERE MODEL SIMULATIONS OF THE RESPONSE TO OCEAN FRONTS.

This presentation investigates climate responses to western boundary currents using the Community Atmosphere Model (CAM). Recent observational and regional model studies performed at high resolution have revealed a significant impact of western boundary currents on the atmosphere. However the typical grid spacing of most climate models is too coarse to resolve the large air-sea heat fluxes and sea surface temperature gradients occurring at ocean fronts. Here we employ global atmospheric simulations at 1/2deg. or finer which both better resolve the fronts and also allow for determination of distant responses. Particular focus areas are i) how does the coupling between SST and surface momentum and heat fluxes vary with resolution in the horizontal and vertical? ii) what are the local effects of western boundary currents? (Abstract ID 11060)

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EFFECTS OF LONGSHORE NON-UNIFORMITIES IN A BAR TROUGH SYSTEM ON LONGSHORE CURRENTS

A nearshore experiment was performed during February 2010 at Cape Hatteras, NC as part of the USGS Coastal Change Processes project to study the nearshore processes that drive sediment transport maintaining a 22km long, shore-attached shoal complex and the nearby coastline shape. As part of the experiment, longshore currents were estimated from video observations of the surfzone, measured in situ by an instrument deployed outside the surfzone in view of the camera, and simulated by numerical modeling. A storm event spanning February 12 and 13 had the strongest longshore currents at over 1m/s, therefore the greatest potential for sediment transport. The intensity variance images from the video during this event and bathymetric surveys indicate that the nearshore morphology was characterized with a nearshore bar and trough that varies in depth alongshore through the camera field of view. Video-derived flow estimates indicate that the longshore current maxima occur well inside the trough. Modeling results suggest that the longshore flow may be driven, at least in part, by a longshore pressure gradient resulting from differences in the cross-shore profile of wave-induced setup. (Abstract ID 11263)

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STATISTICAL COMPARISON OF HISTORICAL INSITU MEASUREMENTS TO SATELLITE OCEAN COLOR

Improving the quality, consistency, and spatial coverage of long-term ocean color records is of great interest to climate change researchers trying to understand large-scale trends in primary production. Significant efforts have gone into collecting databases of in-situ bio-optical measurements in order to calibrate the satellite remote-sensing data products that provide global synoptic coverage. The World-wide Ocean Optics Database (WOOD), developed at JHU/APL under the auspices of ONR, is an extensive database with an emphasis on comprehensive spatial coverage and understanding the sub-surface vertical structure. In addition to an aggregation of public holdings, such as NASA and NODC datasets, optical data from numerous other sources have been accumulated to extend the geographic coverage, including NAVOCEANO cruises targeting under-sampled regions. Quality screening has been a priority. Comparison of in-situ chlorophyll and diffuse attenuation data to ocean color satellite estimates are presented for the subtropical Northwestern Pacific and Atlantic Oceans. Statistics are focused on understanding bias and frequency distributions, appropriate for ground truth that is co-located but not coincident in time. Primary regions of interest are oligotrophic waters that comprise over 50% of the world ocean. However, these regions are often under-represented in calibration comparisons because a small percentage of in-situ measurements are located in offshore central gyres. (Abstract ID 9336)

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PLANKTON AGGREGATION IN A MESOSCALE EDDY AND A FRONT IN WATERS OFF NEW CALEDONIA (SOUTHWESTERN PACIFIC)

This study builds on recent investigations of biogeochemical impact of mesoscale eddies in the North Atlantic and the subtropical North Pacific. Eddies and fronts are prominent boosters of the ocean biological pump. These phenomena have been shown to potentially enhance nutrients injection into the euphotic zone, plankton aggregation and carbon export. During two interdisciplinary oceanographic cruises off New Caledonia, we sampled the dynamical and biogeochemical ocean conditions including currents, nutrients, chlorophyll, zooplankton, micronutrient and acoustic backscatter. A strong mesoscale anticyclonic eddy (March 2008) and a tight front (August 2011) were observed to substantially structure the ecosystem from nutrients to zooplankton in response to the ocean dynamics. The observed increase of primary and secondary producers could be explained by plankton frontal aggregation process in high velocity boundaries at the front and at the edge of the anticyclonic eddy. (Abstract ID 11023)

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GLIDER OBSERVATION SYSTEM SIMULATION EXPERIMENTS USING A GENETIC ALGORITHM SOFTWARE

A Genetic Algorithm (GA) software that has been developed for determining preferential paths to achieve optimal coverage in areas of large model forecast uncertainty (Heaney et al., 2007). By using environmental model data, the Environmental Measurements Path Planner (EMPath) gives sampling platforms (such as autonomous ocean gliders) the real-world scenario with the available description of currents and other variables that will impact the platforms path. The goal of utilizing additional tools for glider placement in advance will aid the Navy in optimizing the value of glider data. Automation is needed to manageably increase the number of gliders in a given area. Furthermore, allowing the GA to do the background work of optimizing glider paths allows the operational center to avoid a reactive approach. Observation System Simulation Experiments (OSSEs) were performed using GA inputs derived from several criteria and approaches. These experiments have a more theoretical setting in which a model configuration is considered as the true ocean from which data can be extracted and assimilated in the other simulations. The goal was to evaluate the skill and limits of each approach. (Abstract ID 9653)

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EXTRATROPICAL FORCING OF TROPICAL ATLANTIC CLIMATE VARIABILITY DURING BOREAL FALL

A recent linear inverse modeling (LIM) study is tested within the framework of a coupled GCM. The LIM shows remarkable predictability of the tropical Atlantic’s “Meridional Mode” (AMM) during boreal fall and suggests forcing by extratropical Atlantic SST anomalies. To investigate the validity and mechanism of the LIM, a set of ensemble simulations are run using CAM3 coupled to a slab-ocean. The GCM confirms the LIM and excitation of the AMM is found to involve at least two processes: the predominant one is a thermodynamic wind-evaporation-SST (WES) feedback, and the other is a low-cloud/SST feedback. The WES feedback is found to amplify the AMM-like response by a factor of three compared to when it is absent, but tropical SST anomalies are still found when the WES feedback is suppressed. Meanwhile, the low-cloud/SST feedback is found to be locally important in the north tropical Atlantic stratoscumulus region during boreal summer, but is unlikely to affect the large-scale AMM-like response. Additionally, seasonality is crucial, favoring forcing during the early boreal winter. A mechanism for this Atlantic extratropical-tropical connection is proposed. (Abstract ID 11209)

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TURBULENT DISSIPATION AND ITS ROLE IN COPEPOD BIOGEOGRAPHY.

The spatial distribution of turbulent dissipation may be critical to plankton biogeography. Curry & Roy (1989) hypothesized the existence of a turbulent “Optimal Production Window” for plankton, which theoretically relates the magnitude of the turbulence to plankton population production. This presentation will focus on how the distribution of copepods by size may be affected by the distribution of turbulent dissipation rates in the water column. We examine the role of turbulence in copepod biogeography using a bio-physical profiler, which records co-incident measurements of both turbulent dissipation rates and plankton images. Preliminary results suggest that small scale turbulence plays an important role in the biogeography of copepods in Bedford Basis, based on the copepods’ size distribution with respect to depth. (Abstract ID 9528)

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INFLUENCE OF ANTHROPOGENIC ACTIVITIES AND NATURAL PROCESSES ON HISTORIC DEPOSITIONAL PATTERNS AND ENVIRONMENTAL CHANGE IN THE MOBILE BAY ESTUARINE SYSTEM (USA)

Over the last two centuries, the interplay between natural processes and anthropogenic activities has had a significant influence on the supply and deposition of sediment to the Mobile Bay Estuarine System. Based on modern bathymetry and morphology, the bay proper consists of three depositional sub-basins: middle bay, lower bay, and Bon Secour bay. Lead-210 (210Pb) geochronologies of seven box cores constrain the depositional history of the bay and each sub-basin. At the bay scale, linear sediment rates over the last 120 years average 0.4 cm y-1, which is slightly higher than local sea-level rise (0.298 cm y-1). Dauphin Island Tide Station,
NOAA). However, differences in deposition are observed within and among sub-basins, reiterating the need to understand controls on spatially heterogeneous bay infilling. For example, sedimentation rates for the middle sub-basin east of the shipping channel are three to four times higher than rates west of the shipping channel. This difference is in part controlled by channel dredging and spoil disposal, which isolated the western middle bay from sediment supply from the Mobile-Tensaw Rivers. (Abstract ID 10570)

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THE RELATIONSHIP BETWEEN PHYTOPLANKTON PIGMENT CONCENTRATIONS AND DMS, DMSO, and DMSP IN A DIATOM-DOMINATED BLOOM IN THE ROSS SEA, ANTARCTICA

DMS, DMSO and DMSP concentrations along with phytoplankton community composition (assessed by pigments) were measured from December 2004 through January 2005 in the Ross Sea, Antarctica. Ratios of DMSp, DMS and DMSP to Chl a increased under shallow mixing conditions. Additionally, BIO-ENV statistical analysis showed that the variability observed in DMSpp, DMSp1, and DMSp2 was best explained by the combined concentrations of the xanthophyll cycle pigments diadinoxanthin and diatoxanthin, indicating that dimethylsulfate speciation is responding the same environmental stimuli as these pigments, namely light and nutrient stress. Our results support the hypothesis of an antioxidant function for DMS, DMSO, and DMSP. Additionally, evidence of recurring sub-ML populations of P. antarctica was found in otherwise diatom-dominated waters as indicated by both high Hex-FucoChl a and high DMS/PhChl a below the pycnocline, which could impact the biogeochemical sulfur cycle in the Ross Sea by exporting DMSO out of the ML. (Abstract ID 12477)

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LABORATORY TESTING OF DYNAMICAL SYSTEMS CHARACTERIZATIONS OF GEOPHYSICAL FLOWS

New dynamical systems methods of characterizing and quantifying small-scale/stochastic effects in geophysical flows as coherent structures have emerged in recent years (e.g. LCS, FTLE, FSLE, spatial variance in SSH and Vorticity PDF). These structures relate small-scale stochastic processes with larger mean flow characteristics such as jets and barriers to transport/mixing. However, it is difficult to both define these structures and diagnose their effect using the same, low-resolution set of remote sensing and mixing. However, it is difficult to both define these structures and diagnose their effect using the same, low-resolution set of remote sensing and mixing. Therefore, the study of the plasticity and evolution of these flow characteristics is the subject of this work.

We recently participated in an extensive field study of submesoscale features, primarily in the vicinity of Santa Catalina Island, California, known as SubEx I. This was a UCLA led effort involving many other collaborators. Extensive in-water, airborne, and satellite data were collected during the weeklong experiment. The NRL’s role was to provide airborne infrared and hyperspectral ocean color imagery along with in-water optical property and remote sensing reflectance measurements. While a large number of phenomena were sampled, this presentation focuses on a single ~280 m diameter core eddy sampled extensively. Fourteen aircraft overflights were made spanning approximately 1.5 hours. This provided a unique opportunity to document the temporal evolution as revealed by the infrared sea surface temperature imagery and the ocean color signatures. The IR imagery provided detailed insight into the motions of the eddy, including drift, rotation, and deformation. Those data will be compared with ocean color imagery. These remote sensing data will then be compared with the available in-water measurements. (Abstract ID 11514)

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WAVE DAMPING, VELOCITY, AND TURBULENCE PROFILES IN COASTAL VEGETATION

Laboratory observations of wave damping and velocity and turbulence profiles through coastal vegetation were obtained during the summer of 2010 at Oregon State University. The three, 10 m long vegetation beds consisted of emergent leaf burrush (Schoenoplectus pungens) with different stem densities. Wave damping was observed to be stronger in the bed with the highest density. The majority of the wave damping occurs in the first wave length into the bed and the damping changes based on the characteristics of the incoming waves. Velocity observations were also collected 3 m into the vegetation bed with an ADV at 50 Hz. The horizontal wave orbital velocity is smaller than that predicted with linear wave theory with a stronger depth decay. However, the vertical velocities are larger than that predicted by theory, indicative of the increased turbulence induced by the vegetation. The stern drag coefficient will also be computed and compared with local values of the Reynolds and Keeligan-Carpenter numbers. (Abstract ID 12502)

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IMAGING WAVES, FRONTS, AND MIXED LAYER DYNAMICS WITH PHASED ARRAY SONARS

Structures associated with surface mixing, internal waves, and fronts span scales from a few centimeters to kilometers. Further, the smaller scales react to the larger scales. Getting “in-context” measurements of the whole range of scales is important. Phased-array Doppler sonar (PADS) have been developed and used since the early 1990s in places ranging from the Equator to the Arctic, near shore to the deep sea, studying waves (internal and surface), fronts, rip currents, etc. The newest PADS spans ~100’ of aperture, resolving scales from 10’s of centimeters to several hundred meters, on a plane oriented either vertically or horizontally. Insights gained by resolving a continuum of scales over a 2D slice include putting the detailed small-scale measurements into the context of larger scale shears, tides, and diurnal mixed layer evolution, and, perhaps, resolving the back-effect on the larger scales. (Abstract ID 12319)

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NITRIFICATION IN UPWELLING INFLUENCED WATERS: A SPATIO-TEMPORAL STUDY IN MONTEREY BAY

The spatial and temporal dynamics of nitrification were investigated during two periods of upwelling in Monterey Bay. The first of the two-pronged approach was to conduct daily nitrification measurements at a near-shore mooring, in order to understand how shifts in water masses affect nutrient cycling at a single point in the bay. The second approach was to
study the spatial variations in nitrification at specific points within the upwelling regime: the plume of recently upwelled water; high productivity waters within the upwelling shadow, and points near and within the front. Nitrification produced 0.2 to 85 nmol of nitrate per liter per day; activity was highest when nitrate concentrations exceeded one micromolar in the euphotic zone. Thaumarchaeal 16S rRNA and amoA ranged from below detection to 10^{4} copies per ml/b. Following a twenty micromolar decline in nitrate at the base of the euphotic zone, a steep decrease in nitrification and the abundances of thaumarchaeal 16S rRNA and amoA were observed. Results of this study indicate nitrification and abundance of associated microbial assemblages to be highly variable during upwelling in coastal waters. (Abstract ID 11811)

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CLIMATE CHANGE IMPACTS ON THE MESOPELAGIC HABITAT AREA ABOVE OXYGEN MINIMUM ZONES

Previous studies have suggested that climate change will expand oxygen minimum zones and compress the mesopelagic habitat area that is vitally important to a wide array of organisms. Additionally, temperature increases in the mesopelagic zone will reduce tolerances for hypoxic conditions further decreasing the amount of habitat available to resident organisms. We combine physiological knowledge of oxygen tolerances with environmental predictions to understand the mechanisms driving changes in the geographically vast and ecologically important mesopelagic habitat. Using earth system models developed by NOAA/Geophysical Fluid Dynamics Laboratory, we project changes, between 2000 and 2100, to the mesopelagic zone that are quantified for oxygen thresholds ranging from 5 to 100 μmol/L. Temperature changes at the threshold depths are also considered. Preliminary analysis indicates that the mesopelagic zone thickness is predicted to expand in some areas and compress in others, and temperature is predicted to increase at tolerance thresholds worldwide. These predicted changes indicate that there will likely be impacts on the ability of organisms to utilize the mesopelagic habitat. (Abstract ID 11961)

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ATTACHED BACTERIA FLUX AS A MECHANISTIC CONTROL ON MESOPELAGIC PARTICLE REMINERALIZATION

Sinking organic particles are a rich food source for heterotrophic bacteria living in the mesopelagic zone of the ocean environment. Bacteria can only transport bits of organic molecules into the cell, and have adapted to overcome this constriction by producing extracellular enzymes to cleave bits of organic matter from larger molecules, effectively transferring an essential function to the external environment. As bacteria metabolize, organic matter is converted back into inorganic nutrients. In order to assess the mechanisms of remineralization, we have developed a model to look at production and activity of particle attached bacteria and extracellular enzymes in the context of marine ecosystems. The model includes six state variables: dissolved organic matter, particulate organic matter, free-living bacteria, particle-attached bacteria, extracellular enzyme, and hydrolysate. Model results indicate that bacterial populations, both free-living and attached, are not self-sustaining when constrained by measurements unless there is a flux of attached bacteria into the mesopelagic zone. Without sustained bacterial populations, remineralization ceases to occur disrupting biogeochemical nutrient cycles. (Abstract ID 11959)

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DIFFERENTIAL UTILIZATION OF IRON MINERALS BY MARINE PHYTOPLANKTON

Diatoms are important primary producers that play an essential role in controlling the flux of nutrients through the water column and the sequestration of atmospheric carbon. Despite their significant contribution to primary productivity, diatom growth is limited in 25% of the ocean, largely due to iron deficiency. Much of the iron in the oceans is found in insoluble mineral forms, the availability of which is essentially uncharacterized. Here we investigate the effect of iron mineralogy on the rate and magnitude of diatom growth. Two diatom species, the centric Thalassiosira pseudonana and the pennate Phaeodactylum tricornutum, were grown in separate culture experiments on a range of ferrous and ferric minerals characteristic of different oceanic iron sources. Iron mineral type strongly affected diatom growth, with more soluble ferrous silicates resulting in the production of much more biomass than insoluble ferric (hydr) oxides. P. tricornutum was more efficient than T. pseudonana at using less soluble Fe mineral forms, presumably because of more advanced biological uptake mechanisms. These results indicate that shifts in dust source mineralogy could affect oceanic primary production and community structure. (Abstract ID 112880)

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COSEE WEST – COLORADO COLLABORATIVE: USING SCIENTISTS’ RESEARCH INTEREST TO DRIVE TEACHER PROFESSIONAL DEVELOPMENT WORKSHOPS

COSEE West—Colorado Collaborative is a partnership that focuses on making ocean sciences relevant to inland audiences; it also exposes teachers from the interior Southwest and Southern California to ocean-climate-related issues faced by each. A different theme is chosen annually for a workshop series based on the research interests of scientists located within Colorado’s Front Range. Unique features of the partnership include the use of videoconferencing to broadcast two Saturday half-day workshops to COSEE West and rural Colorado teachers, and a teacher exchange program to attend each partner’s Summer Institute. Once a topic is chosen, scientists are recruited and trained to work with teachers. Evaluation of the scientist training indicates that participants find it valuable to help them prepare for their lectures and interactions with teachers. Post-workshop evaluations demonstrate that the scientists enjoy the workshop experience and would like to continue to work with this program. Teachers consistently rank the scientist lectures as a highlight of each workshop, which also includes activities, field trips, and discussions. (Abstract ID 9522)

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EXPLORING DUAL FORMULATION WEAK CONSTRAINT 4D-VAR DATA ASSIMILATION FOR THE CALIFORNIA CURRENT SYSTEM

We describe current research investigating weak constraint ocean data assimilation methods using the dual formulation 4-dimensional variational (4D-Var) systems of the Regional Ocean Modeling System (ROMS) applied to the California Current System (CCS). Model errors are a significant source of uncertainty in ocean forecasting. Weak constraint data assimilation offers a means for accounting for model errors by relaxing the commonly made assumption that the numerical forecast model is perfect and explicitly accounting for model errors in the assimilation. Since, in general, very little is known about the amplitude and structure of the model errors, practical implementation of the weak constraint approach offers a considerable challenge. A key difficulty is specification of the a priori model error covariances. Here we discuss attempts to identify and characterize the nature of the model errors in the ROMS CCS configuration. We present results from experiments designed to test various hypotheses about these errors, with the aim of informing the appropriate design of prior model error covariance structures and increasing understanding of the potential impact of model error on forecast skill and ocean predictability. (Abstract ID 9768)

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OPTIMALITY-BASED MODELING OF PLANKTON FOR USE IN EARTH-SYSTEM MODELING

Based on the assumption that natural selection tends to produce organisms optimally adapted to their environments, we consider optimality as a guiding concept for modeling aquatic micro-organisms (plankton). This is closely related to trait-based ecology, which regards traits and functionality as the result of the optimization inherent in natural selection. This approach is particularly well suited to plankton, because of their long evolutionary history. We review recent modeling studies of planktonic organisms that have been based on the assumption that adaptation of species and acclimation of organisms maximize growth rate, subject to trade-offs, and propose that the trade-offs serve as ‘hyper-parameterizations’ which constrain the adaptive response in such models. Compared to mechanistic models not formulated in terms of optimality, this approach has in some cases yielded simpler models with greater generality. We present examples of optimality-based models that can be incorporated into Earth-system
models, the expected benefits, and associated challenges. (Abstract ID 9316)

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**PREDICTING OCEAN CURRENTS FROM BIO-OPTICAL DATA USING THE 4DVAR-NCOM OCEAN ASSIMILATION SYSTEM**

A 4DVar ocean assimilation system has been constructed at NRL, which employs the weak-constraint, indirect, representor technique to assimilate oceanic observations with the Navy Coastal Ocean Model (NCOM). Up to this point, this assimilation system has been used to ingest observations of physical ocean prognostic variables (temperature, salinity, velocity and height). However, NCOM has the capability of easily incorporating additional tracer fields that are in addition to temperature and salinity. In this presentation, bio-optical properties (such as absorption) will be treated as tracer fields and experiment results (both twin-data and real) showing the assimilation of bio-optical observations into the NCOM-4DVAR system as an additional tracer field will be overviewed. Through the advection term in the tracer physics, information from the time series of bio-optical data will feed through the assimilation system and provide a correction to the velocity field. These experiments will be performed in the Monterey Bay region where a significant coupled modeling effort was undertaken and a large quantity of bio-optical data was collected in the summer of 2008 and the fall of 2010. (Abstract ID 11257)

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**IVAD – ENHANCING MARINE CLIMATE DATA RECORDS**

The status of a new initiative to embed observational bias adjustments, improved uncertainty estimations, and advanced quality control (QC) into the International Comprehensive Ocean-Atmosphere Data Set (ICAOES) will be described. ICAODS is the most complete and extensive archive available of historical in situ marine meteorological observations—presently at Release 2.5 covering 1662-2007. ICAODS is used by the marine climate community to develop long-term assessments of climate on a global scale; however, the range of expert-derived data corrections, adjustments, and QC created for these assessments are not readily available to all users. Developing the ICAODS value-added database (IVAD) will establish the infrastructure to capture adjustments and will provide the research community with easy access to observations and recommended adjustments. IVAD will (a) establish a database management system to support the development of value-added records and access service for users; and (b) implement modifications to an internationally recognized data archive format to expand the capabilities for record tracking, data provenance, and inclusion of new parameter adjustments and essential metadata. IVAD will support development of new marine climate data records and summary products. (Abstract ID 11916)

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**SAMOS – SUPPORTING MARINE ATMOSPHERE-OCEAN RESEARCH**

The authors will report on ongoing activities within the United States (U.S.) to expand routine acquisition, quality control, and distribution of underway surface marine observations collected by research vessels. The Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative, in partnership with the Rolling Deck to Repository (R2R) project, has recruited 29 research vessels to routinely provide navigational, meteorological, and oceanographic observations to a data assembly center (DAC) at the Florida State University. The DAC evaluates the quality of the observations, collects essential metadata, provides data quality feedback to vessel operators, and ensures the long-term data preservation at the U.S. National Oceanographic Data Center. A description of the SAMOS data stewardship protocols will be provided, including dynamic web tools that ensure users can select the highest quality observations. Vessels recruited to SAMOS collect a high concentration of data within the U.S. continental shelf and also frequently cruise well outside routine shipping lanes. The former provides the opportunity to evaluate ocean models in critical marine habitats while the latter support satellite calibration and retrieval algorithm development over remote oceans. (Abstract ID 11948)

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**AIR-SEA-WAVE COUPLED MODELING OF WESTERN NORTH PACIFIC TYPHOON FANAPI (SEPTEMBER 2010)**

Air-sea-wave interaction for Typhoon Fanapi (September 2010) is explored using the Naval Research Laboratory's state-of-the-art tropical cyclone version of the ESMF-based (Earth System Modeling Framework) Coupled Ocean and Atmospheric Prediction System (COAMPS-TC). COAMPS-TC is run in high resolution with 6-way coupling between the atmosphere, ocean (NCOM), and wave models (SWAN). Validation data for the simulation utilizes observations obtained during ITOP 2010, including float and drifter, mooring, satellite altimeter, and ship data. Recent upgrades in both atmospheric and wave physics parameterizations in COAMPS-TC have shown improvements in forecast track and intensity for Typhoon Fanapi and other tropical cyclones. Additionally, the forced and relaxation stages of the ocean response of Typhoon Fanapi is explored, including the formation of an intense cold wake. (Abstract ID 10531)

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**CARBON AND NITROGEN CYCLING IN IMPounded AND UNIMpounded RIVERS IN THE OHIO RIVER WATERSHED**

The Great Miami River and the East Fork River are both large tributaries to the Ohio River in the Mississippi headwaters. Each stream serves the local community in different ways. The Great Miami River runs alongside the Great Miami burned valley aquifer and therefore has a great impact on the groundwater that supplies many people in the area with their drinking water. The East Fork River is dammed and the reservoir is within a state park and serves many recreational purposes. We will present data on carbon and nitrogen cycling in both rivers, collecting during weekly sampling for analysis of dissolved CO2, N2O, and CH4, dissolved organic carbon and nutrients, and suspended sediments and organic matter in each of the rivers. This study emphasizes the geochemical changes that occur in a river when it is dammed. If the reservoir is shown to reduce carbon and nitrogen fluxes to the Mississippi River, this will positively impact coastal water quality. However, this environmental benefit may be offset by very high emissions of carbon dioxide, methane, and/or nitrous oxide. (Abstract ID 12668)

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**INTERACTION BETWEEN VERTICAL MIXING AND UV INHIBITION OF PHYTOPLANKTON PHOTOSYNTHEsis IN THE ROSS SEA POLynyA: A LARGE EDDY SIMULATION STUDY**

We have developed a bio-physical model that couples particle trajectories generated by a large eddy simulation (LES) model of Langmuir circulation with a photosynthesis model that includes the time-dependent response of phytoplankton to UV and PAR irradiance. Parameterized with physical and biological observations and experimental data from a research cruise in the Ross Sea Polynya (RSP) in the austral spring of 2005, the coupled model tracks the light history and photosynthesis of 1600 individual phytoplankton (cells/colonies) entrained in a simulated turbulent Langmuir flow. Compared to the 14C-estimated productivity profile (fixed-depth incubations) and predictions from photosynthesis models that do not include vertical mixing, we show, on average, less photoinhibition and more productivity near the surface, but less productivity at depth as cells damaged by UV and excess PAR near the surface are pumped down. Indeed, the model shows that for the light history, vertical mixing, and repair rates typical of the late-spring RSP bloom, the inhibitory effect of UV radiation exceeds the
penetration depth of UV wavelengths resulting in less productivity integrated over the depth of the surface mixed layer. (Abstract ID 12410)

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BATHYMETRIC ANALYSIS OF BULLS SCARP: A COMPLEX SHELF-EDGE PROMONTORY EXTENDING INTO THE GULF STREAM OFF CHARLESTON, SC
Bulls Scarp is a cape-like promontory located at the continental shelf edge, 100 km off the coast of Charleston, SC. Multibeam sonar data collected in July 2011 aboard the NOAA Ship Nancy Foster reveal a variety of complex bathymetric features. The 1.8 by 10.9 km survey area ranges in water depths from 40-210 m. Data were analyzed using CARIS HIPS and SIPS 7.1 software and reveal seafloor features including sand waves, current scour, depressions, a small canyon, multiple ledges and a possible iceberg plough mark—the southern-most feature of its kind identified in the western North Atlantic. This survey fills a gap along a 100 km section of the 50 m isobath of essential fish habitat within the South Atlantic Right. Such bathymetric information is contributing to the designation of possible essential fish habitat and marine protected areas. (Abstract ID 9953)

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TRACKING LARVAE IN THE STRAIT OF GORDO
Hake and herring are commercially important fish in the Strait of Georgia between Vancouver Island and mainland British Columbia. In this project larval particles of these species are tracked for up to four weeks after they hatch using two models: ROMS (Regional Ocean Modeling System) and LTRANS (Larval TRANsport model). LTRANS is an offline Lagrangian particle model that simulates larval behavior and runs with ROMS output files. Sensitivity analysis is performed on larval start position, start time, year and vertical swimming behavior. Aggregation and disaggregation regions are mapped based on the calculated larval distribution in the Strait. The importance of vertical behavior, and the connectivity between the northern and southern strait will be discussed. This study will help to identify important habitat in the Strait. (Abstract ID 12240)

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PROKARYOTIC ABUNDANCE, SALTINITY GRADIENTS, AND PRIMARY PRODUCTION IN THE NORTHERN GULF OF MEXICO
The Mississippi River strongly influences environmental conditions in the northern Gulf of Mexico, providing the majority of both sediment and freshwater input and helping shape water movement and salinity gradients throughout the Gulf. This in turn can stimulate primary production and determine the pico-prokaryotic community structure of areas influenced by this freshwater plume. Data for temperature, salinity, chlorophyll-a and pico-prokaryotes were collected both at the surface and at depth in oligotrophic open-Gulf waters, within the plume itself, and at other mid-salinity locations in the western Gulf. Overall pico-prokaryotic abundance had the strongest relationship ($r^2 = 0.72$) to salinity. Surface abundance patterns also closely resembled salinity gradients. Subsurface populations of pico-prokaryotes also closely related to changes in temperature. Despite regression analysis and surface mapping showing a fairly strong linear relationship with chlorophyll-a, pico-prokaryotes displayed a somewhat different pattern of abundance. The results of this study begin to explain the ecology of this class of organisms and further model development, sampling, and experimental manipulation of this population using these results is essential to our further understanding of pico-prokaryotes in marine environments. (Abstract ID 10565)

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RESONANT FORCING BY EASTERLY WAVES IN THE NORTHEASTERN TROPICAL PACIFIC
Easterly waves (EW) are ubiquitous low level atmospheric disturbances able to resonate and force strong inertial currents in the northeastern tropical Pacific. Using data from two Tropical Atmosphere Ocean/Eastern Pacific Investigation of Climate Processes buoys located along 95°W and a multi-parameterization one-dimensional turbulence model, we examine the impact of EW forcing on ocean mixing. In particular we determine how the loss of wind forced inertial kinetic energy (IKE) is partitioned between turbulent mixing dissipation and the radiation by near-inertial wave (NIW) for several EW forcing events. The momentum budget of the simulations shows that for near-resonant forcing events significant higher fractions of IKE are radiated away as NIWs, usually accounting for half of the IKE loss, while in non-resonant events IKE decays primarily through turbulent dissipation. Additional experiments with a 2D model produces NIWs that radiate similar amounts of energy and have vertical scales that are similar to recent high resolution Lowered Acoustic Doppler Current Profiler observations, suggesting that this region may be a hotspot for internal swell generation. The degree to which these waves fuel interior diapycnal mixing is investigated. (Abstract ID 12104)

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NEAR-FIELD DYNAMICS OF THE DEEPWATER HORIZON ACCIDENTAL BLOWOUT: CHEMICAL PARTITIONING, INTRUSION DYNAMICS, AND DISPERSANT EFFECTIVENESS
The vertical partitioning of hydrocarbons throughout the water column of oil and gas released from the Deepwater Horizon (DH) accident occurred within reacting multiphase plumes in the near field of the spill. Socolofsky et al. (GRL, 2011, 38, L09602) classify the DH plume as stratification dominated and predict the intrusion formation from empirical equations fit to laboratory results for non-reactive plumes. This presentation extends this work using a validated integral plume model for stratification-dominated plumes, incorporating dissolution, hydrate formation, and effect of dispersants via simulation of a broad range of initial oil droplet sizes. Results are compared to field observations, including analysis of backscatter signatures from nearby ADCPs. The model confirms that oil droplets above a few 100 microns in diameter rose rapidly to the surface to form a surface slick within a 2 km radius of the wellhead. Smaller droplets entered multiple subsurface intrusions, the most significant of which was between 800 and 1200 m depth. Dissolution was the primary mechanism for hydrocarbon mass to enter the deepwater intrusion layers, which contained most of the discharged gas. (Abstract ID 12195)

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DECadal VARIABILITY IN THE SEA LEVEL AND KUROSHIO TRANSPORT IN THE EAST CHINA SEA DETECTED BY A DATA ASSIMILATION OCEAN MODEL
Dally results of a data assimilation ocean model (COPE2) during period from 1 January 1993 to 31 December 2009 were used to investigate Pacific Decadal Oscillation (PDO) related signals in the sea level and Kuroshio transport in the East China Sea (ECS) and the influences of mesoscale eddies on them. Two periods with different responses of sea level and volume transport to the PDO index were identified. One is from 1993 to 2002 and the other from 2003 to 2009. In the first period, the sea level inside the ECS had a negative correlation with the PDO index, while the Kuroshio transport had a positive correlation with the PDO index. Such well-known relation, however, disappeared in the second period when the PDO-related signals were weakened and the mesoscale eddy activities in the Subtropical Countercurrent (STCC) zonal band were enhanced. The strengthened baroclinic instability associated with vertical shears in the Subtropical Countercurrent and North Equatorial Currents (STCC-NEC) system likely plays an important role to the enhanced mesoscale eddy activities, which in turn strongly affect the Kuroshio transport in the ECS. (Abstract ID 10175)

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THE RESPONSE OF THE AEGEAN AND LEVANTINE SEAS TO CHANGES OF THE AIR-SEA FLUXES
The interannual variability of the Aegean-Levantine seas (Eastern Mediterranean) air-sea interaction processes and the oceanic dynamical response are investigated with direct observations and long-term modeling experiments. Winter cruises and profiling float deployments in the region reveal a very complicated and sensitive circulation and water mass formation pattern, subject to intense atmospheric forcing of large variability. In order to investigate the effect of air-sea interaction, numerical simulations were performed over a period of forty years (1960-2000) by an eddy resolving model, based on the Princeton Ocean Model, and with a 6-hours atmospheric forcing provided by the ARPERA dataset (a dynamical downscaling of the ERA40 reanalysis). The simulations show significant variability of the stratification, circulation and water mass formation, consistent with available observations over the period. Air-sea interaction and lateral exchange with adjacent basins
are forcing this variability. While long term trends of heat and freshwater fluxes are important for pre-conditioning the changes in the stratification, it is extreme pulses of buoyancy fluxes and variability of the wind field that trigger events of abnormal circulation and water mass formation processes. (Abstract ID 9466)

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OBSERVATIONS OF AN INTENSE ANTICYCLONIC EDDY IN THE NORWEGIAN SEA

The deep pool of warm water in the Lofoten Basin of the Norwegian Sea is well-known, and for decades there has been suggestive evidence of a permanent anticyclonic eddy centered over the deepest spot in the basin. A survey of the region in the summer of 2010 revealed for the first time the presence of an intense eddy with a core of adiabatic water from below a shallow seasonal mixed layer > 1000 m. The ADCP data revealed a very well-defined axisymmetric velocity structure with a core relative vorticity of ~90° (f = local Coriolis parameter) and highest velocities (0.7-0.8 m/s) at about 18 km radius (at 600-700 m depth). The stability of the eddy was documented by RAFOS floats that remained in the eddy up to 300 days. A float at 900 m depth near the center exhibited an orbital period of 26.0 hours, only 2% longer than the pendulum day, for over 50 days. Whereas a float at the same depth and radius of 17 km, orbited with a period of less than 48 hrs for 100 days. (Abstract ID 12473)

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POTENTIAL PERTURBATION OF SEA SURFACE HEIGHTS IN THE INTERIOR OF THE PHILIPPINE ARCHIPELAGO BY ROSSBY WAVES

In the equatorial Pacific Ocean, the intrinsic manifestation of the El Niño-Southern Oscillation (ENSO) events are represented as the zonal displacement of the Pacific warm pool and the corresponding dynamical consequences. The oscillatory nature of the ENSO requires the displacement of the warm pool as a Kelvin wave that can excite westward propagating Rossby waves which should then be reflected at the western boundary as a Kelvin wave. The efficiency of wave reflection, however, is limited by the complex configuration of the western boundary (i.e. the gappy island configuration of the Philippine archipelago). The reflection coefficient of Rossby waves with periods of 180-250 days was previously held at ~30% thus suggesting the dissipation of a significant fraction of the wave energy. Here we study these ENSO-related Rossby waves as westward propagating sea surface height anomalies (SSHA) derived from merged satellite altimetry observations. We then use sea level observations from several coastal tide gauges to explore the possibility that part of the wave energy is dissipated as coastally trapped waves that perturb the interior of the Philippine archipelago. (Abstract ID 12529)

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CONSTRAINING METHANE DYNAMICS AT GAS HYDRATE SYSTEMS THROUGH LONG-TERM INTERDISCIPLINARY MONITORING AT CABLED OBSERVATORIES

Numerous geophysical and biogeochemical monitoring programs over the past decade have documented that gas hydrate systems are dynamic with properties changing over time scales of minutes to years. Three gas hydrate observatories have been established, two along the Cascadia margin and one in the Gulf of Mexico, to further understand how these deposits evolve through time, and their effect on the biosphere, ocean, and atmosphere. These observatories provide the opportunity to track how internal and external forces drive and manipulate gas hydrate and methane dynamics, and will place fundamental constraints on the methane fluxes into and out of the gas hydrate stability zone (GHSZ). The cabled observatories will also enable researchers to respond to events by adaptive sampling and to conduct real-time interrogative experiments. The next decade promises to be an exciting time for gas hydrate research, and cabled observatories will be the potential to revolutionize how this research is conducted. This talk will highlight recent advances on understanding methane dynamics below, and within, and above the GHSZ, and will explore how observatories could advance our understanding of gas hydrate systems. (Abstract ID 10524)

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DYNAMICS OF SOUTHWARD FLOW UNDER THE FLORIDA CURRENT AND COASTAL CURRENT IN THE STRAITS OF FLORIDA

Observational data, consisting of ADCP transects across the Southeast Florida shelf and long-term mooring observations, is used to study the presence of southward flow along the Florida coast. During summer, the southward flow has the form of a jet attached to the Florida shelf below the Florida Current. During winter, it weakens, migrates westward over the shelf, and eventually reaches the surface to form a coastal countercurrent. This annual migration may explain the seasonal pattern of the coastal circulation on the Southeast Florida shelf (mean transport northward during summer months and mean transport southward during winter months). In this work, we test the hypothesis that the southward flow is remotely driven by processes that impact the pressure-gradient field at the observation site. Our analysis includes a conceptual theoretical model and a previously reported case of a long surface wave that developed after Hurricane Floyd (1999) made landfall in North Carolina; this wave propagated southward as a coastal trapped wave, causing an abrupt reversal of the direction of flow on the Southeast Florida shelf. (Abstract ID 12521)

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INTERACTIONS BETWEEN TURBULENT MIXING AND CORAL REPRODUCTION

Broadcast spawning is the mechanism by which corals and many other marine animals reproduce. Male and female adults release gametes into the flow leaving the physics of turbulent stirring and mixing to bring sperm and egg close enough for fertilization to occur. Using fluorescent dyes as surrogates for gametes, we conducted laboratory experiments to study the effect of obstacle wakes and three-dimensional turbulence on the coalescence of egg and sperm. Our results show that structured stirring imparts strong spatial correlations on initially segregated gametes in both organized and chaotic flows. Of particular interest is the frequent occurrence of correlations between high-concentration sperm and egg filaments existing at intermediate timescales. These correlations increase in the downstream direction until being dispersed at longer timescales. The results provide a mechanism for understanding the success of broadcast spawning, as well as other mixing processes. This is likely to be significant in understanding the impacts of anthropogenic change on coral reef systems and our ability to preserve these systems. (Abstract ID 12245)

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CONSTRAINING THE RATES OF N FIXATION AND DENITRIFICATION IN A GLOBAL OCEAN MODEL USING OCEANIC N:P RATIOS

Fixed-N (NO3, NO2, NH4) is one of the major limiting nutrients throughout the ocean preventing production and the biological sequestration of atmospheric CO2. Despite its importance, global rates of the main source (N fixation) and sink (denitrification/anammox) processes remain uncertain. Previous estimates of the oceanic fixed-N budget range from a significant deficit (~400 Tg N yr^-1) to a nearly balanced budget. In this study, we compare different experiments in a coupled global ocean circulation-biogeochemical model to observational N:P ratios to better constrain the rates of N fixation and denitrification. Sensitivity experiments with constant CNP stoichiometry (i.e., “Redfield” ecosystems) is compared to experiments where dynamic elemental stoichiometry is considered including a higher N:P ratio for N-fixers and faster recycling of DOP relative to DON through the microbial loop. The model that best compares to observational N:P ratios includes dynamic elemental stoichiometry and has N fixation, water column denitrification, and benthic denitrification rates of about 200, 80, and 120 Tg N yr^-1, respectively. Although uncertainties still exist, our model-data comparison suggests that the preindustrial fixed-N budget was likely close to being in balance. (Abstract ID 9866)

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RADIOIODINE (I-131) AS A TRACER OF ESTUARINE TRANSPORT PROCESSES

Medically derived I-131 is an emerging radiotracer of physical and biogeochemical processes in urban rivers and estuaries worldwide. A gamma emitter with an 8-day half-life, dissolved I-131 is discharged in wastewater effluent from outfalls to aquatic waters. In the Delaware Estuary we are using I-131 to investigate particle transport phenomena associated with seasonal riverflow and estuarine circulation. Repeat shipboard sampling along the estuary in 2010-2011 revealed that I-131 discharged to the tidal freshwater segment is cycled between the water column and bed on time scales of days, and that the dissolved phase does not escape the lower estuary to coastal waters before decaying to extinction. Seaward transport of particulate I-131 appears to be limited by landward density-driven flow and tidal pumping as it is generally undetectable beyond the turbidity maximum zone, even under extreme river discharge as was the case following Hurricane Irene in 2011. These results demonstrate that the estuary has an enormous capacity to trap sediment and particle-reactive constituents derived from the watershed, and provide new insight on I-131 as a source-specific radiotracer of estuarine transport processes. (Abstract ID 10339)

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LOGNORMAL 4-DIMENSIONAL VARIATIONAL ASSIMILATION FOR BIOGEOCHEMICAL VARIABLES

A data assimilation method appropriate for biogeochemical models is discussed and implemented. This method assumes that variables and their errors are lognormally distributed and thereby ensures positive-definite state variables following data assimilation. We implement and investigate the effect of this lognormal assumption within the framework of 4-Dimensional Variational Assimilation (4DVAR). In simple 0-dimensional and 1-dimensional systems, this approach effectively reduces the observation-model misfits. However, in more realistic 3-dimensional biogeochemical problems, the large scale of the state vector and non-quadratic nature of the cost function create practical challenges in the minimization. We solve these by imposing a quadratic approximation to the cost function which allows minimization in a single iteration. Our approximation is evaluated by comparing its performance with that of the non-quadratic cost function using the 3-variable nutrient-phytoplankton-zooplankton (NPZ) model and a second, more complicated NPZD model. Outcomes from the two cost functions are comparable, showing misfit reductions of the same order of magnitude. As desired, assimilated solutions not only reduce misfit but also preserve the positive-definite property of ecosystem variables. (Abstract ID 9742)

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RESEARCH OF HYDRODYNAMICS AND TWO LAYER CIRCULATION IN THE NAKDONG RIVER, SOUTH KOREA

After building the dyke in Nak-Dong River estuary, mixing of freshwater inflow to ocean and seawater to upstream is controlled by operating sea gate. When the sea gate was opened, fresh water rapidly met seawater and stratification type showed salt-wedge. To research of hydrodynamic and two layer circulation in the Nak-Dong River estuary, we investigated velocity and salinity using ADCP and CTD during one semidiurnal tidal cycle at three channels. Velocity is showed generally 0-0.05m/s from estuary dyke to 3.5 km seaward at the channel 1. Low salinity(0 psuu) trap near the surface at the southward point from estuary dyke trap but high salinity water is maintained consistently at the bottom. Residual velocity is not changed during tidal cycle from estuary dyke to 3.5 km seaward. Ebb-residual current peculiarities over 0.5m/s in all observation area at the channel 2. Channel 3 showed two-layered flow. Surface residual velocity is nearly 0.5m/s to seaward and bottom layer residual velocity is nearly 0.5-0.5 m/s to landward. (Abstract ID 12835)

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DEEP OCEAN WARMING AND ITS SENSITIVITY TO SURFACE HEAT FLUX

In a recent study, Song and Colberg [JGR, 2011] have shown that neither the global mean nor the regional trends of altimetry sea-level rise (SLR) can be explained by the upper-ocean steric height plus ocean mass trends from the Gravity Recovery and Climate Experiment (GRACE). Outcomes from the two cost functions are comparable, showing misfit reductions of the same order of magnitude. As desired, assimilated solutions not only reduce misfit but also preserve the positive-definite property of ecosystem variables. (Abstract ID 9742)
being deployed off Washington and Oregon for the next 25 years. This system will include various sensors, including echosounders to detect zooplankton and fish, broadband hydrophone clusters for detecting various marine animals in biologically relevant areas, and low-frequency line arrays to study vocalizing baleen whales across the Juan de Fuca plate region. These capabilities will enable monitoring of acoustically active individuals engaged in feeding, migration, socializing, and other aspects of natural history. In combination with other tools (e.g., animal tags, remote sensors) these rich data streams will be integrated to monitor ecosystems and the physical and biological forces driving their composition. The use of this powerful cabled monitoring network to synoptically observe and acoustically monitor marine life provides an unprecedented opportunity to systematically study this important area and the influences of climate variability and human activities on marine life. It also demonstrates the vast benefits for understanding the ocean with emerging technologies and cross-disciplinary collaboration. (Abstract ID 12435)

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WATER COLUMN NITROGEN DYNAMICS IN THE EASTERN CHUKCHI SEA
Spatial variability of ammonium (NH$_4^+$) regeneration and potential uptake rates were measured at four stations in the Eastern Chukchi Sea region as part of the Chukchi Sea Offshore Monitoring in Drilling Area (Chemical and Benthos) project. Vertical distributions of nitrification, NH$_4^+$ regeneration and uptake rates were determined by isotope dilution experiments, with added $^{15}$NH$_4^+$ or $^{15}$NO$_3^-$, on surface, mid-water, and bottom water samples under natural light and dark conditions during a late summer cruise in 2010. Ammonium regeneration (0.03 to 0.31 µmoles/h) and potential uptake rates (0.01 to 0.30 µmoles/h) varied geographically and with water depth within a similar range of values. The balance between regeneration and uptake was net negative at station 103 (65.72N, -168.96W) during both light and dark conditions. At the other stations, NH$_4^+$ cycling was net positive under light and net negative at mid-depths under dark conditions. Regeneration was insufficient to account for uptake rates at the southern station. In contrast, regeneration rates were comparable to uptake rates, and in some places, regeneration was sufficient to generate a net positive N cycling at the other stations. Results provide numbers for estimates of regenerated primary productivity through the water column and rate values applicable for regional N budgets. (Abstract ID 12101)

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INFLUENCES OF PRECIPITATION ON WATER MASS TRANSFORMATION AND MERIDIONAL OVERTURNING IN MARGINAL SEAS
The influences of precipitation on the properties of water mass transformation and the strength of the meridional overturning circulation in marginal seas are studied using theoretical and idealized numerical models. Nondimensional equations are developed for the temperature and salinity anomalies of deep convective water masses, making explicit their dependence on both topography as well as on the strength of atmospheric forcing. In addition to the properties of the convective water, the theory also predicts the magnitude of precipitation required to shut down deep convection and switch the circulation into the haline mode. High resolution numerical model calculations compare well with the theory for the properties of the convective water mass, the strength of the meridional overturning circulation, and also for the shutdown of deep convection. The model also shows that for precipitation levels that exceed this critical threshold, the circulation remains in a thermally direct mode even in the absence of deep convection. (Abstract ID 9703)

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LINKING CHROMOPHORIC DISSOLVED ORGANIC MATTER CHARACTERISTICS TO ECOSYSTEM BIOGEOCHEMISTRY
Historically, riverine dissolved organic matter (DOM) has been considered to be derived from highly degraded soil organic matter, thus its efficient removal in the marine environment presented a paradox. Utilizing riverine examples from the Arctic to the Tropics we examine relationships between chromophoric DOM (CDOM) and lignin (a biomarker for vascular plant derived DOM) and the reactivity of this material in the environment. In combination with other tools (e.g., animal tags, remote sensors) these rich data streams will be integrated to monitor ecosystems and the physical and biological forces driving their composition. The use of this powerful cabled monitoring network to synoptically observe and acoustically monitor marine life provides an unprecedented opportunity to systematically study this important area and the influences of climate variability and human activities on marine life. It also demonstrates the vast benefits for understanding the ocean with emerging technologies and cross-disciplinary collaboration. (Abstract ID 12435)

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AN INVESTIGATION INTO THE DISTRIBUTION OF HYDROCARBONS IN SEDIMENTS AND THE SUBSURFACE WATER COLUMN AFTER THE 2010 EXPLOSION OF THE MACONDO 252 OIL RIG
The explosion of the Deepwater Horizon oil platform on April 20, 2010 resulted in the third largest oil spill in history: We investigated the distribution and chemical composition of hydrocarbons surrounding the spill site. A complete set of hydrocarbon data were acquired from the NOAA and BP using data from 16 research missions. Several hydrocarbon plumes were identified including near-surface plumes (0.5 to 200m), a small mid-depth plume (800-880m), and a large deepwater plume between approximately 1000 and 1400m below surface. The vertical, lateral, and temporal distribution of hydrocarbons within the water column was investigated, and we found significant differences in the chemical composition of the plumes. The distribution of hydrocarbons remaining in sediments between August and October, 2010 was investigated. All sediment samples with total polycyclic aromatic hydrocarbons (PAHs) concentrations exceeding chronic toxicity limits were located less than 3.2km from the wellhead. All sediment samples with concentrations above the mean pre-spill PAH levels (>600µg/kg), based on 2006 and 2009 survey’s by the Minerals Management Service in the Deep Gulf of Mexico, were found within 12km of the wellhead. (Abstract ID 12211)

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SEASONAL FORECASTING TO SUPPORT THE MANAGEMENT OF WILD FISHERIES AND AQUACULTURE IN AUSTRALIA
Seasonal forecasts from dynamical ocean-atmosphere models of high risk conditions in marine ecosystems can be very useful tools for managers, allowing for proactive management responses. The Australian Bureau of Meteorology’s seasonal prediction system POAMA currently produces operational real-time forecasts of sea surface temperatures for Australia. These forecasts are used in the management of the quota-managed southern bluefin tuna (SBT) in the eastern Australian long-line fishery. Ocean forecasts are combined with a statistical habitat model to produce experimental habitat maps for authorities to use in regulating fishing effort. Similarly, POAMA forecasts around Tasmania, Australia, are utilised by managers of salmon aquaculture farms, with information used to manage feed composition, stocking densities and freshwater bathing, all of which enhance farm production in a variable climate. Advance warning of suboptimal conditions allows for the early implementation of strategies to minimise impacts and helps maintain industry profitability in an uncertain environment. Improved management of marine resources, with the assistance of such forecast tools, is also likely to enhance their resilience and adaptive capacity under climate change. (Abstract ID 9407)

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ANTARCTIC BOTTOM WATER PRODUCTION IN THE ROSS SEA: MODEL SENSITIVITY STUDIES

Production rate and properties of Antarctic Bottom Water (AABW) are sensitive to processes acting on small space and time scales that are poorly resolved or ignored by global climate models. We use a regional ocean circulation model for the Ross Sea to investigate sensitivity of AABW production to high-resolution winds, tides, precipitation, sea ice, and sea-ice thermodynamics. Their relative importance is quantified by changes in production of High Salinity Shelf Water (HSSW) and Ice Shelf Water (ISW), and properties and fluxes of AABW outflows from major troughs. The largest effect results from using winds from a regional atmospheric model rather than a coarser-resolution global reanalysis product. An increase in HSSW production is attributed specifically to more realistic winds in the western shelf region including Terra Nova Bay. Tides also have a significant effect on AABW production by increasing mixing, enhancing ice shelf basal melting beneath the Ross Ice Shelf (hence, producing more ISW), and enhancing the transfer of warm water onto the shelf. These results indicate that models lacking these small-scale processes require parameterizations to accurately represent AABW production. (Abstract ID 10023)

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WARM, PCO2 ENRICHED WATERS UPWELL IN DRAKE PASSAGE DURING LA NINA BUT NOT DURING POSITIVE SAM EVENTS

Southern Ocean properties and circulation are known to respond to large-scale climate modes such as Southern Annular Mode (SAM) and ENSO. However there remains conflicting evidence as to how the response differs during individual phases of strong SAM or ENSO events. This study examines variability associated with these climate modes using a decadal-long time series of observed temperature profiles and surface pCO2 from a year-round, repeat high-resolution transect in Drake Passage. Composites of positive SAM and La Nina are both characterized by strengthening westerly winds, an anomalous poleward shift in the Polar Front (PF) and warming of the Antarctic Surface Waters (AASW) south of the PF. In addition, during La Nina, inventory of AASW decreases, its depth extent shoals and pCO2 increases. Corresponding composites of wind-driven Ekman pumping suggest significant upwelling occurs south of the PF during La Nina that draws the warmer and enriched pCO2 waters from below. In contrast, no significant changes in AASW depth, upwelling or surface layer pCO2 occur during positive SAM events rather, warming of the AASW occurs due to increased air-sea heat fluxes. (Abstract ID 10240)

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SURFZONE VERTICAL VORTICITY AT IMPERIAL BEACH DERIVED FROM GPS-TRACKED DRIFTERS

GPS-tracked surfzone drifters are used to investigate surfzone vertical vorticity (associated with horizontal currents). During Fall the 2009 experiment at Imperial Beach, CA, drifters were deployed on five days with more than 30 released on four days. In addition, six instrumented tripods were deployed on a cross-shore transect spanning the surfzone that measured waves and currents. Drifters were deployed in a variety of conditions with significant wave heights between 0.6 < H < 1.0 m, tidal swings up to 2 m, and mean alongshore currents between 0 -- 0.5 m/s. Owing to the relatively large number of drifters and long deployments (as long as 2 hrs), drifter statistics are improved relative to previous surfzone deployments. When there were strong alongshore currents, releases were relatively short, up to 1 hr in length, and drifters traveled approximately 1000 m in the alongshore. When the alongshore current was weak, releases were relatively long, up to 2 hrs in length, and drifter separations were up to 1000 m approximately one hour after release. The drifter observations suggest alongshore inhomogeneity in the mean flow, perhaps related to modeled alongshore variations in the incident wave field. Surfzone vertical vorticity is mapped, and two-particle dispersion statistics indicative of surfzone vertical vorticity are calculated. (Abstract ID 9994)

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OBSERVING VERTICAL MIXING BY SHOALING INTERNAL WAVES IN THE NEARSHORE

On the south shore of Oahu, Mamala Bay experiences consistent internal wave action and shoaling. Two month long field experiments in the springs of 2010 and 2011 observed cool pulses and bores at the 23m site of the UH Kilo Nalu Nearshore Observatory. Shoaling internal waves in Mamala Bay were observed generating sudden drops in temperature and increases in salinity. Rapid fluctuations in density in the trailing edge of these bores suggest turbulent fluctuations were occurring. This supports the idea that internal tides are a mechanism for
mixing of offshore water with nearshore environments. A tower of velocimeters and fast sampling CTDs directly measured the turbulent characteristics including buoyancy flux at different elevations in the bottom 8 meters of the water column. Further analysis acts to characterize the behavior of this stratified turbulence and compare it with existing models for mixing in a stratified fluid. (Abstract ID 11060)

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LOCAL ENERGY LOSS NEAR A SILL DUE TO HYDRAULIC JUMPS CONTROLLED BY STRATIFICATION.

Direct measurements of energy dissipation are performed with a microstructure drop sonde over the Drøbak Sill in the Oslofjord in the southeastern parts of Norway. The measurements reveal areas of highly enhanced turbulent kinetic energy dissipation rates (~10−3 W kg−1) when tidal flow of up to 8 m/s pass over the 20 m deep sill and generate internal hydraulic jumps. During one of two tidal cycles, hydraulic jumps are suppressed on the ocean side of the sill because of larger densities outside the sill than inside. Mixing in the fjord may cause a mean circulation that facilitates hydraulic jump generation on the inside relative to the outside. However, long-term ADCP measurements on the sill reveal that hydraulic jumps are also suppressed occasionally on the inside, probably due to fluctuations in the ocean side density field. Even though the local energy loss is large, a substantial fraction of the barotropic tidal energy loss radiates away as internal tides. (Abstract ID 10965)

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Southern Patagonia and Tierra del Fuego are well suited for reconstructing Holocene westernly wind variability in the Southern Hemisphere. The westerly winds influence the amount and distribution of precipitation in southern South America and on a larger scale the global carbon cycle through their impact on air-sea gas exchange in the Southern Ocean. Here we present a detailed Early Holocene paleoclimatic reconstruction derived from a sediment core collected in Lago Fagnano, a large open-basin, E-W trending lake in southern Tierra del Fuego. Our sediment core can be divided into two intervals based on the dominant sediment facies. The younger interval (since ~6000 cal yr BP) primarily contains hemipelagic sediments with well-defined laminations. We focus on the older interval, which is dominated by mass transport deposits such as turbidites and debrites. The sediment core was analyzed for stable isotope (δ13C & δ15N) and bulk C/N ratios in order to understand sediment provenance. From this we infer the sediment source and the climatic trigger mechanisms of the Lago Fagnano mass transport deposits. (Abstract ID 10718)

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AN OVERVIEW OF ICE-OCEAN-ECOSYSTEM INTERACTIONS AND CHANGES IN THE WESTERN ANTARCTIC OCEAN

An overview summary will be presented that highlights our current knowledge of ice-ocean-ecosystems interactions and changes in the western Antarctic sector of the Southern Ocean. Particular topics will include the following: (1) recent results from ship-based surveys, moorings, autonomous underwater vehicles and models deployed in the Bellingshausen and Amundsen Sea sectors that are beginning to resolve the eddies on the continental shelves, the role of bathymetry in directing flow and fronts on the continental shelf, and the sub-surface circulation in, under and out of ice shelf cavities; (2) recent field campaigns focused on better defining micronutrient sources and the ocean circulation mechanisms affecting nutrient variability and biological productivity; and (3) new observations and modeling results highlighting changes in species distributions, food web structures and carbon pathways. Indeed, this overview summary can only present the tip of the iceberg regarding all the recent findings relevant to this session. No doubt, in the talks that follow there is bound to be some excitement, surprises and eureka's! (Abstract ID 11546)

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PALEOCLIMATE IMPLICATIONS OF AN ISOTOPIC ANALYSIS OF EARLY HOLOCENE SEDIMENTS FROM LAGO FAGNANO, TIERRA DEL FUEGO

The Lago Fagnano mass transport deposits such as turbidites and debrites. The sediment core was analyzed for stable isotope (δ13C & δ15N) and bulk C/N ratios in order to understand sediment provenance. From this we infer the sediment source and the climatic trigger mechanisms of the Lago Fagnano mass transport deposits. (Abstract ID 10718)

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FRACTAL DIMENSIONS, CLAY MINERAL AGGREGATES, OPTICAL MODELS OF SUSPENDED SEDIMENT, AND THEIR APPLICATIONS

A two-component suspended mineral model: primary and aggregated primary mineral particles, described by an extended gamma distribution, generates a particle size distribution. Mie calculations are performed on the primary mineral particles. Latimer's coated sphere optical model of an aggregate and the Kleefeld-Hill fractal aggregate model of a clay mineral aggregate are used for modified Mie calculations for the aggregates. The result is a theoretical calculation of the mineral mass-specific scattering cross section. The theory and models predict 1) The negative spectral slope of the mass-specific scattering cross section of suspended minerals, 2) the “flattening” of the spectral slope for the mass-specific scattering cross section, and 3) the positive slope of the mass-specific scattering cross section. These observations have all been reported for the northern Gulf of Mexico, USA and the Irish Sea, UK. From these results we can invert, from field measurements of the mass-specific scattering cross section, the processes taking place that control the fate of suspended minerals, coagulation, aggregation, sedimentation, and resuspension. Acknowledgement: This work performed at Naval Research Lab, Sverdrup Center for Program Element 0601153N (Abstract ID 9341)

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THE OPTICAL PROPERTIES OF GREENLANDIC COASTAL WATERS: MODELLING LIGHT PENETRATION IN A CHANGING CLIMATE

Greenlandic fjords are very productive and pristine ecosystems, which the local population is
both intrinsically linked to and dependent on through heritage, industrial fisheries, and tourism. The availability and spectral quality of light are key parameters controlling the productivity of these waters. Although solar elevation and sea ice cover play an important role, during the summer months light is also regulated by water constituents such as dissolved and particulate organic matter, phytoplankton and suspended sediments. The relative importance of each of these constituents varies depending on the influence of shelf water entering the fjords, extent of glacial ice melt and the size and vertical distribution of the phytoplankton biomass. In this study the data from two contrasting sites are compared: Young Sound, a fjord in Southeast Greenland where strong tides ensure a regular supply of warm shelf water which melt glacial ice before it can leave the fjord. (Abstract ID 10913)

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DIVERSITY AND ACTIVITY OF ARCHAEA AND BACTERIA ASSOCIATED WITH AUTHIGENIC CARBONATES AT DEEP-SEA METHANE SEEPS

Anaerobic oxidation of methane at methane seeps by the syntrophic aggregates of sulfate reducing bacteria and methanotrophic archaea impacts the cycling of carbon through the chemosynthetic food web and through carbonate generation. We explored the diversity and activity of carbonate-associated microbial communities from methane seeps at Hydrate Ridge, OR, USA and off of Costa Rica through stable isotope tracer experiments using molecular fingerprinting and 16S rRNA clone libraries, and FISH-nanoSIMS. Consortia of actively metabolizing archaea and bacteria were identified in week-long and months-long incubations showing incorporation of CO2, CH4, and NH4. Carbonate-associated microbial communities at inactive sites showed lower biomass, but higher bacterial diversity compared to active site communities, while methanotrophic archaea (e.g. ANME-1, ANME-2a, -2b, and -2c) dominated the active carbonate microbial communities. Exploring co-occurrence among bacterial and archaeal OTUs, we found potential interactions among the methanotrophic archaea and sulfate-reducing bacteria and members of the microbial community not yet associated with anaerobic methane oxidation, including Actinobacteria and ANME-2c, and ANME-1 and Marine Crenarchaeota Group II. (Abstract ID 12831)

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THE FIRST IN SITU HIGH RESOLUTION SST OBSERVATIONS IN THE ARCTIC OCEAN

Summer arctic sea ice extent has been decreasing in recent years, resulting in an unprecedented warming. Direct observations of this ocean warming are rare, causing reliance from hydrographic surveys by icebreaker CTD, and from satellite SST sensors. Nearly all Arctic ocean buoys are designed for deployment on thick ice floes, not in the seasonally ice free zones (SIZs) which warm in the summer. To address this need, a new UpTempO (= Upper Temperature of the polar Seas) buoy project was initiated in 2009. The buoy is adapted from the widely used SVP (Surface Velocity Program) buoy, but instead of a subsurface drogues, a 60 meter long string of 12 unevenly spaced thermistors hangs down from the floating surface hull. The uppermost thermistor is at 2.5 meters depth; all sensors report hourly. In 2011, funding from NSF and NOAA allowed the deployment of 10 buoys in the Canada Basin. We will discuss early results from these buoys, including (i) a very warm (~10 degC) and thin (~10 m) surface layer and (ii) a remarkable diurnal signal of several degrees both in open water and under ice floes. Future plans for UpTempO include a NASA-sponsored campaign with autonomous SST-sensing aircraft overflying an UpTempO buoy. (Abstract ID 10808)

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TROPHIC SPECTRA REVEAL COMMUNITY STRUCTURE IN A TERRESTRIAL SYSTEM

Recent advances in compound-specific isotopic ratio analysis (CSI-AA) have allowed researchers to measure trophic fractionation of 15N in specific amino acids, namely glutamic acid and phenylalanine. These amino acids have proven useful in food web studies because of the wide and consistent disparity in their respective fractionation tendencies. This discrimination at the molecular level allows glutamic acid to reflect the trophic position of a consumer, while phenylalanine represents the background signature of 15N in the plants at the base of the food web. In controlled feeding trials, we used CSI-AA to confirm the accuracy of the Chikaraishi C3-plant equation for trophic levels 1-4. We then collected wild arthropods from an old-field site, and each specimen was analyzed using both the Chikaraishi method and the conventional bulk-15N method. Regression analysis characterized the relationship between the output of these two methods, allowing us to convert bulk-15N values into trophic level estimates (among the many specimens not analyzed via CSI-AA). This approach facilitated greater sample sizes and thereby permitted investigations of population- (trophic spectra) and community-scale parameters. (Abstract ID 11515)

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COMPARATIVE STUDY OF THE BIOGEOGRAPHY AND LIFE HISTORY OF NORTH ATLANTIC COPEPODS

In this modeling study we address two questions: (1) factors that control for different spatio-temporal patterns of warm- and cold-water copepod species in the Gulf of Maine, and (2) what controls the observed seasonality differences of copepod species between the Gulf of Maine and the North Sea. The biogeographical boundaries of the cold water species Pseudocalanus spp. and the warm water species Centropages typicus overlap in these two shelf areas in the northwestern and northeastern Atlantic respectively, but their life-history characteristics differ significantly. A population model coupled to a three-dimensional ecosystem model including species-specific processes and parameters were used in this study. Our analysis focuses on the relative contribution of feeding strategies, predation control and advection on differences. We also tested whether the model with the same parameters for C. typicus in the Gulf of Maine reproduces the observed patterns, which we applied to the North Sea. Differences in the results can reflect site-specific adaptations to the ecosystem and suggest possible missing control mechanisms that need to be included in the model. (Abstract ID 12830)

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THE CALIFORNIA CURRENT LARGE MARINE ECOSYSTEMS INTEGRATED ECOSYSTEM ASSESSMENT (CCIEA): PRESENT STATUS AND NEXT STEPS

While there is consensus that ecosystem-based management is necessary for managing human impacts in marine ecosystems, we have not integrated multiple impacts across diverse ocean-use sectors or fully evaluated the ecosystem consequences of policy options before they are implemented. Coastal and Marine Spatial Planning requires an integrated, spatially explicit assessment of ecosystem status and forecasting changes in the delivery of ecosystem services under different management scenarios. To address the needs for an analysis of the cumulative effects of ocean use and an evaluation of policy options, we are developing an IEA of the California Current LME that: (1) identifies key attributes of ecosystem structure and function as well as indicators of the effects of human activities on marine ecosystems; (2) summarizes the status and trends of key ecosystem attributes and pressures on those attributes; (3) quantifies natural or human pressures on the key attributes; and (4) evaluates how alternative management strategies and spatial plans influence ocean-use sectors. We discuss the IEA’s status in the context of trade-offs among ecosystem objectives and spatial plans that potentially reduce conflicts among ocean-use sectors. (Abstract ID 11391)

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Sverdrup Award Lecture - LONG-TERM CHANGEs IN THE ROLE OF ZOOPLANKTON IN OCEAN BIOGEOCHEMICAL PROCESSES

Zooplankton play an integral role in the cycling of elements in the sea through their grazing and metabolism. Zooplankton time series reflecting climate or other environmentally-influenced changes in zooplankton biomass and community structure can be used to determine associated changes in biogeochemical cycling, and to predict future changes. Analysis of time series from diverse environments, including the Bermuda Atlantic Time-series Study and the Palmer Antarctica Long-Term Ecological Research program, indicates long-term changes in zooplankton export processes, such as fecal pellet production and diel vertical migration. These changes can have significant effects on the magnitude of the biological pump, which regulates in part atmospheric carbon dioxide and hence can impact climate. Changes in zooplankton community structure also affects the quantity and quality of dissolved inorganic and organic matter they produce, which in turn can affect microbial communities. The role of some major taxa (common to both ecosystems is the significance of gelatinous zooplankton—salp blooms, to export), and process rates in major habitats (mesopelagic zone) are still needed to better incorporate the role of zooplankton into predictive biogeochemical models. (Abstract ID 12903)
The formation of North Atlantic Deep Water (NADW) is a unique fast track for transporting anthropogenic carbon (Cant) into the ocean's interior, making the deep waters in the Atlantic rich in Cant. A 15 year time series of CFC data from 1994 to 2009 from the subpolar North Atlantic is used to calculate the concentrations of Cant by means of the TTD method. The longterm trend over this period is a decrease in Cant storage, which is directly linked to the variability of the formation of Upper Labrador Sea Water. This trend is interrupted by the deep convection event in early 2008, which lead to an Cant uptake of Labrador Sea Water by at least 0.2 Pg carbon. The contributions of the overflow water masses to the Cant reservoir show only small interannual variability. (Abstract ID 10180)

A STUDY OF STRATIFICATION EFFECTS ON MID-SHELF WATERS OFF DELMARVA

The Mid-Atlantic Bight (MAB) shelf waters are one of the most productive in the world (Yoder et al., 2002). However, the mid-shelf region of the MAB has some of the most stratified continental shelf waters and encompasses the location of the 1976 Anoxic Episode, where intense stratification was an important element of the synergism resulting in anoxia and extensive fish/shelfish mortalities (Campbell & O'Reilly, 1988). In this work we analyzed CTD and nutrient data sampled off Delmarva which cut across the mid-shelf region of the MAB. The bi-monthly data was collected during 2005-2007 by NASA Wallop scientists. The seasonal evolution of the stratification in the mid-shelf region will be discussed. The effects of the seasonal stratification on the nutrient, oxygen and chlorophyll fields will be demonstrated. The goal of this work will be to identify areas of stratification and relate to possible low oxygen conditions in the region. Another goal of this undergraduate research is to develop skills in oceanographic data analysis, interpretation and presentation. (Abstract ID 9607)

INTERANNUAL VARIABILITY AND TRENDS IN OXYGEN IN THE MODE AND INTERMEDIATE WATER OF THE SUBPOLAR NORTH ATLANTIC OCEAN

A recent study based on 50 years of oxygen observations in the North Atlantic has revealed a strong decrease in the oxygen concentration in the Subpolar Mode Water (SPMW) and Intermediate Water (IW). These changes were partly determined by changes in circulation, and a decrease in the ventilation, and partly by changes in solubility. This study showed that superimposed on this long-term trends was a substantial amount of interannual to decadal variability that was not well resolved by the available data. The large number of repeat cruises undertaken along the A2 (43°-48°N, 1932-2002) and the 48N lines (2003-2011) provides us with the opportunity to investigate this interannual variability of oxygen with nearly annual resolution needed to understand the main drivers for this variability. Our preliminary results show that the oxygen concentration in the SPMW and IW varied primarily in response to changes in the circulation associated with the contraction of the subpolar gyre related to the NAO index phase. But also changes in the buoyancy forcing and solubility matter, while the changes in export production appear to be relatively unimportant. (Abstract ID 11615)

INTERANNUAL VARIABILITY OF UPPER-OCEAN HEAT CONTENT IN DRAKE PASSAGE

In order to understand the Southern Ocean heat budget, it is necessary to identify the response of the ocean to air-sea heat fluxes. Reanalysis heat flux products and data from the high resolution XBT/XCTD sampling program in Drake Passage are used to establish a first-order budget for the upper ocean. An annual cycle in upper-ocean heat content is in good agreement with the annual cycle in heat flux forcing, which explains -24% of the variance in heat content above 400 m depth north of the Polar Front and -63% of the variance in heat content south of the Polar Front. On interannual timescales, surface heat fluxes and advection both contribute to heat content variability. The impact of heat fluxes appears to be greatest above ~300 m depth, while heat advection may be more important below this depth. (Abstract ID 12695)

Northern far seals in Alaska are declining and information on winter migration patterns will help aid conservation efforts and management goals. We investigated migratory movements, behavior, and habitat characteristics of adult males and females by deploying satellite-linked dataloggers on them in the Bering Sea in October 2009. Dispersal patterns, winter foraging habitats and diving behavior differed greatly between sexes. Environmental determinants, including winter cyclones, upwelling features, mixed-layer depth, ecosystem, and lunar cycle explained some of the movement and diving variability. We believe that as winter storms intensify and temperatures fall in the subarctic N. Pacific, small females with significant physiological constraints must travel far to the south and east to less physically demanding environments with accessible prey in the surface mixed layer. Much larger males with greater physiological capabilities can remain in regions farther north and exploit prey below the surface mixed layer. These contrasting strategies segregate the sexes during winter and eliminate potential competition between them. They also expose themselves within the population to conservation and management issues confronting a significant portion of the N. Pacific Ocean. (Abstract ID 11253)

INTERMEDIATE WATER OF THE SUBPOLAR NORTH ATLANTIC OCEAN

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LONG-TERM OBSERVATIONS OF ATMOSPHERIC O2/CO2 RATIOS OVER THE SOUTHERN OCEAN

Atmospheric inverse models, ocean biogeochemistry models, and dissolved gas measurements have all suggested subtle but systematic changes in the efficiency of anthropogenic carbon uptake in the Southern Ocean. However, expected changes in atmospheric CO2 gradients over the Southern Ocean are too small to be detected by current observations, ocean model predictions of the biogeochemical response to changes in wind-forcing are model-dependent, and pCO2 observations are spatially and temporally limited. Long-term observations of atmospheric O2/CO2 ratios in spatial gradients and temporal variations have the potential to provide detection of trends in Southern Ocean thermal, biologic, and anthropogenic forcing, tests for ocean biogeochemistry models that are independent of errors in atmospheric transport models, and process-relevant signals that are spatially integrated over large regions and contiguously year-round. We will present an evaluation of seasonal cycles and interannual trends in O2/CO2 ratios in spatial gradients from the Scripps O2 Laboratory flask sampling network and in short-term fluctuations from the NITW Baring Head continuous O2 program, and their comparison to atmospheric transport models driven by a suite of ocean biogeochemistry models and dissolved gas climatologies. (Abstract ID 10802)

INTERANNUAL VARIABILITY OF UPPER-OCEAN HEAT CONTENT IN DRAKE PASSAGE

In order to understand the Southern Ocean heat budget, it is necessary to identify the response of the ocean to air-sea heat fluxes. Reanalysis heat flux products and data from the high resolution XBT/XCTD sampling program in Drake Passage are used to establish a first-order budget for the upper ocean. An annual cycle in upper-ocean heat content is in good agreement with the annual cycle in heat flux forcing, which explains -24% of the variance in heat content above 400 m depth north of the Polar Front and -63% of the variance in heat content south of the Polar Front. On interannual timescales, surface heat fluxes and advection both contribute to heat content variability. The impact of heat fluxes appears to be greatest above ~300 m depth, while heat advection may be more important below this depth. (Abstract ID 12695)
HUMBOLDT SQUID (DOSIDICUS GIGAS) IN THE CALIFORNIA CURRENT SYSTEM

Humboldt squid (Dosidicus gigas) have undergone a range expansion in the northern California Current System during the last decade, but little is known about long-distance migratory capabilities of individual squid. We used archival data from five pop-up archival transmitting (PAT) tags deployed on Dosidicus in California waters to create a probabilistic model that estimates daily locations and migratory pathways. The model compares tag-sampled maximum depths and surface temperatures with bathymetry and remotely-sensed sea surface temperature data and assigns probabilities based on all combinations of potential paths consistent with deployment and popup positions. We identify several types of long-distance migration, including a >650 km southward transit into Mexican waters and a 330 km bidirectional movement north and then south. Results indicate that Dosidicus is capable of sustaining mean speeds of about 40 km/day for >17 days and suggest a maximum migration speed of 54.3 km/day (0.63 m/s). This study develops a tool for estimating animal movement without relying on light data, and provides new insight into Dosidicus migratory capabilities that are relevant to both seasonal migrations and episodic range expansions. (Abstract ID 9962)

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SEQUENCE AND EXPRESSION ANALYSIS OF UNIQUE NITRATE REDUCTASES IN HARMFUL RAPIDPHYSIUM SPECIES

Nitrate reductase (NR) is a multi-domain protein that catalyzes the rate-limiting step in nitrate assimilation. Here we report hybrid NRs (NR2-2/2HbN) identified in two harmful algal bloom species, Heterosigma akashiwo and Chattonella subtilis, with a 2/2 hemoglobin (2/2Hb) inserted into a prototypical NR. Phylogenetic analysis supports the placement of the 2/2Hb domain of NR2-2/2HbN within group I 2/2Hbs with high similarity to mycobacterial 2/2Hbs, known to convert nitric oxide to nitrite. Experimental data confirms that H. akashiwo is capable of metabolizing nitric oxide and shows that HNR2-2/2HbN expression increases in response to nitric oxide addition. Here, we propose a mechanism for the dual function of NR2-2/2HbN in which nitrate reduction and nitric oxide dioxygenase reactions are cooperative, such that conversion of nitric oxide to nitrite is followed by reduction of nitrite as assimilatory cellular nitrogen. By linking nitrate reduction to NO detoxification in NR-2/2HbN, the integration of the 2/2HbN domain within NR would protect raphidophytes against nitrosative stress while also providing them with a unique metabolic advantage in an environment where nitrate is a valued resource. (Abstract ID 1229)

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INSIGHTS INTO COUPLED TURBULENT MIXING AND OVERTURNING CIRCULATION

Turbulent mixing is thought to influence the ocean meridional overturning circulation (MOC), however a detailed physical understanding of the coupling between mixing and the MOC is yet to emerge. This coupling is examined through idealized laboratory experiments with a convective overturning driven by an applied salt flux at the surface. Additional mechanical mixing was imposed using horizontal rods that are yo-yoed continuously through the water column. The resulting density stratification and overturning rate were, for large rod velocities, found to be consistent with an existing theoretical model. The overturning rate increased with increasing mixing rates. The total diffusivity is parameterized and it is found that for weak (or no) externally imposed stirring the correction itself maintained an apparent background vertical diffusivity that is 100 times larger than the molecular level, outweighing the externally forced mixing. Insights into relevant mechanisms governing ocean mixing and stratification will be discussed. (Abstract ID 9788)

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GEOTRACES NORTH ATLANTIC SECTION – ND ISOPODE DISTRIBUTION: SOURCES, SINKS AND INTERNAL CYCLING

Neodymium (Nd) isotopes are a powerful tracer of water masses and trace element cycling in the ocean. Due to scarcity of data, the processes controlling their distribution are not well understood. We present Nd isotope compositions (εNd) and concentrations in seawater collected during the 2010 US Sectional GEOTRACES cruise in the eastern North Atlantic. Our first results show a range of εNd from -12 to -10 and Nd concentrations of 12.5 to 24.5 pmol/
kg. Stations close to the coast have little variations, with the exception of MOW forming a local maximum in nGD. However, small changes can be detected in our high precision concentration data: near the coast of West Africa, nGD concentrations form a local maximum within the OMZ. Further off the coast, where continental input is low, nGD concentrations are also lower and the nGD is governed by water mass mixing. Between 150m and 200m water depth, STMW from the West Atlantic is present, as indicated by a band of constant potential temperature and nGD of about -10. Here the nGD concentration strongly increases from 12.5 to 17 pmol/kg in the upper 500m, whereas at greater depths only little increase is detected. The dataset has been compiled by three laboratories that participated in the international GEOTRACES intercalibration efforts. The collected dataset of this cruise will therefore also function as a continuous cross-calibration to yield a robust nGD database for the GEOTRACES program. (Abstract ID 12609)

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Fjord Oceanography – A Review of Important Dynamic Processes and Modes of Circulation

Fjords provide excellent environments for studies of several ocean processes. The upper layers of many fjords have baroclinic estuarine circulation, internally driven by local freshwater supply and wind mixing. The amount of freshwater in the surface layer may be hydraulically controlled by the topography of the mouth. Topography is also important for tidal circulation and for generation of internal tides and jets and topography may isolate basins by preventing water exchange with neighboring basins and the coastal area. Exchange of water in isolated basins below sill is driven by diapycnal mixing that decreases the density. Turbulence in sill basins usually gets most of its power from internal tides generated at sill. Externally forced baroclinic circulation, driven by temporal variations of the vertical density distribution in the coastal water outside fjords, is usually much larger than the internally forced estuarine circulation. The understanding of important dynamic fjord processes and internally and externally forced circulation modes of fjords and isolated deep fjord basins is reviewed using observations and simple dynamical models. (Abstract ID 12444)

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The Effects of Ocean Acidification on the Growth of Early Life Stage Walleye Pollock, Theragra Chalcogramma

Ocean acidification has become a concern over the past decade, largely due to the uncertainty of how organisms and ecosystems will be affected. The Bering Sea supports a number of commercially important fisheries and is expected to be one of the regions most affected by ocean acidification. The purpose of this study was to determine how early life stages of commercially important fisheries and is expected to be one of the regions most affected by ocean acidification. The study was to determine how early life stages of walleye pollock may respond to decreases in ocean pH. Walleye pollock eggs were obtained from laboratory broodstocks and incubated across a range of pH treatments (7.2, 7.6, 7.9, and 8.05). Standard length, body depth, eye diameter, and yolk area of newly hatched larvae were measured. Accounting for differences in hatch time, size at hatch was not significantly affected by pH. In a separate experiment, juvenile walleye pollock were reared across the same range of pH treatments and growth rates determined through biweekly measurements (length and mass). On average, fish grew slightly faster at the 7.6 treatment, though this was not significant. Results to date on walleye pollock suggest that early life stage development is not significantly influenced by ocean acidification. (Abstract ID 10802)

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Cross-SHELF Exchanges Induced by Troughs

Cross-shef exchanges play an important role in biological systems and in the mass balance of ice sheets in Antarctica. In this presentation we focus on the influence of a trough over the circulation of an idealized continental shelf, and examine its potential as a mechanism for onshore transport of heat. Results are from process-oriented simulations with a high-resolution (1km) 3-D ocean model thermodynamically coupled to a static ice shelf. The model reproduces several features from observations in Marguerite Trough (Bellingshausen Sea), notably the intrusion of warm waters at mid-depth over the downstream wall of the trough. Such an intrusion appears in all runs and reaches the interior of the ice cavity. The details of the circulation pattern change substantially however according to the direction of the shelf break jet. In particular, lower heat exchanges are obtained when the jet is opposite to direction of Kelvin waves. The basal melt rates obtained in these idealized scenarios are substantial (more than 1m/year) and their significance is discussed in the context of the West Antarctic Ice Sheet. (Abstract ID 10009)

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Connecting Global-Scale Planktonic Food Web Dynamics and Biogeochemical Fluxes

Most global biogeochemical models emphasize resolution of broad-scale nutrient cycling. Coarsely-resolved planktonic food web dynamics in these models, however, limits the mechanistic resolution of biogeochemical processes and the utility of these models for assessing climate impacts on marine resources. We have augmented the planktonic food web dynamics of the biogeochemical component of NOAA/GFDL’s earth system model to ameliorate these limitations. Additions to the 1.0 version of this model, called COBALT (Carbon, Ocean Biogeochemistry, and Lower Trophics) include three zooplankton groups with flexible feeding behaviors, explicit bacteria and improved resolution of microbial processes, and improved bioenergetics formulations. We demonstrate that COBALTV1.0 captures patterns in the energy flow through bacteria, microzooplankton, small and large phytoplankton, and mesozooplankton using a range of global-scale data sets. Biogeochemical fluxes are then compared against the preceding model formulation (TOPAZ2) to identify differences arising from enhanced resolution of planktonic food web dynamics. Ongoing efforts to improve ecological resolution of biogeochemical processes with COBALT will also be discussed. (Abstract ID 12643)

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Understanding the Delivery, Residence Time, and Advection of Fluvial Sediment Out of a Coral Reef-Lined Embayment Through Empirical Observations and Modeling

Oceanographic measurements and sediment samples were collected in Hanalei Bay, Kauai, USA, and were integrated with a physics-based numerical model to better understand the delivery, residence time, and advection of fluvial sediment out of a coral reef-lined embayment. Combined wave-current shear stresses were more energetic in the western and southern portions of the bay that are exposed to trade winds and storm waves, resulting in little fine-grained terrestrial sediment accumulation. Shear stresses along the sheltered eastern part of the bay off the river mouth, however, were below the threshold for erosion of fine-grained sediment during more than 90% of the study period, resulting in net accumulation of fine-grained sediment material. This sediment was slowly reworked and transported clockwise out of the bay, exposing corals to elevated turbidities for weeks to months. These observations and model results suggest that storms during low-energy oceanographic conditions negatively impact corals by reducing water quality and cover hard substrate suitable for coral recruitment with unconsolidated sediment. Energetic conditions, however, appear to result in potentially shorter residence times for fine-grained fluvial sediment in the bay. (Abstract ID 11922)

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Sea Ice Response to Atmospheric Storms

Episodes of increased near-inertial motion have been observed in the ice-covered winter Arctic ocean suggesting sea ice may act as a link in the energy cascade from atmosphere into the ocean. The response of sea ice to atmospheric storms is examined using data from a moored array deployed on the Beaufort continental slope from August 2008-August 2009 and reanalysis winds. Many storms occur during the Arctic winter, but not all of these create an ice response. However, three unusually strong storms passed near the array in November, December, and March, and were accompanied by elevated levels of near-inertial kinetic energy in both the ice and ocean. The ice response to atmospheric forcing in this region is predominantly controlled by ice mechanics. However, the “perfect storm” event consisting of the proper ground velocity and track is able to overcome these mechanisms and excite the ice during these events. Storm characteristics, which caused wind directions to switch over the array in an inertial period (~1.626 hours), had the biggest impact on sea ice inertial response. (Abstract ID 12327)

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Lipid Content and Composition of Juvenile English Sole Parophrys vetulus in Relation to Dissolved Oxygen and Estuarine Versus

Lipid content and composition of juvenile English sole Parophrys vetulus in relation to dissolved oxygen and estuarine versi...
COASTAL HABITATS

The body condition of juvenile English sole, Parophrys vetulus, is determined by the quality of the nursery location where they settle. Juvenile English sole body condition was compared between nearshore coastal and estuarine nursery habitats, and in relation to seasonal progression of temperature and hypoxic conditions along the central Oregon coast. Total extractable lipid content (TEL) determined gravimetrically, and relative triacylglycerol (TAG) to sterol composition, determined using latroscan (automated thin-layer chromatography), were taken as measures of body condition for collected juveniles. Changes in TEL and TAG/sterol ratio were found to correlate with seasonal timing, which is related to development of hypoxia, among other factors. Additionally, individuals which had not yet fully metamorphosed yielded much higher values of TEL than other specimens, suggesting that TEL in juvenile English sole decreases significantly after metamorphosis and settlement, as fully metamorphosed yielded much higher values of TEL than other specimens, suggesting that TEL in juvenile English sole decreases significantly after metamorphosis and settlement, as found for other flatfish species. Small sample size made pinpointing the primary reason behind the timing correlation with body condition difficult. However, through the combined methodologies implemented, this correlation can be more clearly resolved with a larger sample size. (Abstract ID 10140)

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TROPICAL AND SUBTROPICAL OCEAN OXYGEN CHANGES, OBSERVATION TO MODEL COMPARISON

In the eastern tropical ocean basins low oxygen layers called oxygen minimum zones (OMZ) exist in the depth range between 100 and 900 m. An important pathway of ventilation is the complicated zonal equatorial current band system that supplies oxygen-rich water to the OMZs. Dissolved oxygen (DO) changes are one focus of the Kiel research initiative ‘Climate-Biogeochemistry interactions in the tropical oceans (SBP-754).’ A global compilation of dissolved oxygen values in the open ocean covering the last 50 years was derived based on available oxygen measurements. The results show declining upper-ocean DO levels in many regions, especially in the tropical oceans, whereas areas with increasing DO levels are observed in the subpolar regions. Although simulated regional patterns of DO change covering the past 50 years differ from observational trend estimates, the large scale mean historical decline is well reproduced by coupled biogeochemistry-climate models. While this strengthens confidence into projections of future DO decline simulated by current models, the regional patterns of projected oxygen changes appear less robust. (Abstract ID 9490)

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IMPACT OF ARCTIC AND ATLANTIC VARIABILITY ON GREENLAND’S GLACIERS

Increasing evidence suggests that ocean variability triggered the recent acceleration of glaciers in western and southeastern Greenland leading to a doubling of the ice sheet's contribution to sea-level rise. This hypothesis is supported by the fact that the timing of the glaciers’ acceleration coincided with the recent warming of the subpolar North Atlantic and by recent measurements showing that warm, salty waters of subtropical origin circulate rapidly through these fjords. Yet the processes regulating the inflow and variability of warm, salty waters inside Greenland's glacial fjords are complex and involve crossing shelves that are strongly influenced by cold, fresh waters of Arctic origin. Here, I present recent measurements from one major glacial fjord in southeastern Greenland and historical data, including a reconstruction of the shelf variability over the last 120 years, which indicate that the properties at the glaciers' margins and the glacial ice's stability are affected both by Arctic and Atlantic variability on interannual to decadal time scales. (Abstract ID 11314)

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EFFECTS OF ENVIRONMENTAL STRESS ON THE COMMUNITY COMPOSITION AND FOULING MODULATING ROLE OF EPIBIOTIC BIOFILMS ON THE BROWN ALGA FUCUS VESICULOSUS

Bacterial biofilms on macroalgae are highly diverse, intricately structured communities, often host specific which have the potential to substantially affect interactions between the host alga and its environment. Thus, they can play important roles in the settlement process of macrofoulers. Under stressful environmental conditions, the bacterial community's composition may be altered, possibly entraining shifts in its ecological function. In this context, we asked the following questions: Do stressful temperature conditions lead to a re-structuring of the epibiotic biofilm on F. vesiculosus, and does a potential shift in the composition of the biofilm affect its role as a mediator for fouling? To shed light on this matter, F. vesiculosus from the Baltic Sea was cultivated in the laboratory under different temperatures ranging from optimal to stressful temperature conditions. Its bacterial biofilm community was analyzed by 454 sequencing of the 16S rRNA gene sequences (V2 region). In field assays, epiphytic biofilms were tested for repellent effects on attachment of barnacle larvae. First results indicate that there were temperature dependent shifts in the bacterial community. Bacterial diversity was higher at temperatures considered optimal for F. vesiculosus. Furthermore, temperature dependent repellent effects of biofilms on cyprids were observed. (Abstract ID 10999)

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CHEMOSENSORY GRAZING BY CALANOID COPEPODS #2

1978, Poulet and Mansot showed results from feeding copepods with artificial food: microcapsules enriched with a homogenate of naturally occurring phytoplankton and microcapsules filled with neutral albumin. The animals ingested preferentially the enriched capsules. We repeated the experiments using updated techniques—microfluidic devices to produce droplets with small particle size distributions at different sizes, and high-speed digital holography for direct observations of the feeding process. Our starting point was to feed the calanoid copepods with droplets of mineral oil with or without dissolved beta-carotene as the chemical attractor. The results, expected and unexpected, will be shown in videos. (Abstract ID 10565)

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UNDERSTANDING CARBON EXCHANGE UNDER GLOBAL CHANGE: RECENT ESTIMATES OF AIR-SEA CO2 FLUX ON THE CHUKCHI SEA SHELF

Seasonal and annual carbon flux balances between ocean and atmosphere in continental shelf waters result from the complex interactions of nutrient availability, temperature, seawater density, phytoplankton and zooplankton ecology, terrestrial carbon inputs, bathymetry, and physical oceanographic processes. Some continental marginal seas have been identified as perennally net carbon sources to the atmosphere, others as perennally net carbon sinks, and others as seasonally dynamic sources and sinks. (Chen and Borges, 2009). For the Chukchi Sea shelf, Bates (2006) reports values, based on spring and summer 2002 measurements, of 30-90 mmoles CO2 m-2 d-1 for seasonally ice-free regions of the shelf, representing nearly 40 Tg C in annual net air-to-sea flux. Here, we report recent updated estimates of the seasonal air-to-sea carbon dioxide flux on the Chukchi shelf based on surface pCO2 measurements taken during summer 2010 and 2011 cruises, as well as on data obtained from the Lamont Doherty Earth Observatory Global Surface pCO2 Database. The dynamics of carbon cycling and the fate of carbon fixed on this extremely productive, shallow, Arctic sea shelf are a significant component of the global carbon budget, and these values help characterize the feedback of rapid climate change to the carbon flux in this region. (Abstract ID 12535)

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CHANGES IN GREENLAND'S COASTAL MARGINAL ICE ZONE 1979-2011

The sea ice that extends along Greenland's east coast during winter and early spring defines a biologically active region where intense ocean-ice-atmosphere interactions take place, and Greenland's east coast marginal ice zone (MIZ) is shown here to have narrowed by 40% over the satellite era (1979-2011). Also, the annual appearance of pack ice versus marginal ice along the various segments of Greenland's coast showed physically important decadal variations, but there was not trend comparable to the MIZ narrowing. Oceanic and atmospheric factors associated with the trend and variability in MIZ width included changes in Northern Hemisphere sea ice extent, variations in sea ice flux through the Fram Strait, and variability in patterns of atmospheric circulation. To quantify the width of Greenland's coastal MIZ, satellite data were analyzed using a novel method based on idealized sea ice concentration fields that satisfied Laplace's equation. (Abstract ID 10694)

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IF YOU BUILD IT
Two approaches are taken to use satellite observations in oceanographic products: (1) stand-alone products constructed solely from observations (satellite, ground, or ship-based); (2) products created from a blend of dynamical models, satellite and/or in-situ data. Examples of these approaches are given, including a pilot forecast system off Oregon that assimilates both satellite (SSH and SST) and coastal HF Radar data. Nowcast and forecast fields from that model were placed on the scatterometer data. An extensive database spanning over 20 years has been constructed. Using Newton's equations of motion, a simple iceberg motion model is created to describe an iceberg's translational and rotational motion. Data assimilation techniques are used to improve the performance of the iceberg model, resulting in better motion estimates. Iceberg motion models can be inverted to infer the ocean current driving the motion. These ocean currents can be used to validate conventional ocean currents in the Southern Ocean (e.g., OCCAM). (Abstract ID 10036)

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PHYSICAL AND BIOLOGICAL RESPONSE OF THE SOUTHERN OCEAN TO THE SOUTHERN ANNULAR MODE 1997 TO 2011

The Southern Annular Mode (SAM) is the dominant mode of climate variability in the southern hemisphere. In recent decades, its mostly positive phase has been associated with a strengthening and southerly migration of the westerly winds over the Southern Ocean. These winds drive the large-scale overturning circulation and therefore modulate vertical fluxes of nutrients and dissolved inorganic carbon, which fuel Southern Ocean productivity. The satellite ocean color data record is now long enough (1997 to present) to discern circumpolar and regional trends in surface ocean productivity, in response to the SAM. This presentation documents interannual and spatial variability in sea surface temperature, winds, mixed layer depths and surface chlorophyll as a function of the SAM. While this presentation is focused on physics and productivity, the ultimate goal of this work is to understand the air-sea carbon dioxide flux for the Southern Ocean, and develop a predictive capability for the future. (Abstract ID 11053)

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ABSENCE OF IRON-LIGHT CO-LIMITATION IN SOUTHERN OCEAN PHYTOPLANKTON

We examined the interplay of light and iron availability on the intracellular iron concentrations, specific growth rates, and photosynthetic physiology of Southern (S.) Ocean diatoms (Eucampia antarctica and Proboscia inermis), and the haptophyte Phaeocystis antarctica. Intracellular iron concentrations and iron/carbon (Fe:C) ratios increased with decreasing irradiance in temperate diatoms (Thalassiosira weissflogii and Thalassiosira oceaniae), in support of both published theoretical predictions and experimental findings of the antagonistic relationship between low iron and light. In contrast, S. Ocean species required lower intracellular iron concentrations and Fe:C ratios to maintain growth rates comparable to those of temperate diatoms, and their growth requirements for iron decreased or remained relatively constant with decreasing light. These results suggest the current paradigm that low light increases algal cellular iron requirements is not applicable to S. Ocean phytoplankton. Moreover, iron-limited cultures of S. Ocean species grown at low light intensities exhibited higher relative growth rates and photosynthetic efficiencies of PSII (Fv/Fm) than cultures at saturating light intensities, suggesting that they were not simultaneously co-limited by low iron and light. (Abstract ID 9441)

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ICEBERG AND OCEAN CURRENT MODELING

By utilizing differences in the radar returns from glacial ice, sea ice, and sea water, it is possible to detect and track large Antarctic icebergs using microwave wind scatterometers using reconstruction-enhanced images produced by the Scatterometer Record Pathfinder Project (www.scp.byu.edu). The size and orientation of the icebergs can be also automatically estimated from the scatterometer data. An extensive database spanning over 20 years has been collected. Using Newton’s equations of motion, a simple iceberg motion model is created to describe an iceberg’s translational and rotational motion. Data assimilation techniques are used to improve the performance of the iceberg model, resulting in better motion estimates. Iceberg motion models are validated using iceberg tracks gathered from space-borne scatterometer data. The iceberg motion tracks double as markers for the predominant ocean currents. Thus, given the observed iceberg tracks, the iceberg motion model can be inverted to infer the ocean current driving the motion. These ocean currents can be used to validate conventional numerically-derived ocean currents in the Southern Ocean (e.g., OCCAM). (Abstract ID 10036)

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BIOGEOCHEMICAL INTERPRETATIONS OF COLORED DISSOLVED ORGANIC MATERIAL OPTICAL SIGNATURES

The optical properties of CDOM in surface waters are visible from space and observable throughout the water column in real time using in situ sensors. Due to their ease of measurement, CDOM optical properties are used as proxies for the quantity, quality and processing of dissolved organic matter (DOM) in natural waters. This tutorial will focus upon the use of these optical signatures to provide insight into the cycling of DOM. Examples will explore the use of CDOM to estimate: DOM, lignin and black carbon export from Amazon Rivers to the Arctic Ocean; the source of DOM in ice sheets; and the photoreactivity of estuarine and ocean CDOM. Each of the above examples relies on empirical relationships between the process of interest and DOM color or fluorescence. The drivers of these relationships will be discussed along with the assumptions and caveats associated with scaling from CDOM optical properties to DOM cycling. (Abstract ID 10381)

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THE ROLE OF SYNECHOCOCCUS IN CARBON EXPORT IN THE COSTA RICA DOME: VERTICAL TRANSPORT WITHIN MESOZOOPLANKTON FECAL PELLETS

Recent inverse modeling results have called into question the prevailing paradigm that vertical carbon flux is fueled by the production of large phytoplankton and suggested that picoplankton production may dominate carbon export in the open ocean. The Costa Rica Dome (CRD) is an open ocean upwelling region with incredibly high concentrations of Synechococcus in the surface ocean (exceeding 100,000 cells ml⁻¹). To assess the role of Synechococcus in vertical flux, we measured both the concentration of individual Synechococcus cells (by flow cytometry) and the concentration of the diagnostic pigment phycoerythrin (by gyclerol uncoupling) in sediment trap samples at two depths beneath the CRD. Phycoerythrin estimates of Synechococcus carbon flux exceeded the flow cytometric estimate of the flux of individual cells by an order of magnitude. Nevertheless, even the phycoerythrin measurements suggested that Synechococcus contributed less than 1% of total vertical carbon flux. Paired measurements of phycoerythrin in the guts of mesozooplankton collected by oblique net tows through the euphotic zone suggest, at least for phycoerythrin, that Synechococcus may have been transported to depth within mesozooplankton fecal pellets. (Abstract ID 10032)

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FAST TRANSPORT OF SEDIMENTS FROM SHALLOW WATERS TO DEEP SEA: OBSERVATIONS OFF SOUTHWESTERN TAIWAN

The offshore area of southwestern Taiwan is mainly composed of a narrow Gaoping shelf, broad Gaoping slope and two major submarine canyons, the Gaoping Submarine
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Potential area for the generation of tsunami hazards in the future. (Abstract ID 9747)

Instability of seafloor which induced by faulting or liquefaction on Gaoping shelf and slope near submarine cable breakages from shallow waters to deep sea floor. Our findings suggest the instability of seafloor which induced by faulting or liquefaction on Gaoping shelf and slope near submarine cable breakages from shallow waters to deep sea floor. During the month-long observation period (August, 2011), various forms of intermittent internal activity are recorded. Packets and singular waves of depression and elevation as well as sharp bore-like features are observed to strongly modulate water-column velocity and stratification at both mooring locations. The surface expression of these events, visible as roughness streaks in Argus imagery, are tracked through time and space then compared to wave propagation direction from velocity measurements and theoretical phase speeds. Subtidal (upwelling/downwelling) and tidal-band (tidal phase) background oceanic conditions are both shown to influence the number and form of wave events that occur on the inner shelf. (Abstract ID 10085)

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Characterizing the 2011 Great Flood Plume of the Mississippi River

The Mississippi River experienced record flooding in 2011 with the average monthly flow measured at Tarbat Landing, MS in May being the largest since 1930. Analysis of satellite ocean color data and data collected on field surveys conducted on board the R/V Endeavor and R/V Cape Hatteras from 2 to 28 July 2011 showed that the plume covered an area greater than 25,000 km$^2$ and was as thin as 2 m at some locations. Unlike in normal years when the plume flows mainly over the Louisiana Texas shelf, satellite imagery showed that in 2011 the plume spread southeastward, eventually traveling around the Florida Keys into the Atlantic Ocean and covered about 150,000 km$^2$ beyond the continental shelf of the eastern Gulf of Mexico. The southeastern plume persisted for over two months and was characterized by extremely high amounts of colored dissolved organic matter and phytoplankton biomass. We will present the results of the bio-optical and biogeochemical data collected during our field survey and discuss the consequence of the plume. (Abstract ID 11258)

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Linear vs Nonlinear Filtering with Scale Selective Corrections

We compare the behaviors of an Ensemble Kalman Filter (EnKF) and fully nonlinear particle-based filters (PF) with a simple model of balanced dynamics. The filters have a very similar forecast step but the analysis step of the PF generalizes the optimality of the EnKF analysis to non-Gaussian distributions. We compare the EnKF to two flavors of the particle filter sampling from discrete and continuous PDs. The model admits a chaotic vortical mode coupled to a comparatively fast gravity wave mode. It is initialized such that it evolves either on a slow manifold or such that the fast varying variables are slave to the slow varying variables and lastly in the fully nonlinear manifold. Identical twin assimilation experiments are performed, wherein the true state is balanced, but the observational errors project onto all degrees of freedom, including the fast modes. EnKF and PFs capture the variables in slow manifold well since, once the variables are attracted towards the slow manifold, they stay there. PFs capture slaved modes better for a lower observation frequency. The performance of the PFs is shown to be much better in the fully coupled nonlinear model as well. The filter analysis step in the PFs maintain the balance in both variables much better than the EnKF implying that the curse of Gaussian assumptions in linear Kalman Filter based estimates are overcome by PFs and this can improve balanced estimation in nonlinear geophysical problems. (Abstract ID 10277)

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Latitude of Easternward Jet Prematurely Separated from the Western Boundary in a Two-Layer QG Model

The separation latitude of the Kuroshio and its extension are located far south of the subtropical-subpolar gyre boundary. Motivated by this structure, we investigate parameter dependence of the latitude of the easternward jets from the prematurely separated western boundary current, using a simple two-layer quasi-geostrophic model. Negative Ekman pumping velocity is adopted to drive a single-gyre circulation. Depending on parameters representing the nonlinearity, diffusivity and partial-slip boundary condition, an easternward jet with recirculation gyres on its north and south occurs in some parameter region, in which the width of the inertial boundary layer relative to the deformation radius is comparable to that in real oceans. It is found, however, that the latitude of easternward jet is almost independent of these parameters once the premature separation occurs, and it is largely determined by the meridional distribution of the Ekman pumping. It is also found that the streamfunction at the jet axis is around the half of the maximum of the Sverdrup streamfunction. This gives us a clue to predict the latitude of the easternward jet from the wind-stress distribution. (Abstract ID 11380)

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SEA SURFACE HEIGHT CHANGES EAST OF JAPAN IN TWENTY-FIRST CENTURY CLIMATE PROJECTIONS

Sea surface height (SSH) changes east of Japan in twenty-first century climate projections are investigated using output from fifteen coupled models participating in the Coupled Model Intercomparison Project phase 3. In the region east of Japan (145E – 160E, 35N – 40N), an increase in the SSH due to the change in the ocean circulation is nonnegligible compared to global mean steric sea level rise, based on multi-model ensemble (MME). In addition, in this region, the MME mean SSH change is comparable to inter-model standard deviation of the SSH change. A northward shift and an intensification of the Kuroshio Extension (KE) induce the SSH change east of Japan. Models with a larger northward shift (intensification) of the KE exhibit a poleward shift of the position of the maximum easternward wind stress (an increase in easternward wind stress at 3N); the former (latter) models have a positive (negative) SLP change in the North Pacific. (Abstract ID 11165)

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Biogeochemical Impact of Mesoscale Disturbance in the Subtropical North Pacific

Mechanisms to supply the nutrients required to sustain primary productivity of the subtropical ocean are not fully understood yet. Intermittent upwelling induced by mesoscale disturbances has been considered as one of the possible mechanisms, while observation of such a process has been very limited. Combination of profiling float observation and satellite altimetry has been considered as one of the possible mechanisms, while observation of such a process has been very limited. Intercomparison Project phase 3. In the region east of Japan (145E – 160E, 35N – 40N), an increase in the SSH due to the change in the ocean circulation is nonnegligible compared to global mean steric sea level rise, based on multi-model ensemble (MME). In addition, in this region, the MME mean SSH change is comparable to inter-model standard deviation of the SSH change. A northward shift and an intensification of the Kuroshio Extension (KE) induce the SSH change east of Japan. Models with a larger northward shift (intensification) of the KE exhibit a poleward shift of the position of the maximum easternward wind stress (an increase in easternward wind stress at 3N); the former (latter) models have a positive (negative) SLP change in the North Pacific. (Abstract ID 11165)

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OBSERVATIONS OF HIGH-FREQUENCY INTERNAL WAVES ACROSS THE OREGON INNER SHELF

We present observations of high-frequency internal activity from the Oregon inner shelf using a combination of two in-situ moorings (20- and 10-m isobaths) and video remote sensing. High-frequency measurements of velocity from bottom-mounted Acoustic Doppler Current Profilers and temperature from thermistor chains are combined with Argus sea-surface imagery (2-min sampling) to provide a unique description of wave kinematics as they traverse an offshore bathymetric feature (15-m reef) and propagate across the inner shelf. During the month-long observation period (August, 2011), various forms of intermittent internal activity are recorded. Packets and singular waves of depression and elevation as well as sharp bore-like features are observed to strongly modulate water-column velocity and stratification at both mooring locations. The surface expression of these events, visible as roughness streaks in Argus imagery, are tracked through time and space then compared to wave propagation direction from velocity measurements and theoretical phase speeds. Subtidal (upwelling/downwelling) and tidal-band (tidal phase) background oceanic conditions are both shown to influence the number and form of wave events that occur on the inner shelf. (Abstract ID 10085)
INTERACTIVE EFFECTS OF CO2 AND IRON ON ELEMENTAL COMPOSITION OF DIATOM \textit{PSEUDONITZSCHIA PSEUDODELICATISSIMA}

Partial pressure of CO2 (pCO2) and iron condition varies due to biological and anthropogenic activities. However, we have very little data about interactive effects of these factors on phytoplankton physiology and stoichiometry. Here we investigated the effects of pCO2 and iron on the elemental composition of diatom \textit{Pseudo-nitzschia pseudodelicatissima} using the dilute batch method under four pCO2 (~180, ~380, ~600 and ~800 µatm) and five dissolved inorganic iron (Fe′) (~5, ~10, ~20, ~50, and ~100 ppm L−1) conditions. Net nutrient uptake rate per unit surface area increased with the increase in Fe′ for all elements whereas it decreased with the increase in pCO2 for C, P and Si. The C:N ratio decreased significantly with Fe′ whereas C:P ratio increased significantly with pCO2. The S:C and S:N ratios decreased with the increase in Fe′ and pCO2. Our results indicate that pCO2 and iron availability can influence the biogeochemistry of nutrients in future high-CO2 oceans and similarly for present phytoplankton blooms and the past earth history in which pCO2 and iron conditions dramatically change over seasonal and geological time scales. (Abstract ID 10116)

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A relationship between paths of the Kuroshio and Kuroshio Extension (KE) is investigated, using the satellite-derived altimetry dataset. We define the axis of Kuroshio and KE as the 220-cm sea surface height (SSH) isoline. During the analysis period of 16 years from January 6, 1993 to December 31, 2008, we can specify 835 paths for the Kuroshio and KE. In this study, we focus on the three typical paths of the Kuroshio defined as follows: typical large meander (LM) path (LM) is distributed south of 32°N in a region of 136–137°E, nearshore nonlarge meander (NLM) path (nNLM) is located north of 32°N at 136°E, 33°N at 138°E, and 34°N at 140°E, and offshore nonlarge meander path (oNLM) is located north of 32°N at 136°E and south of 33.5°N at 140°E. The numbers of paths for nNLM, oNLM, and LM are 184, 309, and 35, respectively. Since the Kuroshio sometimes takes undulated paths, others (307 paths) not regarded as the three typical paths are discarded in this study. We investigate the relationship between the three paths of Kuroshio and KE path. Results show clear relationships: When the Kuroshio takes the LM path (LM) path, the KE path tends to be convoluted, i.e., an meanders. On the other hand, when the Kuroshio takes the LM path (LM) path, the KE path tends to be straight, i.e., an straight. (Abstract ID 9866)

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A TREATMENT OF UNSTABLE MODES IN 4D-VAR DATA ASSIMILATION

Strong sensitivities due to unstable modes appearing through the processes of tangent linearization or adjoint integration are major issues to resolve for a proper ocean climate state estimate by 4D-VAR. Better understanding the property of growing perturbations is important when considering a practical data assimilation system. By using a tangent linear code of the state-of-the-art global ocean general circulation model, we have approximately derived leading backward Lyapunov vectors and corresponding Lyapunov exponent. The vectors are spatially localized mainly near the equator, that implies unstable modes might be related to oceanic tropical instability waves. We discuss how to reduce these modes in the context of climate data assimilation. Our strategy is based on selective noise reduction by one of various regularization approaches. (Abstract ID 10853)

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OBSERVING OCEAN PROCESSES WITH STUDENT-BUILT OCEAN DRIFTERS AND TIME ANIMATIONS IN GOOGLE EARTH

The Marine Advanced Technology Education (MATE) Center and COSEE NOW are using ocean drifters to teach college students about the inter-relationship of ocean processes and bioavailability. To fully understand their effect on iron bioavailability in the ocean, it is critical to determine the oxidation states and mineral forms of iron in these materials, and to determine the extent to which they can be differentiated based on their source regions. In this context, we collected glacial and non-glacial samples from Patagonia and elsewhere, and analyzed their solid-phase iron speciation by synchrotron-based X-ray absorption spectroscopy. We

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SPRING ICE AND SALT FLUX IN THE EASTERN BERING SEA MARGINAL ICE ZONE

Sea ice on the Eastern Bering Sea can reach as far south as Bristol Bay, with varying extents in warm and cold years. Annual ice forms in the northern Bering Sea in late autumn and winter, and is advected southward by northwesterly winds. The ice edge retreats under southerly winds or when local insolation or below-zero ocean temperatures melt ice faster than it is replaced. The southern marginal ice zone (MIZ) is dynamic, forming, breaking, and banding in spring as the average extent is reeding. We present a data set of 27 ice cores from NSF-BEST cruises in the Bering Sea MIZ in spring 2007-2009. Thicknesses ranged from 23-~329 cm, salinities 2.5-10.5 psu, temperatures from ~9.5 to ~1.8°C and nitrates from 0-13 µmol kg−1. We combine these in-situ data with shipboard observations, AMSR, E-13 concentrations and Modis True Color satellite data to estimate southward transport of freshwater/salt by sea ice at two latitude bands in the middle domain of the central Bering Sea Shelf. (Abstract ID 11702)

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SIGNATURES OF LANGMUIR TURBULENCE IN THE HURRICANE OBL

In high winds the OBL deepens under the combined influence of surface cooling, wind induced shear, and Stokes drift generated Langmuir turbulence. We examine the combined impact of these processes by carrying out LES of the hurricane OBL using high resolution (1024x1024x256) mesh sizes over a time period of 72 hours. The surface wind and wave fields input to the LES are products derived from the WAVESWATCH III framework with “exact” computations of the nonlinear energy transfers, the wind input by Snyder (1981), and the energy dissipation proposed by the Romero and Melville (2010) model. The high amplitude transient winds force wind-waves and swell that are most often mis-aligned with the local winds, and the rough OBL responds by developing temporally and spatially transient Langmuir turbulence. The Langmuir cells tend to track the local winds on the resonant side of the storm track and become vigorous at the time of maximum winds. An opposite pattern happens on the non-resonant side of the storm track as cells weaken and become nearly non-existent. These coherent structures impact the mean currents, SST, vertical velocity moments, entrainment at the thermocline, and dissipation. The simulations are carried into the storm wake with surprising changes to the near surface dissipation. (Abstract ID 9534)

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CHARACTERIZING PARTICULATE IRON SPECIATION IN DUSTS AND SEDIMENTS AND ITS EFFECT ON IRON SOLUBILITY IN THE OCEAN

Iron is a limiting nutrient for phytoplankton in extensive regions of the ocean. Dusts and advected sediments represent critical external sources of oceanic iron. Their iron can take a variety of forms, each of which has unique solubility and dissolution rate, and thus bioavailability. To fully understand their effect on iron bioavailability in the ocean, it is critical to determine the oxidation states and mineral forms of iron in these materials, and to determine the extent to which they can be differentiated based on their source regions. In this context, we collected glacial and non-glacial samples from Patagonia and elsewhere, and analyzed their solid-phase iron speciation by synchrotron-based X-ray absorption spectroscopy. We...
found that glacial materials have distinct iron mineralogy dominated by primary ferrous silicates, which are more soluble, while non-glacial materials contain significant fractions of insoluble secondary ferric (hydr)oxides. Iron leaching experiments on the samples and culture experiments with phytoplankton confirmed the relationship between iron speciation, solubility and bioavailability. Therefore, modulation between glacial and non-glacial iron sources to the ocean could influence particulate iron speciation, and potentially marine productivity. (Abstract ID 9823)

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THE MEASUREMENT OF SURFACE WAVES BY SPACEBORNE SAR, AIRBORNE SAR AND BUOY ALONG THE COAST OF HAINAN

In this paper, the ocean wave spectra and the associated wave parameters are retrieved from the airborne and spaceborne SAR images which are acquired nearly simultaneously near the east coast of Hainan during the flight experiment of application at land and sea. The wave parameters from SARs are compared with the observation from Waverider buoy over the study site. The wave spectrum is derived by the inversion of quasi-linear transform which relate the ocean wave spectrum to the SAR image spectrum. The errors of retrieval wave propagation direction of waves for both SARs are less than 20° and the errors of the wave height, wave length and wave period is less than 20%, which shows the good agreement of SAR wave parameters with in-situ observation. The offshore breaking is also shown in SAR multi-polarization images. The intensity of wave breaking stripe is proportional to the signal to noise ratio of SAR spectrum. The results can be used to evaluate the performance of ocean wave observation by spaceborne and airborne SAR. (Abstract ID 10947)

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A ZEROTH-ORDER, OBSERVATIONALLY BASED PARAMETERIZATION FOR VERTICAL DIFFUSIVITY IN THE THERMOCLINE

Due in part to a growing body of observational evidence that vertical mixing in the ocean is highly spatially variable, regional climate modeling efforts have recently considered the effects of a geographically varying background diffusivity in the ocean interior. Studies have suggested that local changes in the diffusivity can have far-reaching ramifications, particularly through their effect on sea surface temperature. Here we present a simple parameterization for vertical diffusivity in the thermocline which is based on direct measurements of turbulence. Data were collected over the past two decades, at a mix of open-ocean locations including the North Atlantic, the Brazil Basin, and the South China Sea. Based on previously approaches to parameterizing bottom enhanced mixing above topography, we estimate a diffusivity profile based on a vertical structure function which is scaled by the integrated kinetic energy dissipation. A simple exponential decay, indexed from the transition layer, is found to model the dissipation profile surprisingly well through 1500 m of water, across variations of a decade and a half in integrated energy level. We also explore more complicated structure functions which attempt to capture higher-order variability in the dissipation profiles. It is hoped that simple parameterizations such as these can help provide the climate modeling community with an easily-implemented, zeroth-order improvement over constant diffusivities in the thermocline. (Abstract ID 12827)

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DEVELOPMENT AND EVALUATION OF OCEAN-CLIMATE MODELS: NEW WAYS OF DISCRETIZING A COUPLED OCEAN-ATMOSPHERE MODEL

A long-range global weather prediction model developed at ESRL is being coupled to a HYbrid Coordinate Ocean Model (or HYCOM-like) ocean. The atmospheric model FIM (http://finn.noaa.gov/) uses an icosahedral horizontal grid and a hybrid-isentropic vertical coordinate resembling the one used in HYCOM. -- Grid nesting is common in weather modeling, but grid discontinuities are usually kept away from the region of interest. To avoid joining disparate grids at the ocean-atmosphere interface, arguably the region of most interest in coupled modeling, HYCOM is re-coded for an icosahedral grid. This lets us couple the ocean model, now renamed OFIM, to FIM without requiring interpolation of air-sea fluxes. The mathematical similarity of FIM and OFIM allows them to share major components of their dynamic core and software engineering innovations developed for FIM. -- Preliminary results from the ocean model alone and the coupled model will be discussed. Numerical merits of new ways of discretizing equations will be assessed by comparing solutions from OFIM and the standard HYCOM, both subjected to the same CORE forcing. Our ultimate intent is to run the coupled model at ~30km global horizontal resolution. (Abstract ID 12133)

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EVIDENCE FROM CLIMATE MODELS FOR A ROLE OF ENSO EVENTS IN SHAPING THE CLIMATOLOGICAL SIZE AND TEMPERATURE OF THE WARM-POOL

Theory and empirical studies have suggested that an underestimate of the ENSO asymmetry may result in a climatologically smaller and warmer western Pacific warm-pool. Simulations of the tropical Pacific climate by 19 IPCC A1B4 climate models that do not use flux adjustment are evaluated in light of this suggestion. The evaluation reveals systematic biases in both the mean state as well as in the ENSO statistics. It is found that the mean state in most of the models has a smaller and warmer warm pool. This common bias in the mean state is accompanied by a common bias in the simulated ENSO statistics a significantly weak asymmetry between the two phases of ENSO. These findings add support for the suggested impact of ENSO asymmetry on the tropical mean state—the climatological size and temperature of the warm-pool in particular. More importantly, together with previous studies, the findings light a path to improve the simulation of the tropical Pacific mean state by climate models: enhancing the asymmetry of ENSO in the climate models. (Abstract ID 9631)

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EUTROPHICATION INDUCED ACIDIFICATION OF SUBSURFACE COASTAL WATERS

Anthropogenic nutrients have fueled massive coastal algal blooms, which deplete bottom waters of oxygen when the organic matter (OM) from these blooms is respired. As a result, coastal hypoxic zones are now widespread and are accompanied by substantial degradation of benthic ecosystems. In addition to depleting oxygen, OM respiration releases carbon dioxide (CO2), which acidifies the waters. Based on a biogeochemical model, this CO2 input decreased pH by large but variable amounts (up to 1.1 pH unit), with largest effects at low temperature and salinity. These model predictions agreed well with pH data from hypoxic zones in the northern Gulf of Mexico and Baltic Sea, two eutrophic systems with large temperature and salinity differences. The decreases in pH are well within the range that adversely impacts marine fauna, and the combined adverse biological effects of low oxygen and low pH could be much worse than either stressor alone. These combined impacts could worsen substantially in the future with projected increases in atmospheric CO2, which can interact synergistically with respiratory CO2 inputs, and thereby heighten the acidification of hypoxic coastal waters. (Abstract ID 11896)

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StUDIES OF SMALL-SCALE LATERAL DISPERSION IN THE OCEAN

We present results from two rhodamine dye release experiments conducted in the seasonal thermocline of the Sargasso Sea, one in a low strain region (~10^-6 s^-1), the second in an intermediate strain region (~10^-5 s^-1). Both experiments lasted approximately 6 days, covering spatial scales of order 1 to 10 km for the low strain regime, and up to 60 km for the intermediate strain regime. The evolution of the dye patches is discussed, along with the growth of horizontal and vertical tracer moments, and accounting for both diffusivity and strain. The dye data are further related to other data, e.g., from drogue drifters and shipboard ADCP, in an effort to assess possible underlying mechanisms, including shear dispersion as a null hypothesis. (Abstract ID 12296)

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EXPERIMENTAL STUDY OF WAVE SET-UP AND CURRENTS ON THE MACRO-INTERTIDAL BEACH

Macro-Intertidal beach is characterized by periodic movement of shorelines and surfzones. It is very different environment compared to the normal beach in terms of wave forcing, wave induced currents and sediment transport. However, not much research was done on the macro-intertidal beach and often coastal practices such as beach nourishment and construction are performed based on the information or experiment acquired on the normal beach. The west coast of Korea is composed of intertidal beach and mudflat and tidal ranges are from 5 m to 8 m. They are difficult to study but provide some benefits like depth contour information from waterline movement or time and space for managing instruments when the beach is exposed during an ebb tide. Wave height transformation, wave set up and wave
induced currents were observed using a series of gauges and camera images. The XBEACH model was tested at different tidal conditions and compared with the measurement data, and sediment transport including surfzone movement effect was simulated and studied. This study provides basic information to be considered for coastal practices on the macro-continental beach. (Abstract ID 11286)

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VIKING AGE SHELLS RECORD MARINE CLIMATIC SEASONALITY DURING THE MEDIEVAL CLIMATE ANOMALY, ORKNEY ISLANDS, SCOTLAND
Proxy records reconstructing marine climatic conditions during the Medieval Climate Anomaly (MCA; ~900–1350 AD) are strongly biased towards decadal to annual resolution and summer/growing seasons. Here we present new archives of seasonal variability in North Atlantic sea surface temperature (SST) from shells of the European limpet, Patella vulgata, which accumulated in Viking shell and fish middens at Quoygrew on Westray, Orkney. SST was reconstructed at submonthly resolution using oxygen isotope ratios preserved in three shells from the 10th Century and four shells from the 11th–12th Century. All shells recorded warmer summers by 1-3 degrees C and colder winters by 2-4 degrees C relative to the last 20th Century (1961-1990). Therefore, seasonality was higher during the MCA relative to the last 20th Century. Our findings provide a new test for the accuracy of seasonal amplitudes resulting from paleoclimate model experiments. (Abstract ID 10326)

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HOW USEFUL ARE ESTUARINE MODELS TO EXPLAIN THE DYNAMICS OF CROMPHORIC DISSOLVED ORGANIC MATTER (CDOM) IN SUBTERRANEAN ESTUARIES?
We hypothesize that traditional estuarine concepts are useful to explain the dynamics of chromophoric dissolved organic matter (CDOM) in subterranean systems. We studied CDOM in two contrasting estuarine systems in the Northern Gulf of Mexico, i.e. a surface estuary (Savannah River) and a subterranean estuary (STE, beach at Turkey Point). Using parallel factor (PARAFAC) analysis, we identified four humic-like components in the surface estuary that significantly correlated with salinity. In the STE, we identified one tyrosine-like and three humic-like components that did not correlate with salinity, seawater level, or nutrient concentration. These results indicate that contrasting surface estuaries where CDOM dynamics are largely driven by salinity, there is no predominant driving force that could explain CDOM variability in a STE. We also introduced regression matrices as a companion of PARAFAC analysis to picture the complete variability at a given site. In addition, we also linked fluorescence data to detailed molecular data obtained by Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR-MS). It can be concluded that traditional estuarine concepts of freshwater-seawater mixing can not simply be applied to subterranean systems. (Abstract ID 8934)

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SEASONAL VARIABILITY OF SOUTH CHINA SEA THROUGHFLOW
Indonesian throughflow (ITF), the transfer of water from tropical/subtropical Pacific to Indian Ocean through the Indonesian seas plays a significant role of the global ocean system. Observation of ITF branch from the Pacific Ocean into the Luzon Strait-South China Sea Karimata Strait have been conducted since 2008 using arrays of trawl resistant bottom mounted ADCPs in the Karimata and Sunda Straits. Seasonal variability of the transport will be presented. During northwest monsoon from October to April, monsoon winds transport South China Sea water via Karimata Strait and transport Indian Ocean water via Sunda Strait into the Java Sea that affects the main Indonesian throughflow in the Makassar Strait. This reversal monsoon current inhibit upper layer of the main ITF and force the ITF to flow beneath it, which makes Makassar ITF thermocline intensified and cooled. On the other hand, during Southeast monsoon from April to October, monsoon winds transport Java Sea water into the South China Sea and Indian Ocean. Consequently, it will influence the air-sea interaction and ITF characteristics within the Indonesian Seas and Indian Ocean. (Abstract ID 11518)

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SCALING TURBULENCE IN THE UPPER OCEAN: MEASUREMENTS FROM A VERTICALLY RISING MICROSTRUCTURE PROFILER
Microstructure measurements from the freely rising Air-Sea Interaction Profiler (ASIP) are used to study the turbulence characteristics of the upper ocean mixed layer. Measurements consist of 263 profiles from Vestfjorden, Northern Norway over five days in April 2011 and 296 profiles from the North Atlantic over two weeks in July 2011. Profiles of the dissipation rate of turbulent kinetic energy (ε) are calculated from the measured profiles of vertical shear for the mixed layer depth to the surface. Simple scaling laws of Seipolion by the surface buoyancy flux and turbulence near a solid surface (i.e. law of the wall) are investigated for a wide variety of wave and meteorological forcing conditions on the upper mixed layer. (Abstract ID 11949)

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FLUID INTERACTIONS DURING PREDATION BY THE INVASIVE Cetenophore MNEPHOPSIS LEIDYI
The ctenophore Mnemiopsis leidyi is a voracious predator and a highly successful invasive species that has been repeatedly documented to reduce zooplankton abundance and diversity. Like many suspension feeders, predation by M. leidyi is driven by morphology, behavior and a unique feeding-current signature. Correspondingly, motile prey, particularly copepods, are known to remotely sense and respond to the stereotyped flow-field signatures produced by predators and this has implications for prey selection patterns. However, quantification of the feeding current generated by a natural predator in conjunction with escape behaviors of copepods has been rare. Simultaneous recordings of the ctenophore feeding current and swimming behavior patterns of the copepod Acartia tonsa were made in a laboratory tank using Digital Particle Image Velocimetry (DPIV). DPIV measurements produced the instantaneous velocity vectors generated by the feeding current. These measurements allowed us to quantify the shear deformation rates associated with the feeding current and the corresponding thresholds and escape behaviors of A. tonsa, including swimming speed, acceleration and frequency and location of escape. This work has implications for predation by M. leidyi in native and introduced habitats. (Abstract ID 10075)

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MEASUREMENTS OF NEAR-SURFACE WAVE COHERENT TURBULENCE IN THE PRESENCE OF BREAKING WAVES
Wave fields in the open ocean evolve according to the radiative transfer equation, which has three source terms, wind input, non-linear wave-wave interactions, and dissipation. Of these, dissipation is the least well understood, but is thought to be frequently dominated by wave breaking. We will present R/P FLIP-based measurements of near-surface turbulent kinetic energy (TKE) dissipation taken during the ONR HiRES program off the coast of California in 2010. DPIV techniques have been applied to images of surface temperature structure, captured by a pair of long-wave IR cameras, to reconstruct the velocity field at the sea surface. These velocities were then used to derive TKE dissipation at the surface. Synchronized subsurface velocity measurements from an array of profiling pulse coherent Nortek Aquadopps allowed us to calculate a dissipation profile to depths O(10) significant wave heights, Hs. Turbulence measurements were supported by wind and wave data, allowing us to measure the wave coherence of TKE dissipation and relate it to wind and wave conditions, especially wave breaking. Implications of our results will be discussed. (Abstract ID 10699)

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IMPACTS OF BREAKING WAVES ON AIRFLOW AT HIGH WIND CONDITIONS

Impacts of breaking waves on near-surface atmospheric turbulence and on the drag coefficient are investigated using large eddy simulations (LES). The form drag of resolved breaking waves is diagnosed based on the instantaneous wind velocities and positions of the intermittent breaking waves, which are simultaneously simulated during the LES. Then, the form drag introduced in the LES domain interior and at the LES bottom boundary. It is found that the directionality of the breaking waves results in reduced dissipation of turbulent eddies that are much larger than the breaking wave height. In contrast, eddies whose scales are comparable to the wave height are strongly disrupted by the breaking waves. The breaking waves also induce wake turbulence. In very young sea conditions, typically observed in laboratories, the form drag of breaking waves may completely dominate the overall drag and may play an important role in modifying the relationship between the drag coefficient and mean wind speed. (Abstract ID 10812)

FOOD WEB STRUCTURE OF MACROFAUNA AT ARCTIC HYDROTHERMAL VENTS

Initial discoveries of hydrothermal vents in the Arctic included the surprising absence of vent-endemic, chemosymbiont-bearing fauna. To assess the diets of Arctic vent fauna at the southern Mohn's Ridge we used stable isotopes and hypothesized that greater utilization of chemosynthetic food sources (i.e. lighter delta 13C- and delta 15N-values) would be observed in (1) fauna from the immediate vicinity of vents relative to fauna from non-vents, and (2) fauna at high-temperature vents compared to low-temperature vents. Mean isotopic values of fauna from a high temperature vent were significantly lighter than faunal signatures from the non-vent habitat reflecting a greater contribution of sulfide oxidizing bacteria. No significant differences in faunal isotopic signatures from low temperature vents were found when compared to faunal signatures from the non-vent habitat. Overall, the fauna from low temperature and near-high temperature vent and non-vent sites appear to obtain most of their nutrition from suspended particulate-organic matter. We hypothesize that the shallow depth of venting may lead to iron-enhancement of surface production that sinks to the seabed, with subsequent incorporation into faunal food-webs around the vents. (Abstract ID 10992)

A CTD/HYDROGRAPHIC SECTION ACROSS 67°S IN THE FAR SOUTH PACIFIC OCEAN

WOCE Hydrographic Program section 504B carried out originally from Academic Ioffe in 1992, was recollected from RVIB Nathaniel B. Palmer during February - April 2011 as part of the NSF and NOAA funded US Global Ocean Carbon and Repeat Hydrography Program. Although the expedition lost 9 days to stormy weather, a boundary-to-boundary transect across the Pacific sector at about 67°S and two spur sections south to the Antarctic continental shelf were completed. Nearly all ocean layers were warmer in 2011 than 1992, and most of the intermediate and deep waters were saltier. A major new observation was that in 2011 the Ross Sea deep outflow off Cape Adare was both warmer and much fresher than during 1992, and the densest observed outflow water was less dense by about 0.05 sigma-units. High quality, full-depth shipboard CTD/O, routine hydrography, ocean carbon, and CFC data and documentation are now available to the community via the CCHDO. (Abstract ID 10597)

GROUP I WHOLE GENOME ANALYSIS OF UNCULTURED, AMMONIA-OXIDIZING MARINE GROUP I ARCHAEA FROM THE MESPOLAPIC USING SINGLE-CELL GENOMICS

Putative ammonia-oxidizing Marine Group I (MG-I) Archaee are thought to play a critical role in oceanic nitrogen and carbon cycling. However, current cultured marine representatives most likely do not capture genomic variation of uncultured populations. We employed meta- and single cell genomic to investigate the genetic diversity of uncultured mesopelagic MG-I within the South Atlantic and North Pacific Gyres. PCR-screening and whole-genome sequencing of single amplified genomes (SAGs) revealed genes supporting autotrophic and heterotrophic carbon assimilation, and genes involved in the proposed ammonia oxidation pathway of *Nitrosopumilus marinae*. Gene arrangement and content of a high-quality draft SAG was most similar to *N. marinae* than the sponge symbiont Ceratochaete syphonosom. and all three contained a large core genome. Fragment recruitment analysis indicated this SAG was more representative of dark ocean populations than existing marine cultures. Additionally, the SAG harbored several genomic islands, potentially providing additional adaptability to ocean life, and may be indicative of differences between MG-I populations from the Atlantic and Pacific oceans. The metabolic potential of other uncultured, dark ocean bacterial and archaeal groups will also be discussed. (Abstract ID 12689)

FOOD WEB STRUCTURE OF MACROFAUNA AT ARCTIC HYDROTHERMAL VENTS

Initial discoveries of hydrothermal vents in the Arctic included the surprising absence of vent-endemic, chemosymbiont-bearing fauna. To assess the diets of Arctic vent fauna at the southern Mohn's Ridge we used stable isotopes and hypothesized that greater utilization of chemosynthetic food sources (i.e. lighter delta 13C- and delta 15N-values) would be observed in (1) fauna from the immediate vicinity of vents relative to fauna from non-vents, and (2) fauna at high-temperature vents compared to low-temperature vents. Mean isotopic values of fauna from a high temperature vent were significantly lighter than faunal signatures from the non-vent habitat reflecting a greater contribution of sulfide oxidizing bacteria. No significant differences in faunal isotopic signatures from low temperature vents were found when compared to faunal signatures from the non-vent habitat. Overall, the fauna from low temperature and near-high temperature vent and non-vent sites appear to obtain most of their nutrition from suspended particulate-organic matter. We hypothesize that the shallow depth of venting may lead to iron-enhancement of surface production that sinks to the seabed, with subsequent incorporation into faunal food-webs around the vents. (Abstract ID 10992)
OCEAN CLIMATE VARIABILITY IMPACTS ON BIGEYE TUNA (THUNNUS OBESUS) CATCH IN THE SOUTHERN INDONESIAN SEAS

We investigate how oceanographic conditions related to ocean climate variability of El Niño Southern Oscillation (ENSO) influence on bigeye tuna (Thunnus obesus) catch rates in the Southern Indonesian Seas (SIS). We utilized Sea Surface Height Anomaly (SSHA) from TOPEX/POSEIDON, Sea Surface Temperature (SST) from NOAA/AVHRR, Chlorophyll-a from SeaWIFS and bigeye tuna catch data from PT. Perikanan Nusantara, Indonesia. Analyses were done using empirical orthogonal function (EOF) and wavelet spectrum analysis in order to know spatial and temporal decorrelations related to the main forcing of the ocean climate variability for the period of 1997 to 2008 (12 years). The results showed that total variance of the first two mode of SSHA, SST, and Chlorophyll-a explain 59.94%, 35.52%, and 55.26%, respectively. These reflect that SSHA and Chlorophyll-a give more response to the ENSO forcing in the study area. Further analysis performs conducive oceanographic conditions related to the highest bigeye tuna catch correspond to the areas of negative 22-26 cm of SSHA, 23.5-24.5°C of SST, and 0.05-0.15 mg m−3 of Chlorophyll-a. Those events occurred during El Niño in 1997/1998, 2002/2003 and 2006 (Abstract ID 10918).

CLIMATE CHANGE IMPACTS ON MARINE LIFE BASED ON LONG-TERM OBSERVATIONS

To date there has been no comprehensive analysis of climate change impacts on marine life, raising concerns that marine ecosystems have been overlooked in policy assessments. We compiled a global database from ~300 long-term (>20 year) observational studies, including >2000 biological time series, that addressed climate change impacts on plankton to predators. Using a GLM, we found widespread, pervasive, and remarkably consistent (82% consistent) responses across trophic levels, regions (from tropical to polar systems), taxonomy, and life history characteristics. Despite slower warming in the oceans, rates of change in phenology and re-distribution, for example, are similar among marine and terrestrial taxa, with many commonalities (earlier phenology), but also differences presumably due to complex oceanographic-climate change relationships. Overall impacts may have been underestimated because key climate-sensitive regions and lower trophic level species are poorly represented in database (published literature). Greater attention should be paid to species with disproportionate roles in marine ecosystem functions to better understand mechanisms of ecosystem change, and the repercussions to human-ocean systems (fisheries, ecotourism, etc.) that may be altered with continuing marine ecosystem reorganization. (Abstract ID 12488).

GEOCHEMICAL GRADIENT IN LAU BASIN

The East Lau Spreading Center (ELSC) and Valu Fa Ridge comprise a ridge segment in the southwest Pacific Ocean where rapid transitions in the underlying mantle kilometer manifests themselves by gradients in seafloor rock geochemistry. At the spreading center in the north, basaltic host rock extrudes while the influence of subduction in the south creates mainly basaltic anedetic host rock, with a continuous gradient between these two end members. We studied the geology and microbial diversity of three silicate rock samples and three inactive sulfide chimney samples collected along the ELSC and Valu Fa Ridge by X-ray diffraction, elemental analysis, thin section analysis, bacterial 16S rRNA sequencing and metagenomic analysis. Here, we discuss the geological and biological differences between the collected rocks. The bacterial community composition changed as the host rock mineralogy and chemistry changed from north to south. Also, the bacterial community composition on the silicates is distinct from those on the inactive chimneys, and the interior conduit of an inactive chimney hosts a very different community from the exterior. Preliminary results from the metagenome sequencing will be presented. (Abstract ID 12553).

Sediment fluxes to the earths coastal ocean

Milliman and Syvitski (1992) demonstrated a strong correlation between long-term sediment load, drainage area, and basin relief. Based on dimensional analysis, Syvitski and Milliman (2007) developed a complex multi-parameter model BQART able to scale for geology, geography and human disturbance. BQART captures the suspended (wash) load of a river. Human disturbance often magnifies a climate event, such that in Taiwan, much sediment is released through intense precipitation events. How much of this sediment discharge relates to the weather event versus the preconditions by deforestation and farming on steep mountainous slopes that subsequently trigger landslides during the precipitation event? The global impact on human alteration of river sediment loads is huge ranging from accelerated delta subsidence, to changes in coastal fisheries, the health of coastal reefs, or even how water and sediment enters the coastal ocean. Hyperpycnal flow events for example, have become more common for some rivers, and less common for other rivers (Syvitski and Kettner 2011). (Abstract ID 9432).

NUMERICAL MODEL AND OBSERVATIONS OF INTERACTIONS BETWEEN A COASTAL SHELF TIDAL FRONT AND A BAROTROPIC JET

Tidal fronts occur during the summer season on temperate continental shelves with strong tidal currents (Simpson and Hunter, 1974). Recent observations (Sentchev et al, in revision) in the Iorise Sea (shelf sea to the West of France) have shown that the Ushant tidal front is co-located with a tidal residual current, raising questions about the interactions between the temperature front and the barotropic current. An idealised model configuration has been set up, which shows that the vertical motion induced by the divergence of the Ekman transport at the bottom of a barotropic jet acts to re-stratify (resp. de-stratify) the water column on the left (resp. right) side of the jet, thereby enhancing (resp. reducing) the ability of tidally-generated micro-scale turbulence to mix the water column. (Abstract ID 11103)
Effective use of autonomous robots in oceanographic studies requires the ability to take measurements at prescribed times and locations to meet scientific goals. This can be achieved by devising reference trajectories along which robots should move; adherence to prescribed trajectories, however, is hindered by the presence of time-varying flows which may occasionally exceed the robots’ throughput velocity. We develop motion planning strategies that anticipate and mitigate the effects of strong flows by allowing temporary, bounded deviations from the reference trajectory. We combine these motion-planning strategies with model predictive control to improve robots’ closed-loop trajectory-tracking performance. Our algorithms will be used to guide the autonomous operation of two SLOCUM underwater gliders in an extended field experiment to study persistent wintertime phytoplankton blooms near Long Bay, SC, in February 2012. In the experiment, two gliders will be deployed; one will be used for profiling along a cross-shore transect, while the other will act as a semi-stationary mooring at the edge of the Gulf Stream. (Abstract ID 12686)

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DECadal-Scale Variation in Phosphate Concentration in the Western North Pacific from 1950s to Present

Significant decreasing and increasing trends in phosphate were observed in the surface and mid-layers, respectively in the western North Pacific including Oyashio and Kuroshio. Synchronous bidecadal-scale oscillations in phosphate were also found between the two layers in the waters. Differences in the relationship of the trends and the oscillation in these layers suggest that they are driven by separate processes. The trend component may be induced by attenuation of water exchange between the two layers. In contrast, the influence of the 18.6-yr period nodal tidal cycle on the formation rate of intermediate water in the Chukotsk Sea may cause the bidecadal-scale oscillation. The phosphate concentration showed a significant positive correlation with dominant plankton species in the Oyashio and Kuroshio waters. Phosphate is important nutrient for primary productivity and the relationships suggest that the variation in phosphate affected plankton production due to changes in primary production. (Abstract ID 12662)

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THE RESPONSE OF BIOGEOCHEMICAL CYCLES TO OCEAN ACIDIFICATION

Laboratory and field experiments have shown ocean acidification (OA) impacts phytoplankton photosynthesis, nutrient uptake and iron cycling, but constraining their quantitative impact on ocean biogeochemical cycles requires numerical models that necessitate a number of assumptions. We will use a variety of recent model simulations to examine the impact of OA on primary production rates, nutrient requirements and the speciation and cycling of iron, with and without consideration of climate change and test plausible scenarios that have arisen from experimental work. Even without climate change, there is a large uncertainty in the response of biogeochemical processes to OA impacts on carbon and iron cycling that can be as large as climate effects alone and might structure phytoplankton physiological strategies across multiple timescales. Also including climate variability permits the highlighting of key processes that require better quantification towards reducing uncertainties by further coupled experimental-modelling studies. With a large seasonal cycle in pH, limitation of phytoplankton growth by iron and upwelling of carbon rich deep water, the high latitudes of the Southern Ocean can be used as a natural laboratory for such investigations. (Abstract ID 12348)

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GLIDER DEPLOYED BIO-OPTICAL INSTRUMENTS: LESSONS LEARNT AFTER 5-YEAR SAMPLING ACROSS THE LIGURIAN FRONT

Dynamical processes occurring at oceanic fronts influence the vertical (surface-interior)
and lateral (cross-front) exchanges of heat, fresh water, nutrients which impact on primary production. As case study in a temperate area with contrasted biological seasonality (summer oligotrophy, spring phytoplankton blooms), the long term monitoring of hydrological and biological properties across the Lagurian front has been set up since 2006. Glider transects have been sustained in the aim of characterizing biophysical coupling processes from mesoscale to seasonal and interannual scales. A large panel of bio-optical instruments has been deployed: optode, radiometers, fluorometers, backscatterometers and more recently UV nitrate analyzers in the frame of the SeaExplorer and Vague French national programs dedicated to autonomous in-field surveys for coastal water quality. Lessons learnt during these deployments will be presented, in particular adjustments made on payload configurations, sampling protocols or data processing, that have optimized the interoperability of glider deployed sensors and the sampling of observed patterns. (Abstract ID 10235)

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THE FLUX OF SOLUBLE ORGANIC-IRON(III) COMPLEXES FROM ESTUARINE SEDIMENTS REPRESENTS A SOURCE OF STABLE IRON(III) TO THE CONTINENTAL SHELF

Iron speciation in a blackwater estuary was investigated using competitive ligand equilibration--adsorptive cathodic stripping voltammetry (CLE-ACSV). While total dissolved iron in the water column decreases along the salinity gradient, the percentage of dissolved organic Fe(III) complexes measured by CLE-ACSV in the overlying waters of sediment cores increases with salinity. The speciation of iron in the pore waters demonstrates that these complexes originate in the underlying sediments. Diffusive fluxes indicate that only 8% of the sedimentary flux of Fe(III) is delivered to the continental shelf during low riverine discharge. During normal flow conditions, however, the sedimentary flux represents 63% of the total riverine flux of Fe(III). These findings suggest that the flux of dissolved iron to the continental shelf is controlled by the sedimentation of iron in the estuary and the removal of organic-Fr(III) complexes from the sediments. This estuary generates five to eight times higher concentrations of dissolved Fe(III) than the average major world rivers, suggesting that it is, along with other small blackwater rivers, currently underestimated in world average river flux calculations. (Abstract ID 11598)

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ON THE VERTICAL STRUCTURE OF WESTWARD PROPAGATING ROSSBY WAVES AND EDDIES

Altimetry have over the past 20 years revolutionized our understanding of oceanic Rossby waves by revealing ubiquitous westward propagation in all basins at nearly all latitudes with characteristics often markedly different from those expected from linear standard theory. This result prompted much theoretical investigation seeking to understand the role of background mean flow, topography, dispersion, and nonlinearities in accounting for the observed propagation characteristics of westward propagating signals. However, because the altimeter signal is intrinsically limited to the surface, there is correspondingly less understanding of the vertical structure of such signals. Theoretical considerations suggest that mean flow, topography, dispersion, and nonlinearities can all significantly affect the vertical structure of westward propagating signals. In this work, the success and limitations of generalized linear theory accounting for mean flow and topography is tested against empirically determined vertical structures from high-resolution numerical simulations of the Atlantic ocean. We also discuss the relative importance of topography and background mean flow in causing surface intensification of Rossby waves vertical structures. (Abstract ID 10287)

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WILL PERMAFROST MELTING IMPOSE NITROGEN LIMITATION ON COASTAL BACTERIAL COMMUNITIES IN THE WESTERN ARCTIC?

A predicted consequence of a warming Arctic is a 10-fold increase in the release of carbon-rich (C:N 25) permafrost-derived organic carbon (OC) to the coastal ocean. As a result, the competition between autotrophic and heterotrophic plankton communities for nitrogen is predicted to intensify. To investigate this hypothesis we explored the genetic and biogeochemical potential of bacterial communities in the Western Arctic to utilize nitrate, which would allow greater assimilation of this additional OC. Community DNA samples collected from surface waters during the spring, summer, and winter from the Chukchi shelf revealed the ubiquitous presence of bacterial assimilatory nitrate reductase (nasa) genes. Surprisingly little genetic diversity at this loci was observed. Recovered nasa genes were dominated by sequences similar to those observed in the Eastern Arctic. In a series of bacterial growth bioassays, the addition of permafrost-derived OC, collected near Barrow, Alaska, stimulated bacterial growth and activity and the utilization of nitrate at near Redfield ratios. These observations support the hypothesis that increased permafrost-derived OC release will intensify the competition between autotrophs and heterotrophs for nitrogen in a melting Arctic. (Abstract ID 11909)

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ESTIMATES OF THE TURBULENT KINETIC ENERGY BUDGET IN THE CONVECTIVE BOUNDARY LAYER

The terms of the steady-state turbulent kinetic energy (TKE) budgets in the nighttime convective boundary layer (CBL) are estimated using the microstructure data obtained from the Turbulence Ocean Microstructure Acquisition Profiler (TurboMAP). To minimize the effect of horizontal advection, the TurboMAP was deployed from a ship following a satellite-tracked surface drifter. During the entire period of the microstructure measurements, the stratification did not change significantly, indicating a linear depth dependence of the turbulent buoyancy flux. We therefore prescribe a vertical profile of the buoyancy flux term decreasing linearly from its value at the sea surface down to zero at the bottom of the CBL. The dissipation term is directly calculated from the micro-scale vertical shear of horizontal velocity measured using a shear probe, whereas the shear production term is estimated assuming the similarity law. The transport term calculated as the residual of the other three terms vertically redistributes the TKE from the upper half of the CBL to the lower half, consistent with the Thorpe scale of the same order of magnitude as the depth of the CBL. (Abstract ID 9676)

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DEVELOPMENT OF A SIMPLE PRETREATMENT METHOD USING NOBIAS CHELATE-PAI RESIN FOR MEASUREMENT OF COPPER ISOTOPE COMPOSITION IN SEAWATER

Copper is an essential trace metal and shows a vertical profile of a recycled-seawater type in the ocean. The copper isotopic composition in seawater has been reported recently. This is an important study in chemical oceanography, because the copper isotopic composition has a potential that clues to understand biological cycling of copper in the present and past oceans. However, precise isotopic analysis of Cu has been retarded by low concentrations of copper and coexisting elements that cause interferences with the measurement by MC-ICP-MS. Therefore, removal of the matrix elements is essential to obtain reliable isotopic data of seawater. For this reason, the previously reported method involved multiple steps of co precipitation and ion exchange. The objective of this study is to develop a simple preconcentration method using NOBIAS Chelate-PAI resin (Hitachi High-Technologies). This resin has both inorganic and ethylenediaminetetraacetic acid groups, forming a stable complex with copper at a low pH and eliminating alkali and alkaline earth metals effectively. We will present the method and results of Cu isotopic compositions data for a series of samples collected from the Pacific Ocean. (Abstract ID 10154)

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ENANTIOMER-SPECIFIC ISOPTOE ANALYSIS (EISA): INSIGHT FROM NITROGEN ISOTOPIC HETERO- AND HOMOGENEITY BY MICROBIAL AND CHEMICAL PROCESSES

A predicted consequence of a warming Arctic is a 10-fold increase in the release of carbon-rich (C:N 25) permafrost-derived organic carbon (OC) to the coastal ocean. As a result, the competition between autotrophic and heterotrophic plankton communities for nitrogen is predicted to intensify. To investigate this hypothesis we explored the genetic and biogeochemical potential of bacterial communities in the Western Arctic to utilize nitrate, which would allow greater assimilation of this additional OC. Community DNA samples collected from surface waters during the spring, summer, and winter from the Chukchi shelf revealed the ubiquitous presence of bacterial assimilatory nitrate reductase (nasa) genes. Surprisingly little genetic diversity at this loci was observed. Recovered nasa genes were dominated by sequences similar to those observed in the Eastern Arctic. In a series of bacterial growth bioassays, the addition of permafrost-derived OC, collected near Barrow, Alaska, stimulated bacterial growth and activity and the utilization of nitrate at near Redfield ratios. These observations support the hypothesis that increased permafrost-derived OC release will intensify the competition between autotrophs and heterotrophs for nitrogen in a melting Arctic. (Abstract ID 11909)
We revealed nitrogen isotopic hetero- and homogeneity for D-α-alanine and L-α-alanine in terms of microbial processes in domain Bacteria and chemical processes in organic synthetic synthesis. D-alanine is a physiologically essential enantiomer for microbial growth and metabolic maintenance. The nitrogen isotopic difference of amino acids in peptidoglycan defined as Δ15N,α (Δ15N,α = Δ15N,α, D - Δ15N,α, L) defined as difference between Δ15N,α, D and Δ15N,α, L in bacteria, representative Bacteria (abundant Firmicutes and Actinobacteria), tended to be Δ15N,α, D-1% lower than the isotopic reference (Δ15N,α, D < -2%). This suggests that isotopically heterogeneous components are mainly controlled by enzymatic pathways prior to formation of the bacterial cell wall.

In contrast, the Δ15N,α, racemic alanine in the chemical pathway during the typical nucleophilic substitution reaction (SN1 type) between 2-bromopropanolic acid and ammonia showed infinitely homogeneous components for each enantiomer. The novel method of enantiomer-specific isotopic analysis (ESIA) is useful for distinguishing the origin of biogenic and abiotic processes and is applicable to enantiomer studies.

[References]


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TEMPORAL VARIABILITY OF OXYGEN IN THE UPPER OCEAN

Variability of dissolved oxygen profoundly influences marine ecosystem and biochemical processes in the ocean. Measurements of dissolved oxygen and nitrate from autonomous sensors in the North Pacific reveal weekly to interannual variability of these properties in the upper water column (σθ ~26.5), primarily driven by the vertical displacement of the isopycnal layer. A strong linear correlation between the isopycnal oxygen and nitrate is observed on this specific layer. This implies that biological responses to anomalous upwelling further enhance the oxygen variability as discussed by Deutsch et al. (2011). Oxygen variability in the surface mixed layer is shown to have an inter-annual “memory” during cold seasons associated with the entrainment of subsurface oxygen anomaly from the previous winter. This mechanism is analogous to the reemergence of the sea surface temperature anomalies in mid-latitudes. These physical and biochemical processes are general and can potentially influence oxygen variability in other regions. This biogeochemical reemergence could be one of the key mechanisms producing multi-year variability of the oxygen. [Reference] Deutsch, C., H. Brix, T. Ito, H. Frenzel, L. Thompson (2011), Climate forcing of ocean hypoxia, Science, 333, 336-339. (Abstract ID 11923)

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CONTRIBUTIONS OF MECHANISMS OF SURFACE WIND RESPONSE TO THE GULF STREAM IN A REGIONAL ATMOSPHERIC MODEL

This study quantitatively evaluates contributions of different mechanisms of near-surface wind response to sea surface temperature (SST) front along with the Gulf Stream. We have developed a new diagnostics method and applied it for a regional atmospheric model with special attentions to pressure adjustment and vertical mixing mechanisms. It is found that the wind speed change across the Gulf Stream is mainly due to the vertical mixing mechanism. Also, most part of the wind curl is produced by the vertical mixing mechanism. However, the wind convergence/divergence is mainly explained by the pressure adjustment mechanism. The different contributions of mechanisms for different wind parameters can be understood from the wind direction to the SST fronts. The wind curl and divergence due to the vertical mixing mechanism can be proportional to crosswind and downwind SST gradient, respectively. Over the western Gulf Stream, the wind direction is roughly parallel to the SST front, and this is ineffective (effective) in producing divergence (curl). (Abstract ID 10988)

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MARINE ECOSYSTEM RESPONSES TO THE CLIMATE WARMING SIMULATION IN THE JAPAN SEA

To understand the ecosystem responses in the Japan Sea to the climate change, we carried out numerical experiments with physical-biological coupled model applying the A1B global warming scenarios. In the 2050s, the seasonal variability of the phytoplankton were characterized by following two events, one is the spring bloom, the other is found in the summer at the eastern part of the Korean Peninsula where a western boundary current is separated from the coast. These results were in good agreement with the general knowledge in the Japan Sea. In the 2500s, the two increasing events above can be found, but they were weak relative to those of the 2000s, i.e. the phytoplankton population in the 2500s is about 80% of that in the 2000s above 30m depth. This difference was caused by decreasing of the nutrient supplies in our model. The nutrient decreasing results from the weakened winter convection and the enhanced summer stratification by the global warming. It is suggested that the global warming makes the ecosystem system in the Japan Sea less productive. (Abstract ID 11013)

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ORGANIC COMPLEXATION OF IRON IN THE PACIFIC OCEAN

Vertical distributions of dissolved iron and organic iron-complexing ligands were determined over a wide area of the Pacific Ocean to examine the vertical and horizontal gradients of the organic complexation. In surface waters, low concentration of dissolved iron was observed with an excess of strong organic ligands, and most of the dissolved iron was estimated to be complexed with these organic ligands. In the subsurface North Pacific, we found that concentrations of dissolved iron around 1000 m depth were higher than the organic ligand concentrations; excess dissolved iron can exist as colloidal Fe and/or organic/inorganic complexes with weak ligands that were not detectable by our method. The presence of excess dissolved iron for organic ligands was also observed in the deep water at a station east of Fiji in the tropical South Pacific. On the other hand, the concentrations of organic iron-complexing ligands were higher than dissolved iron concentrations throughout the water column in the equatorial Pacific. These results suggest that the extent of organic complexation of iron varies in relation to biogeochemical processes in the ocean interior. (Abstract ID 12479)

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ASSESSMENT OF A 1D MODEL FOR INTERPRETATION OF PROFILING FLOAT OXYGEN DATA

Profiling floats equipped with oxygen sensors provide near-ideal platforms to monitor the seasonal evolution of dissolved oxygen. The oxygen sensors have excellent precision and long-term stability, but the accuracy of the data is not yet sufficient for quantitative biogeochemical analysis such as gas exchange. With the number of oxygen sensors rapidly growing in the global float array, it is crucial to understand the uses and the limitations of the data. It has been shown that a one-dimensional surface-mixing model can be applied to float oxygen data to extract a community production signal. If the model accurately recreates the physical processes in the surface ocean, then the residual between the modeled oxygen and the observations can be attributed to biological production or utilization of oxygen. In this study, the 1D model was applied to a number of floats after correcting the data using a newly developed QC protocol. The model results were then evaluated for sensitivity to the accuracy of the QC protocol and other important factors such as exchange and unmodeled physics. (Abstract ID 12804)

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EFFECTS OF BIO-PHYSICAL INTERACTIONS ON PARTICLE DISTRIBUTIONS REVEALED BY IN SITU DIGITAL HOLOGRAPHY, ADAPTIVE SAMPLING AND PROFILING OF BULK WATER PROPERTIES

Cinematic digital holograms recorded by the free drifting ‘HoloSub’ simultaneous measurements of density, chlorophyll and light scattering, and adaptive sampling were used to characterize the particle population and flow in the water column in East Sound, WA. A 20,000 hologram up cast provided vertical profiles of shear strain and dissipation rates, size distributions of species, and orientation of diatom chains. Key results include: (a) formation of multiple 10-20cm thick layers of small particle with broad horizontal extents, in regions of low local shear/dissipation, (b) an intense phytoplankton layer occurred at the base of a stable pycnocline, and primarily contained diatom chains, detritus and Chaetoceros socialis colonies with ~4x106 cells/ml, (c) zooplankton avoided layers with high concentrations of C. socialis colonies and/or particles; (d) diatom chains had a near-horizontal alignment at the pycnocline base; and shallow angles in other low shear regions, but were randomly oriented in regions of high shear, consistent with theories; (e) size distribution of small particles had power laws with varying exponents, while diatom chain and C. socialis colonies sizes had log-normal distributions. (Abstract ID 11533)
Talley, D., Plymouth Marine Laboratory (University of Essex), Plymouth, United Kingdom, northerm hemispheres are carried by the surface overturning cells in the south, and by North vapor transports. The equatorward freshwater transports from the high latitude southern and salinity differences between ocean basins that arise from the pattern of atmospheric water Deep Waters joins the upwelled North Atlantic Deep Water to form the large Antarctic Bottom surface flows that eventually return to the North Atlantic. The remainder of the Indian/Pacific Ocean and the Indian/Pacific Oceans is integral to the global overturn. The Indian/Pacific to the bottom, based on observational syntheses. Diapycnal upwelling in both the Southern in terms of the largest spatial scales of steric height distributions, at all depths from the surface 455

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GLOBAL OVERTURNING CIRCULATION: DOWN-GRADIENT FLOW AND FRESHWATER TRANSPORTS

The relation between the observed global overturning circulation, steric height distributions at all depths, and freshwater transports is examined. The global circulation is down-gradient in terms of the largest spatial scales of steric height distributions, at all depths from the surface to the bottom, based on observational syntheses. Diapycnal upwelling in both the Southern Ocean and the Indian/Pacific Oceans is integral to the global overturn. The Indian/Pacific Deep Waters return to the Southern Ocean, upwelled to the sea surface, and feed the northward surface flows that eventually return to the North Atlantic. The remainder of the Indian/Pacific Deep Waters joins the upwelled North Atlantic Deep Water to form the large Antarctic Bottom Water overturning cell. The distribution of diapycnal fluxes depends mainly on the small salinity differences between ocean basins that arise from the pattern of atmospheric vapor transports. The equatorward freshwater transports from the high latitude southern and northern hemispheres are carried by the surface overturning cells in the south, and by North Atlantic Deep Water and North Pacific Intermediate Water formation in the north. (Abstract ID 10942)

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PHYTOPLANKTON RESOURCE ALLOCATIONS PREDICT ADAPTATION TO THE LIGHT ENVIRONMENT

Pelagic phytoplankton respond to light availability in light. We show, from first principles, how adaptation of cells to the light environment explains observed differences in growth characteristics both within and between species. We present a model that partitions a cell's resources between functional components, e.g. light harvesting, carbon fixation, protection from photodamage and biosynthesis, and we assess how allocation to these components varies when cells maximise growth in a range of simulated environmental cells. Cells adapted to deep mixing have resource allocations that protect them against photodamage, whereas cells suited to more stable environments are heavily photosynthetically inhibited at high light. These results are consistent with observations that show a lack of inhibition for cells that dominate in deep mixing (e.g. diatoms) and heavy inhibition for cells adapted to more stable environments (e.g. Prochlorococcus). We suggest that the model encapsulates a universal mechanism by which cells adapt to the light environment, and that our approach provides a framework for ecosystem models to go beyond the limits of empirical formulations based on a limited number of species cultured in artificial laboratory conditions. (Abstract ID 10316)

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NEW PRODUCTION: A DRIVER OF EXPORT STOICHIOMETRY IN THE OCEAN?

Vertical export of organic carbon in the ocean is constrained by nitrate-based new production, but the efficiency of the biological carbon pump is dependent on the elemental stoichiometry of the surface organic matter. In high-POC/PN regions such as the Arctic, Redfield-based ecosystem models underestimate C-export by up to 30%. In order to elucidate the regulation of exported C/N we synthesised sediment trap data from eight distinct biogeochemical regions ranging from the central Arctic Ocean (north pole) to a temperate upwelling system. The mean exported C/N ranged from 7.4 (aa) in a subarctic shelf system to 9.7 in the central Arctic Ocean. While the entire dataset revealed a decrease in C/N with increasing flux rates, individual regions showed contrasting trends. Mean exported C/N was negatively related to new production in the respective regions, a trend which was confirmed by including other N-limited regions, suggesting nitrogen utilisation as a driver of export stoichiometry at a large scale. This suggests that stoichiometric effects will counteract future increases in C-export in the Arctic Ocean anticipated from projections of reduced sea-ice cover and increased production. (Abstract ID 9690)

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EFFECTS OF THE 18.6-YEAR MODULATION OF TIDAL MIXING ON BICENTRAL CLIMATE VARIABILITY IN THE NORTH PACIFIC

Diapycnal mixing induced by tide-topography interaction, which is one of the essential factors maintaining the global ocean circulation and hence the global climate, is modulated by the 18.6-year oscillation of the lunar orbital inclination, as has therefore been hypothesized to cause bicentral climate variability. In this study, the spatial distribution of diapycnal diffusivity together with its 18.6-year oscillation estimated from a global tide model is incorporated into a state-of-the-art numerical climate model to investigate its effects on climate variability over the North Pacific and to understand the underlying mechanism. It is shown that significant sea surface temperature (SST) anomaly with the period of 18.6 years appears in the Kuroshio-Oyashio Extension region; positive (negative) SST anomaly tends to occur during strong (weak) tidal mixing. This is first induced by anomalous horizontal circulation localized around the Kuril Straits where strong tidal mixing exists, and then amplified through a positive feedback due to midlatitude air-sea interaction. The resulting SST pattern is reminiscent of that associated with the Pacific Decadal Oscillation, suggesting the potential for improving climate predictability by taking into account the 18.6-year modulation of tidal mixing. (Abstract ID 10884)

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SPONTANEOUS GENERATION OF NEAR-INERTIAL WAVES FROM KUROSHIO FRONT INSTABILITIES

Banded structures in diapycnal shear are seen in summer 2008 observations of the Kuroshio front, a signature of loss of balance and near-inertial waves radiating away. We explore this hypothesis by non-hydrostatic and hydrostatic modelling, initialized by an observed hydrographic section, assumed to be in thermal wind balance. The unforced front goes boreally unstable to both mesoscale meanders and sub-mesoscale eddies and filaments. Additionally, spontaneous generation of near inertial waves from the unstable front appears in bursts and at specific locations of the mesoscale meander, particularly east of the Kuroshio trough. Lagrangian spectra show frequency peaks at f to 1.5f. The associated wave energy fluxes show a consistent pattern of energy turning in the high-POC/PN regions as expected from interaction of near inertial waves with a baroclinic jet. The bursts of internal wave energy flux simulated in the Kuroshio front's meander trough have comparable magnitude to wind-generated near-inertial energy fluxes, even after zonal and temporal averaging. The internal wave flux divergence shows generation in high confluence regions where loss of balance conditions prevail, while convergence shows preferential sink of near-inertial energy in frontogenetic, high shear regions. Thus, the generation/destruction of these waves represents a dissipative loss through a cascade from balanced motion through near inertial internal waves, eventually to turbulence and mixing. (Abstract ID 12263)

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Whether you would like to respond to the questions, confirm the answers, or ask for more information, feel free to ask! I'm here to help.
PARAMETERIZING SIZE-STRUCTURED ECOSYSTEM MODELS USING A MODIFICATION OF THE TRADITIONAL DILUTION METHOD

Earth System Models require better parameterizations for accurate climate change predictions. With ecosystem models becoming more complex and size-structured models becoming more common, there is an increasing need for accurate parameterization with size-specific data. We will present a technique we have developed to determine size-dependent phytoplankton growth and grazing rates based on the traditional dilution method. These rates are fundamental to understanding phytoplankton population dynamics and, subsequently, primary production and ocean carbon cycling. This size-dependent dilution method requires data on the phytoplankton size structure from two time points, typically 24 hours apart. The accuracy of this technique was assessed with complex modeled ecosystems, with strong agreement between model rates and those estimated with the size-dependent dilution method (two-sample Kolmogorov-Smirnov test, p<1). Values of size-specific growth and grazing rates for incorporation into Earth System Models can be calibrated with little alteration to traditional dilution experiments that are routinely carried out in many regions of the world’s oceans. This method has been applied to data from the equatorial Pacific, providing new insights into size dependencies of phytoplankton dynamics. (Abstract ID 9781)

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DOES PRACTICE MAKE PERFECT? ROLE OF TRAINING AND FEEDBACK IN IMPROVING SCIENTISTS’ PRESENTATION SKILLS

Within the research and academic communities, there is growing interest in improving scientists’ communication skills. To address this need, we developed a two-day workshop [Presentation Boot Camp (PBC)] that focuses on presenting scientific concepts and research findings to scientific/technical audiences and the general public. Through a series of interactive sessions, participants practice techniques for organizing and preparing presentations that communicate messages more clearly and have a lasting impact on the audience. The PBC also includes training in the use and application of a protocol for evaluating presentations [Presentation Skills Protocol (PSP)]. The PSP focuses on eleven presentation skill sets (e.g., organization, relevance, message, language, delivery, presence) that are operationally defined at three levels of competence. The PSP may be used to provide scientists with feedback on presentation quality and effectiveness and to design professional development programs targeting specific presentation skills. However, use of the PSP alone does not guarantee communication growth or competence. Improvement in communication skills requires formal training in best-practices for preparing and delivering presentations, frequent opportunities to practice, and regular, structured feedback. (Abstract ID 10079)

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POTENTIAL ATMOSPHERIC AND OCEANOGRAPHIC CONTROLS ON THE FORMATION OF HYPOXIA IN THE COASTAL WATER OF MYRTLE BEACH, SOUTH CAROLINA, USA

Over the past few decades, scientists have become increasingly aware of hypoxic water and its potential impact on biota. Based on time-series (every 15 minutes) ocean observations, low oxygen conditions have been found during nearly every summer between 2007 and 2011 in the coastal waters of Myrtle Beach, South Carolina. Observational and modeling data were used to analyze the atmospheric and oceanic controls on the formation of hypoxia. A periodicity analysis was performed for the surface and bottom oxygen data, showing two distinct periodicities: one at 1 cycle per day (a diurnal cycle from solar radiation) and the other at ~1.9 cycles per day (a semi-diurnal cycle from tides). Three-dimensional atmospheric (Weather Research Forecast, WRF) and ocean circulation (Regional Ocean Modeling System, ROMS) models were used to investigate wind variability and ocean circulation, with special focus on upwelling and stratification/mixing before, during and after severe hypoxia events in August and September 2009. Based on these analyses, three conceptual scenarios were proposed to investigate how hypoxia develops in the coastal water of Myrtle Beach, South Carolina. (Abstract ID 11469)

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RELATING WIND STEERING AND PIC PHYTOPLANKTON DISTRIBUTION IN THE OCEAN USING THE ATLANTIC MERIDIONAL TRANSET OBSERVATIONS

The abundance of the smallest phytoplankton, responsible for a major part of CO2 fixation in the ocean, was monitored by flow cytometry on the Atlantic Meridional Transect (AMT)
cruises annually for over a decade. The mean concentration of the smallest algae was about twice as high across the Atlantic Ocean from 30°N to 30°S in autumn 2008 compared to autumn 2005. The observed differences are less likely related to seasonality than to large scale changes of wind forcing taking into account a corresponding 50% increase in the mean wind speed in 2008 compared to 2005. These observations suggest that climate-change induced increase in wind stirring could elevate phytoplankton sequestration of CO2 in the open ocean. More recent as well as earlier observations were used to test this hypothesis and the results of those tests will be presented (Abstract ID 10179)

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COUNTING AND SIZING OF COLLOIDAL PARTICLES IN THE ARCTIC OCEAN

Naturally occurring colloidal particles less than 1 micron in size play multiple key roles in aquatic environments, yet their abundance and size distribution is rarely documented in field studies. We assess the feasibility of using observations of laser light scatting by particles undergoing Brownian motion within a liquid sample coupled with particle tracking analysis to quantitatively estimate the particle size distribution (PSD) of colloidal material. Laboratory experiments with well-defined standards indicate that robust estimates of the PSD in the submicron range can be obtained with appropriate characterization of instrumentation and measurement protocols. We describe field measurements of the concentration and size distribution of submicron colloidal particles, including nanoparticles in the size range of 50-100 nm, from the Chukchi and Beaufort Seas during summer. Initial observations indicate that the concentration of colloidal material varies more than an order of magnitude in this environment, and the slope of the PSD also exhibits considerable variability. Such results suggest that the PSD of the submicron particle fraction can be highly dynamic in marine environments. (Abstract ID 9602)

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COMPARING SHORT-TERM AND LONG-TERM ADAPTED RESPONSES TO CHANGING PCO2 IN A COASTAL DINOFLAGELLATE BLOOM

The ongoing transition to a ‘greenhouse’ ocean will likely affect phytoplankton community structure due to taxon-specific responses to changing PCO2 and pH. Using short-term manipulation experiments to predict these shifts over longer timescales may be problematic, as this approach does not address potential acclimation and adaptation. We incubated a natural mixed dinoflagellate bloom from coastal Southern California for two weeks at three PCO2 levels (190, 390, and 750 ppm) and assessed community structure changes using microscopy and molecular techniques. Then, the major dinoflagellate species in the community were isolated into clonal culture and maintained at all three PCO2 levels under steady state conditions for ~1 year. Periodically, these adapted clones were recombined into artificial communities at the same relative abundances as in the original natural community incubation experiment, and allowed to compete under all three PCO2 levels. Results of the long-term adapted competition experiments yielded both similar and dissimilar trends compared to the original short-term natural assemblage incubations, emphasizing the need for extended experiments to accurately predict long-term phytoplankton community responses to changing pH and PCO2. (Abstract ID 12152)

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ECOSYSTEM RESPONSES IN THE SOUTHERN CARIBBEAN SEA TO GLOBAL CLIMATE CHANGE: RESULTS FROM CARICO OCEAN TIME-SERIES

We present observations from the CARICO Ocean Time-Series between 1996 and 2010 documenting significant changes in the Southern Caribbean’s marine ecosystem during this period. Mean sea surface temperatures (SST) warmed by ~0.8°C and surface waters became more stratified over this period. Chlorophyll a and net primary production decreased at rates of 2.8 and 1.5% yr-1, respectively. Furthermore, taxon dominance in 2005 shifted from diatoms, dinoflagellates, and coccolithophorids to smaller phytoplankton as upwelling of nutrient-rich waters decreased in response to slackening Trade Winds (~1.9% yr-1). Counter-intuitively, flux of sinking particulate organic matter leaving the surface layer increased by ~1% yr-1, presumably driven by altered plankton community structure. Observed changes likely reflect broad-scale ecosystem variations in the Caribbean Sea and Western Atlantic Ocean. For the first time, we link contemporary ecosystem state changes over the last 14 years with three climatic indices; (i) northward migration of the Azores High pressure center by 0.84° latitude, (ii) northeasterly progression of the intertropical convergence zone (ITCZ) controlled by over 600 km, and (iii) interannual variations in the El Niño/Southern Oscillation (ENSO). These are likely manifestations of expansion of atmospheric Hadley circulation predicted by climate models as a consequence of global warming. (Abstract ID 9715)

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SUBMESOSCALE RESTRATIFICATION TRIGGERS PHYTOPLANKTON BLOOMS AT OCEAN FRONTS

Recent advances in numerical modeling and observational techniques have shown that the surface mixed layer contains a rich network of density fronts with scales of 10-100 km. Theoretical and modeling studies have shown that fronts can be unstable to a variety of submesoscale instabilities, which feed upon the available potential energy associated with the front, and restratify the upper ocean. Recent work has demonstrated that restratification, driven by submesoscale instabilities, can be effective even in the presence of strong atmospheric forcing. Here, using large-eddy simulations, we show that an important consequence of this restratification is to reduce the rate of vertical mixing in the upper ocean, which in turn affects marine organisms. In particular, we find that reduced mixing at fronts can trigger phytoplankton blooms under light-limited conditions. Through this mechanism, fronts become hotspots for high latitude primary production when growth is otherwise limited by light exposure. This finding helps to explain the patchy distribution of mid-ocean phytoplankton blooms that characterize satellite images and demonstrates that developing an accurate representation of submesoscale dynamics will be an essential step towards improving biogeochemical models. (Abstract ID 10722)

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THE STRUCTURE OF THE THREE-DIMENSIONAL TRACER CASCADE IN ‘IDENTICAL’ BOUSINESQ AND QG SIMULATIONS

Oceanic tracer fields are stirred along isopycnals by mesoscale eddies, generating a rich forward cascade of tracer variance that can result in finescale features. An important consideration is whether submesoscale features affect the tracer: do unbalanced motions significantly alter the variance and dissipation predicted for balanced mesoscale stirring? We perform a suite of simulations with increasing Rossby number (Ro), using quasigeostrophic and Boussinesq models initialized initially with a balanced, baroclinically unstable front. A tracer with a constant mean lateral gradient is stirred by the flow. At low Ro, the velocity and tracer fields in the two models remain very similar in spectrum and structure. We show that this is because submesoscale stirring dominates submesoscale stirring in the tracer variance budget. Thus, in order to interpret and understand the structure of tracers at the submesoscale, it is crucial to quantify the mesoscale velocity field. (Abstract ID 12349)

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TROPOPHIC LINKAGES IN NORTHERN NEPTUNE WHELEKS (NEPTUNEA HEROS) OF THE CHURCHI SEA USING ISOTOPIC AND LIPID BIOMARKERS
The broad, shallow continental shelf of the Chukchi Sea sustains a rich community of benthic invertebrates with biomass rivaling some of the highest in the global ocean. Species richness and diversity are fueled by high water column production in spring that rapidly sinks to the seafloor. Northern Neptunia wheelis (Neptunia heroes) are dominant epifaunal invertebrates found throughout the Chukchi shelf to the Western Arctic Ocean. The mobility and opportunistic feeding behavior of these predatory gastropods is complex, and provide a model organism to investigate molecular signatures of consumption and potential carbon sources and cycling on the Chukchi shelf. As part of the Chukchi Offshore Monitoring in Drilling Area (COMIDA) project, a suite of lipid biomarkers were measured in Neptunia foot muscle, surface sediment and detrital particles spanning the study area. Results show that Neptunia feed at multiple trophic levels and incorporate primary production either directly through detrital feeding or indirectly via trophic transfer from their prey. Results of compound-specific carbon isotopic analysis on lipid products suggest their retention of multiple food sources as well as anthropogenic hydrocarbons in muscle tissues. (Abstract ID 9878)

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ON THE DRIVERS OF PHYTOPLANKTON BLOOMS IN THE ANTARCTIC SEASONAL ICE ZONE: A GCM APPROACH

The Antarctic seasonal ice zone (SIZ) has been found to support spring phytoplankton blooms on orders of magnitude greater than in neighboring open ocean waters. Blooms are known to begin as soon as the ice begins to deteriorate and are hypothesized to occur when melting sea ice creates a stable, pycnocline where phytoplankton communities can develop in the high-light, high-nutrient conditions. Due to the difficulties in observing the blooms in situ or remotely, we use a high resolution (18 km x eddy grid length) bio-physically coupled global circulation model (GCM) to test this hypothesis. Study areas of the SIZ were identified through correlation of model output with remote sensing estimates of sea surface temperature, sea ice concentration and chlorophyll a concentration. A Generalized Additive Model was used to assess the importance of various modeled parameters on phytoplankton dynamics. Initial results support the hypothesis that physical conditions drive blooms dynamics while nutrient limitation is of lesser importance. (Abstract ID 11075)

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CURRENTS OVER THE EAST FLOWER GARDEN BANK

Five acoustic Doppler current profiler (adcp) moorings and four temperature/salinity strings were deployed on and around the East Flower Garden Bank in the northwestern Gulf of Mexico in December 2010 and were recovered and redeployed in June 2011 until December 2011. These measurements are done in close cooperation with the Bureau of Ocean Energy Management, Regulation, and Enforcement, the Flower Garden Banks National Marine Sanctuary, and a closely related Naval Research Laboratory Mixing Over Rough Topography (MORT) project. Our main objective is to understand the ocean processes over the East Flower Gardens Bank and to examine the importance of the topographic induced processes on shelf edge circulation on longer (e.g. monthly to seasonal) time scales. For the first six months, currents were generally eastward over the bank in the upper water column except for a westward reversal for several weeks during March. Interestingly, currents near the bottom aligned with the bathymetry contours, splitting into northeastward and southeastward branches northwest and southwest of the bank, respectively, while turning southwestward on the east side of the bank, and then flowing offshore. (Abstract ID 10331)

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IMPORTANCE OF HETEROPTIC FEEDING IN SUPPLYING AMINO ACIDS TO SCLERACTINIAN REEF BUILDING CORALS

Reef building (Scleractinian) corals satisfy their nutritional and energy requirements by a combination of heterotrophic assimilation (feeding) and translocation from autotrophic endosymbiotic dinoflagellates (zoanthellae). We determined the source of essential amino acids (AAs) in corals by separately measuring and comparing the stable carbon isotope composition of individual AAs in zoanthallae and coral hosts from two Scleractinian coral species (Montastraea faveolata and Porites astreoides) from the Florida Reef Tract. Using an isotopic mass balance approach, we show that feeding provides a greater proportion of essential AAs to corals growing in deeper waters where photosynthetic production is reduced due to lower light availability. In shallow water, M. faveolata can acquire Lys and Leu from feeding, whereas zooxanthellae are the dominant source of essential AAs for P. astreoides. The considerable variability in feeding behavior within, and between, these two species shows that the relative proportion of feeding-derived nutrients is specific to each colony. This variability is likely the result of food, nutrient, and light availability immediately adjacent to the coral which can be influenced by reef topography, water flow, and boundary layer dynamics. (Abstract ID 9868)

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COASTAL PLANE ESTUARIES AS LOW PASS FILTERS FOR TSUNAMI ACTIVITY

Recent simulations of tsunamis propagating toward Delaware Bay have shown that high frequency components of the tsunami signal are rapidly attenuated with distance from the mouth, while low frequency components pass more easily along the length of the bay. We hypothesize that higher frequency components of the signal are refracted towards lateral shorelines and decay due to wave breaking while, in the low frequency limit, waves see a relatively steeper lateral sidewall and propagate undamped along the estuary in a manner similar to flood waves in rivers. In this study, we first use a weakly dispersive Boussinesq model to study obliquely incident waves on a plane beach, in order to determine the dependence of transition from surging to breaking conditions on Irribarren number and oblique angle of incidence. We then use this information in conjunction with simulations of monochromatic waves in an idealized, V-shaped channel to search for a low frequency cutoff for the onset of breaking conditions in the channel. Results for simulations of realistic events in Delaware Bay are then re-examined in light of the idealized study. (Abstract ID 11819)

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LES OF UPPER OCEAN LANGMUIR TURBULENCE: IMPACT OF WAVELENGTH OF SURFACE WAVES

Large-eddy simulation (LES) of upper ocean turbulence is performed using the Craik-Leibovich equations characterized by a vortex force generating Langmuir turbulence. Key parameters in these equations are the dominant wavelength of surface waves (λ) and the turbulent Langmuir number (La). A measure of wind forcing relative to surface wave forcing. Previous studies have investigated the dependence of turbulent structure on La. The current study focuses on the dependence of the turbulence on λ. This study is motivated by recent field measurements in the Ross Sea Polynya of a shallowly mixed layer during the occurrence of turbulent Langmuir cells. This event was characterized by a nearly constant La, with decreasing λ and decreasing wind stress friction velocity, while surface heat flux transitioned from cooling to heating. LES results show that λ impacts the turbulence directly through near-surface production of turbulence kinetic energy by Stokes drift shear. Simulation results will be further analyzed in order to determine effects of λ on turbulence structure and mixed layer depth. Results will also be compared with Ross Sea Polynya data. (Abstract ID 12692)

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KINETIC ISOTOPIC FRACTIONATION OF ARGON AND NEON DURING AIR-WATER GAS TRANSFER

The use of noble gas isotope ratios as tracers of biogeochemical processes relies on an accurate measure of kinetic and equilibrium isotopic fractionation. The relative mass transfer rates in these equations are the dominant wavelength of surface waves (λ) and the turbulent Langmuir number (La). The current study focuses on the dependence of turbulent structure on La. The current study focuses on the dependence of the turbulence on λ. This study is motivated by recent field measurements in the Ross Sea Polynya of a shallowly mixed layer during the occurrence of turbulent Langmuir cells. This event was characterized by a nearly constant La, with decreasing λ and decreasing wind stress friction velocity, while surface heat flux transitioned from cooling to heating. LES results show that λ impacts the turbulence directly through near-surface production of turbulence kinetic energy by Stokes drift shear. Simulation results will be further analyzed in order to determine effects of λ on turbulence structure and mixed layer depth. Results will also be compared with Ross Sea Polynya data. (Abstract ID 12692)

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GEOSPATIAL AND GEOPHYSICAL ANALYSIS OF THE EVOLUTION OF A TRANSGRESSIVE SHORE-OBQUE SPIT, PLYMOUTH LONG BEACH, PLYMOUTH, MASSACHUSETTS, USA

The Plymouth Long Beach spit complex is located in the southern half of Plymouth Bay, Massachusetts and is approximately 5 km long, varies in width from 55 m to 310 m and trends northwesterly with a shore-parallel orientation. Lowering, thinning, and breaching threaten the integrity of the spit and potentially reduce the sheltering effects for the town of Plymouth from storms. A geospatial shoreline change analysis was conducted using high water shorelines digitized from high-resolution aerial photography acquired in 2008 and an 1853 Office of Coast Survey T-sheet. The shorelines were analyzed for changes to spit area and shoreline movement. Additionally, a 100 MHz ground penetrating radar (GPR) survey was run parallel and perpendicular to the spit to identify areas of previous inlets and/or evidence for washover and landward migration. Spatial analysis shows a net loss of area by 21,926 m2 and shoreline retreat that exceeds 65 m in places with an overall translation of the spit landward. GPR data revealed former inlet positions are not present on historical maps, suggesting breach events followed by stabilization. (Abstract ID 10809)

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A COMPARATIVE HIGH-RESOLUTION STUDY OF AL5N IN SEDIMENTS FROM THE PESCADERO SLOPE, GULF OF CALIFORNIA, AND SANTA MONICA BASIN, CALIFORNIA BORDERLAND

The extent and severity of Oxygen Minimum Zones (OMZ) is increasing globally (Stramma 2010) making it critical to understand the mechanisms driving this change. In an OMZ, low O2 content promotes water column denitrification, which enriches the residual nitrate pool in 15N. This 15N enriched nitrate assimilated by primary producers imparts its isotopic signature on Particulate Organic Nitrogen (PON) exported from euphotic zone and buried in the sediments. Thus, the intensity of anoxia and associated denitrification is reflected in the degree of 15N enrichment in the sedimentary PON. Our high-resolution (1-3 mm) 15N Records obtained from laminated sediment cores from the Pescadero Slope (Gulf of California) and Santa Monica Basin (California Borderland) show distinct temporal fluctuations in the 15-5 PON with a ~10-20 year frequency, likely driven by variability of water column O2 content. The temporal correlation of the 815N signal between the two sites suggests a regional forcing of OMZ changes, rather than local phenomenon. We will discuss the history of OMZ intensity off the Mexican Margin back to 200 ybp. (Abstract ID 10579)

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ASSESSING CORAL REEF VULNERABILITY TO OCEAN ACIDIFICATION VIA HIGH-RESOLUTION BASELINE MONITORING OF CARBON BUDGETS ON PALMYRA ATOLL

Palmyra Atoll's healthy reefs offer an unparalleled opportunity to investigate in isolation the sensitivity of coral reefs to ocean acidification. We report on baseline monitoring of carbonate budgets and dissolved oxygen (DO) from two different reef sub-environments of Palmyra, exhibiting distinct predictable differences in diurnal trends. Our continuous-flow system allowed for 5-minute or higher temporal resolution of DO and carbon system parameters for 72 hours at a lagoon reef site and 48 hours at a back reef site. Discrete water samples were collected for alkalinity measurements every 3-4 hours. The lagoon reef environment exhibited diurnal ranges of 250-300 μmol/kg in DIC, ~100 μmol/kg range in alkalinity values, 0.2 units in pH (8.8-8.2), and 80% range O2 saturation. Alternatively, the back reef environment was characterized by diurnal ranges of 100-120 μmol/kg in DIC, ~70 μmol/kg in alkalinity values, 0.1 units in pH (8.1-8.2), and 30% range O2 saturation. Current velocity, temperature, and salinity measurements quantified local mixing processes. Rates of calcification and photosynthesis at the two sites are likely moderated by the different hydrodynamics and ecological community composition. (Abstract ID 12788)

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TEMPORAL DISTRIBUTION OF TOTAL HYDROLYZABLE AMINO ACIDS IN THE EASTERN OYSTER, CRASSOSTREA VIRGINICA

The Eastern Oyster, Crassostrea virginica, withstands alternating periods of flood and drought, which is reflected in its shell composition. By examining the temporal distribution of amino acids in their shell organic matrices, signals of past flood and drought events in subtropical estuaries may be isolated. In June 2010, live oysters were collected, their shell hinges drilled on a microscale to create a two-year time series, and the total hydrolyzable amino acids quantified. A significant flood in winter 2009 coincided with a drop in all fifteen THAA concentrations, followed by higher concentrations post-flood; percent compositions remained constant, though. When concentrations were compared to the time series of 6°C and 8°C from the same oyster, the flood signals of the stable isopes lagged behind that of the amino acids, emphasizing their importance in biomineralization. These observations suggest that external factors influence shell growth more than internal processes do and demonstrate the potential of using hydrolyzable amino acids in fossil shells as a proxy for reconstructing the pattern of historic floods and droughts. (Abstract ID 11857)

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DIFFERENCES AMONG WATER QUALITIES IN AN URBAN RIVER AND TWO MANGROVE RIVERS OBSERVED IN ISHIGAKI ISLAND, JAPAN.

Mangrove forests have been recognized as essential for the conservation of seashore lines, and spawning and nursery of aquatic creatures. To quantify natural mangrove river's self-purification mechanism, we should know how they are different from urban rivers and what functions they have. The field observations were conducted in 3 different estuaries – one in an urban river and two in mangrove rivers – at the same period from 2008 to 2011. The study sites are located in the coastal zones of Ishigaki Island, Okinawa, Japan. From comparison of their water qualities, turbidity in urban area (Arakawa river) increased about 10 times immediately after rain. On the other hand, turbidity in mangrove estuaries (Fukidō and Miyara rivers) did not change suddenly and the rate of increase was remarkably smaller than in the urban river. TN (Total Nitrogen) and TP (Total Phosphorus) showed the same tendencies. Mangrove natural rivers moderate excess outflow of solids and nutrients to coastal area. In addition, by comparing two types of mangrove estuaries with different river form and land use, we revealed differences of their moderation effects and the behavior of nutrient supply. (Abstract ID 9818)

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ROLE OF A NETWORKED OCEAN IN ASSESSING LARGE MARINE ECOSYSTEMS – MONITORING OCEAN CURRENTS AT A CASCADE OF SCALES WITH HF RADAR

One underlying premise of Ecosystem Based Management and Marine Spatial Planning is the concept of transitioning from ‘one size fits all’ management approaches to one that is tuned to a specific environment. An impediment for this transition will be defining those data sets that are relevant to the management issues and the lack of data at the right scales. For large marine ecosystems, a challenge will be to define the physical environment in which the ecosystem exists. On the U.S. West Coast, a “network of networks” has grown through the oceanographic community obtaining disparate funding from multiple agencies, with the state of California and NOAA leading the funding for the network. NSE BOEMRE, and ONR have also contributed to establishing the infrastructure in the past decade. The networking infrastructure now receives support from the Integrated Ocean Observing System (IOOS) Program Office to develop the data management architecture. This network of 78 real-time HF radar systems provide coverage of ocean surface circulation from Mexico to Canada. Real-time applications of can include tracking spilled oil, assisting in SAR, and assessing the fate and transport of land runoff and offshore discharges. With long term operation of the network, characterization of the physical environment across a multitude of scales will be enabled to assist in defining
A new mathematical model is developed and application demonstrated for perfluorinated octanoic acid (PFOA) diffusive transport in marine water. The traditional completely mixed media box-model is upgraded with an eddy diffusion coefficient and adjacent boxes coupled using the concept of "chemical flux continuity across interfaces" to produce the new model. All the while it retains the mass balance rigor and process simulation features of the traditional advection/diffusion/transport, and reactive model. PFOA data at two oceanic sites fitted to a marine water-column 3-layer physical structure show the profiles of this tracer as being transport dominated. The model's utility and versatility is further demonstrated by quantifying flux into surface waters, accumulation in marine layers and release to the abyss. Process-based and structured mathematical models provide the best theoretical option for unambiguous analysis of persistent organic pollutants (POPs) chemodynamics. The mathematical power of the turbulent diffusion box model (TDBM) will assure it applicability in further theoretical studies of chemical processes in this complex marine zone which should include for example, particle, phase-partitioning, bio-mediated transport, settling, reactions and products, physical-advective pumping, etc. (Abstract ID 11914).

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THE ENERGETIC COST OF AN INTRODUCED MARINE PARASITE ON ITS NEW NATIVE SHRIMP HOST

Upogebia pugettensis was an abundant species that dominated the biogeochemistry of intertidal estuary mudflats; however, their populations declined dramatically following the introduction of the bopyrid isopod parasite Orthione griffenis. Weight losses of Upogebia infested by Orthione are dramatic and only reproductive sized shrimp are infested. Correlations between individual Orthione and food weights are poor nevertheless. We tested whether underweight hosts result from arrested growth and weight losses at particular sizes or growth in size without weight gain, an interaction that has not previously been examined. We cultured pre-reproductive Upogebia to reproductive sizes in sediment filled tubes that could be repeatedly opened for observations without harming the shrimp or their burrows. A broad size range of Upogebia were experimentally infested with diverse size ranges of Orthione and cultured in seawater tanks or in the estuary mudflats along with uninfested control shrimp. Growth of shrimp and parasites were monitored for up to three weeks. Results indicate that underweight hosts result from growth in size without weight gain in addition to the normal expected weight loss among hosts of particular sizes. (Abstract ID 12599)

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BOTTOM UP CONTROLS OF PHYTOPLANKTON BIOMASS IN THE SOUTHERN OCEAN AT SEASONAL AND SUB-SEASONAL TIME SCALES

Bottom-up controls on phytoplankton biomass variability - as mediated by the depth of the Mixed-Layer - are investigated in the Southern Ocean with a focus on the seasonal cycle. The regional characteristics of the seasonal cycle are quantified in terms of the timing of the bloom initiation, its amplitude, regional scale variability and the importance of the climatological seasonal cycle in explaining the overall variance (firmed seasonal cycle reproducibility). The overall response of the phytoplankton seasonal cycle to variability in physical control mechanisms is summarised in a schematic that divides the Southern Ocean into four zones according to the extent of inter-annual seasonal cycle reproducibility and the magnitude of integrated seasonal biomass. Furthermore, the characteristics of the relationships between phytoplankton biomass and transient mixing events at subseasonal time-scales is highly variable and reflects spatial and temporal variations in the degree of phytoplankton light and iron limitation. These relationships are investigated in observational datasets and the coupled Ocean-Biogeochemical model NEMO-PISCES. This study is important in the context of projected changes in ocean stratification that result from climate change. (Abstract ID 11072)

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SATELLITE ESTIMATES OF CHLOROPHYLL PHENOLOGY IN THE CALIFORNIA CURRENT

Eleven years (1997 – 2007) of SeaWiFS ocean color satellite data are used to quantify dominant time/space patterns of chlorophyll phenotype and its variability in the California Current, from Baja to British Columbia. We use state-space models to separate the time-varying chlorophyll signal at each location into three components: a time-dependent background trend, a non-stationary seasonal component (phenology) and an approximately stochastic residual or “error” term. Here, the non-stationary seasonal components are examined. K-means clustering is used first to group the seasonal components into those with the strongest similarity over the study period. The regional geography of these groups, their mean phenology and variability is presented. Within each of these groups, a series of metrics are defined representing various phenological characteristics. K-means clustering is then used to partition each group into those with similar interannual variability in the phenology metrics. These are quantified and then mapped to show the geography and magnitude of changing chlorophyll phenotype in the California Current. Patterns are compared to SST variability and to previously described chlorophyll anomalies indicative of strong forcing. (Abstract ID 9766)

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UPPER OCEAN MANIFESTATIONS OF A REDUCING MEDITERRANEAN OVERTURNING CIRCULATION

Climate model predictions of the IPCC fourth assessment project show a slowing down of the Atlantic Meridional Overturning Circulation during the 21st century. Using a CO2-induced climate change simulation the HIGEM high resolution coupled climate model, we investigate to what extent the reduction in the deep southward transport is balanced by a reduction in the northward flowing surface western boundary transport or an increase in the southward upper interior transport. During 70 years of warming, a 5.3 Sv weakening of the AMOC takes place that is balanced solely by a decrease in western boundary transport. A further 3.0 Sv reduction takes place in the interior subtropical gyre that can be explained by a weakened wind stress curl. This results in a net 8.4 Sv reduction in the northward western boundary transport. At 27 degrees N the largest changes occur in the Antilles current rather than the Florida Straits current. Given the typical western boundary behaviour of the Antilles current it is important not to include this current in definitions of the interior transport, as is commonly done in observations. (Abstract ID 11133)

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NUTRIENT TRANSFER BETWEEN UNICELLULAR NITROGEN-FIXING CYANOBACTERIUM GROUP A (UCYN-A) AND A PICOEUKARYOTE HOST

The unicellular nitrogen-fixing cyanobacterium Group A (UCYN-A) lacks genes for photosystem II and the tricarboxylic acid cycle. We examined a possible symbiosis between UCYN-A and marine picoeukaryotes. We incubated seawater samples with photosystem II and the tricarboxylic acid cycle. We examined a possible symbiosis between the unicellular nitrogen-fixing cyanobacterium Group A (UCYN-A) and a unicellular eukaryote. (Abstract ID 12401)

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JET TRANSITIONS NEAR TOPOGRAPHY: IMPACTS ON TRANSPORT IN THE ANTARCTIC CIRCUMPOLAR CURRENT

The Southern Ocean's Antarctic Circumpolar Current (ACC) must navigate around steep and complicated bathymetric obstacles, which give rise to inhomogeneities in the statistical properties and dynamics of the current. We provide observational and numerical evidence that zonal asymmetries, in the form of topography, impact the ACC's global flow structure and transport properties. Our conclusions are based on a suite of more than 1.5 million virtual drifter trajectories advected using a satellite altimetry-derived surface velocity field spanning 17 years. We focus on sites of "cross-front" transport as defined by movement across selected sea surface height contours that correspond to jets along most of the ACC. Cross-front exchange is localized in the lee of bathymetric features with more than 75% of crossing events occurring in regions corresponding to only 20% of the ACCs zonal extent. These observations motivate a series of quasi-geostrophic numerical simulations with simple, zonally-asymmetric topography. Significantly, regimes occur where the equilibrated number of coherent jets is a function of longitude, and transport barriers are not periodic. Jet re-organization by movement across eddy flux divergences acting to both accelerate and decelerate the mean flow of the jets. The combination of high eddy kinetic energy and re-circulation features enhances particle exchange. (Abstract ID 12725)

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STABLE COPPER ISOTOPE MEASUREMENT IN SEAWATER AND PRELIMINARY RESULTS FROM THE TASMAN SEA

Copper (Cu) is an important micronutrient in aqueous systems and plays a significant role in marine primary production. Many algal processes utilise Cu-centred proteins but succumb to toxicity at nano-Molar Cu concentrations. These effects regulate marine Cu cycling but the mechanisms by which this is accomplished are largely unknown. Stable Cu isotope geochemistry provides a means of investigating marine Cu cycling due to natural fractionation mechanisms which include changes in redox state, biological uptake and equilibrium partitioning. However, the measurement of Cu isotopes in seawater is analytically challenged by the low dissolved Cu concentration in the inorganic seawater matrix. Measurement of the Cu isotopic composition of seawater has been achieved by pre-concentrating samples by solvent-extraction followed by purification using anion-exchange chemistry which exploits the speciation of Cu in chloride media. These techniques yield reproducible Cu isotope values, e.g. 0.84 ± 0.07‰ (1sd, n=13), and are effective over the range of Cu concentrations measured in seawater (0.5 to 6 nmol/L). A number of natural Cu isotope fractionation mechanisms are identified in dissolved and particulate seawater samples collected from the Tasman Sea. (Abstract ID 9804)

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EXTRACTION OF HIGH-RESOLUTION WIND FIELDS OVER THE OCEAN SURFACE FROM TERRASAR-X AND COSMO SKYMED SAR IMAGERY

We discuss the status of our efforts to determine a suitable Geophysical Model Function (GMF) that relates X-band normalized radar cross section (NRCS) to the near surface wind vector over the ocean. We will concentrate on synthetic aperture radar (SAR) imagery from the recently-launched TerraSAR-X (Germany) and Cosmo SkyMed (Italy) satellite systems. Inversion of TerraSAR-X NRCS imagery to wind speed is accomplished using both a simple physics-based GMF as well as an empirical GMF derived by interpolating well-validated C- and Ku-band GMFs to X-band. We compare the retrieved wind vectors with in situ data when available and also with predictions from the Weather Research and Forecast (WRF) model. At vertical polarization, these comparisons show reasonable agreement with in situ data for both the physics-based and empirical GMFs. At horizontal polarization, the empirical GMF is more accurate, especially at higher wind speeds. Preliminary evaluation of Cosmo SkyMed imagery suggests that adjustments to the given NRCS calibration are needed in order to retrieve reliable wind vectors using either of our GMFs. (Abstract ID 12730)

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SEASONAL COUPLING IN THE GULF STREAM REGION BETWEEN THE ATMOSPHERE AND THE OCEAN
Seasonal coupling in the Gulf Stream region between the atmosphere and ocean via feedback to surface heat flux is investigated using models and observations. Heat budget analysis in a regional diagnostic model shows that on interannual time scales, the heat content in the upper ocean leads the flux of heat from the ocean to the atmosphere by approximately three months, with a warmer ocean leading to oceanic heat loss. These results are consistent with results from an eddy-resolving, 20-year, climate-constrained simulation provided by the ECCO2 (Estimating the Circulation and Climate of the Oceans, Phase II) project. To investigate the seasonal dependence of the coupling, we calculated the lag correlation for multi-year timeseries of heat content and surface heat flux for each month of the year. Significant correlations were found between March upper ocean heat content and June surface heat flux. Correlations between February and April heat content with June surface heat flux were also large, with the heat stored above approximately 600 m. The reasons for the high correlation with June surface heat flux are also investigated. (Abstract ID 11817)

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LOW FREQUENCY COASTAL SEA LEVEL ALONG THE AMERICAS

Intertidal to decadal variations in tide gauge sea levels from the western boundary of the North Atlantic are highly coherent from Central America to Nova Scotia. Half of the variance is captured by a single spatially uniform time series despite geographic and oceanographic boundaries, and the processes responsible for this coherence were investigated. The GECCO ocean model adequately reproduces the observed coastal variability, and a diagnosis of monthly model fields showed that the coastal height variations are coherent with open ocean variations over most of the western half of the basin. These variations can be simulated with a simple Rosby wave model forced by winds over the Atlantic. Although these are coastal tide gauges, at these low frequencies the data primarily reflect basin-scale rather than coastal processes, which suggests caution in the interpretation of these data in coastal studies. (Abstract ID 116603)

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EFFECTS OF ELEVATED pCO2 AND NUTRITION ON MYTILUS EDULIS GROWTH: COMPARISON OF FIELD AND LABORATORY STUDIES

 Whereas highly elevated seawater pCO2 (>2000µatm) reduces growth of the blue mussel Mytilus edulis, calcification rates are maintained under intermediate pCO2 levels (<1500µatm) when food supply is sufficient. In a laboratory study, post settled larvae were exposed to different pCO2, and feeding treatments. Calcification was lowered by high pCO2, but CO2 impacts were much less pronounced than the effects of variations in food supply. This was also observed in the high pCO2 and low pH (average pH 7.76) Kiel Fjord. Specimens were characterized by much higher calcification rates compared to mussels that were transplanted to a low pCO2 site (average pH 7.93). These results can be explained by two-fold higher particulate organic carbon (POC) concentrations in the Fjord indicating that calcification is a function of energy supply rather than carbonate chemistry. Thus, today's dominance of mussels in Kiel Fjord is a consequence of high CO2 tolerance of the earliest benthic stage and energy supply in an eutrophic habitat which enables high growth rates. In conclusion, lowered rates of calcification might be a consequence of enhanced energy turnover under elevated pCO2. Under sufficient feeding conditions, mussel calcification appears to be relatively robust towards future ocean acidification. (Abstract ID 12344)

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OBSERVATIONS OF FETCH-LIMITED WAVE EVOLUTION

Observations of surface-gravity wave evolution, including growth, dissipation, and spectral transformation, are applied to evaluate a radiative transfer budget for wave energy. The observations are from the Strait of Juan de Fuca during a series of winter storms with wind speeds up to 20 m/s and wave heights up to 2.5 m. Wave spectra, wind stress, and breaking dissipation are measured from an autonomous wave-following platform termed SWIFT, which uses uplooking sonars to measure turbulent dissipation within breaking crests. A quasi-equilibrium of wind input and breaking dissipation is shown to be robust, even in the case of rapid wave development under strong forcing. This is consistent with an observed equilibrium slope in the high-frequency tails of the wave spectra. These in situ observations are compared with breaking crest-length distributions obtained from video recordings of the sea surface, in which spectral components of the breaking field are identified. (Abstract ID 9955)

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COMBINING PASSIVE ACOUSTICS AND SATELLITE OCEANOGRAPHY TO EVALUATE CETACEAN HABITAT USE IN THE SOUTH ATLANTIC RIGHT

In the South Atlantic Right (SAR), the Gulf Stream (GS) front and Gulf Stream Frontal Eddies (GSFEs) are known to provide important habitat for foraging seabirds, but their effect on cetacean abundance and distribution has not been considered. Using data from moored High-frequency Acoustic Record Packages (HARPs) in Onslow Bay, we assessed the effects of dynamic oceanography on odontocete vocalization rates. Satellite images of sea surface temperature during HARP deployments were used to identify local water masses (Gulf Stream, shelf waters and Gulf Stream frontal eddies) relative to HARP locations for three HARP deployments, representing a total deployment time of 313 days (10/10/2007 – 01/16/2008; 04/24/2009 – 08/9/2009; and 11/8/2009 – 02/24/2010). Both the total duration of all vocal events and the total duration of click events, respectively, were analyzed for all odontocetes together, and also for sperm whales (Physeter macrocephalus), Risso’s dolphins (Grampus griseus), short-finned pilot whales ( Globicephala macrorhynchus), and delphinids separately. The presence of GSFEs and the location of the GS front influenced cetacean vocalization rates and we discuss these findings in relation to the ecology of the study species. (Abstract ID 12848)

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MARINE DISSOLVED ORGANIC MATTER (DOM) AS A COMPONENT OF MARINE AEROSOL AND CLOUD CONDENSATION NUCLEI (CCN) OVER THE PACIFIC OCEAN

The ocean contains a large pool of non-living organic carbon estimated to be 1000 Pg C, of which dissolved organic carbon (DOC) contributes 662 Pg C. While mechanisms for transferring material from surface ocean to atmosphere are well established, there has been little research on the role of marine organic matter in atmospheric processes. We participated in a transect of the Pacific Ocean where we continuously measured cloud condensation nuclei (CCN) activation and a suite of chemical and biological variables. Secondary, size-fractionated seawater sample were collected, re-aerosolized, and analyzed to determine their CCN activation. These experiments indicated that marine high molecular weight dissolved organic matter (DOM) is an efficient CCN. Aerosol particles collected during the cruise were analyzed by Raman micro spectroscopy and contained a range of organic moieties. During a follow-up cruise, biopolymers in the form of gel particles were found to be concentrated in the sea surface microlayer (SML) compared with the underlying water. Our results indicate that marine DOM contributes to marine aerosol with the potential to significantly affect CCN activation. (Abstract ID 10472)

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STAKEHOLDER ENGAGEMENT—A CRITICAL ELEMENT TO MARACOOS SUCCESS

The accomplishment of the MARACOOS mission “To seek, discover, share, and apply knowledge and understanding of our coastal ocean” requires a societal data translation infrastructure that complements the data generation and modeling infrastructure. While modern society has come to accept the benefits of science and technology, there are still situations where multiple use demands, as is the case with the regional marine and coastal resources, cause conflict. What is the best approach for MARACOOS to use in serving complex societal needs? The usual response to this question is education; however, in today’s world of social networking, the answer is engagement. The vision of MARACOOS is to establish a Stakeholder Liaison Service, with Stakeholder Liaisons possessing expertise that can be directed to MARACOOS’ five theme areas: (1) Maritime Safety, (2) Ecological Decision Support, (3) Climate of the Oceans, (4) Coastal Inundation, and (5) Offshore Energy. This Stakeholder Liaison Service, designed to expand information dissemination facilitated by technology, facilitate synthesis integration and translation of MARACOOS products to appropriate end uses for stakeholders, and formalize a system for Stakeholder feedback, will be discussed. (Abstract ID 12051)

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REVISITING THE SOURCE OF CARBON FUELING FISHERIES ON CORAL REEFS

Using a novel stable carbon isotope approach, we revisited the source of carbon fueling fisheries on coral reefs of the South Pacific and compared the results to previous work on reefs in the Caribbean, Indian Ocean, and Australia. We found that the sources of carbon fueling fisheries on coral reefs in the South Pacific are diverse and include both autotrophic and heterotrophic sources. Our results highlight the importance of considering the sources of carbon fueling fisheries on coral reefs in the South Pacific and the need to develop new approaches to understanding the sources of carbon fueling fisheries on coral reefs. (Abstract ID 12495)

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Quantifying carbon flow on coral reefs is fundamental to the development of models capable of predicting the response of reef ecosystems to threats including overfishing and global climate change. While it is often assumed that water-column-based phytoplankton production is the dominant carbon source fueling large predatory fish on coral reefs, microbiologically recycled carbon may also supply significant amounts of carbon to high trophic levels. We addressed the relative dominance of new versus recycled carbon in coral reef food webs using O13C analysis of specific amino acids from samples collected on reefs in the Farasan Banks, Red Sea. Our results highlight the remarkable complexity of food webs on coral reefs. For instance, two congeneric species of a powerful new tool for tracing the origin of nutrients fueling reef ecosystems. (Abstract ID 12657)

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PROJECTIONS OF ICE SHELF BASAL MELTING IN A GLOBAL FINITE-ELEMENT SEA ICE--ICE SHELF--OCEAN MODEL

In the framework of EU project IceSea, we utilize a finite element sea ice--ice shelf--ocean model (FESOM) to quantify heat and freshwater fluxes in the cavities of the Antarctic ice shelves and obtain projections for ice shelf basal melting in a warmer climate. Ice shelf--ocean interaction is described using a three-equation system with a diagnostic computation of temperature and salinity in the boundary layer between ice and ocean. A tetrahedral mesh with a minimum horizontal resolution of 4 km and hybrid vertical coordinates is used. Ice shelf draft, cavity geometry, and global ocean bathymetry have been derived from the RTopo-1 dataset. Simulations for this study were forced with atmospheric data from the Hadley Centre Coupled Model (HadCM3) for the IPCC scenarios A1B and E1 until 2199. Results indicate a strong sensitivity to increased ocean temperatures for the ice shelves in Amundsen Sea. Even stronger impact is found for pulses of warm water on the Weddell Sea continental shelf that may increase basal melting of Filchner–Ronne Ice Shelf by a factor of five. (Abstract ID 11157)

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OBSERVING THE RAPIDLY-EVOLVING ARCTIC OCEAN ENVIRONMENT

Autonomous Ice-Based Observatories (IBOs) hold great promise for building understanding and predictive capability of the rapidly evolving state of the Arctic Ocean and associated ecosystem. IBOs combine suites of sensors mounted on the drifting sea-ice pack to provide (via satellite) year-round measurements of the upper ocean, sea ice, snow and atmosphere. Advances in IBO instrument design and capability have improved long-term functionality and returned additional oceanographic information, including ocean velocity and biogeochemical measurements. The emerging changes in sea ice will necessitate modifications to IBOs - adaptations already include enhanced buoy design for open water deployments and survival of seasonal freeze-up. Arctic researchers are in the early stages of designing floats, gliders and autonomous vehicles (integrated acoustically with IBOs) to provide broad spatial coverage of the seasonal ice zone. In the coming decades, measurements from an extensive array of ice-based and mobile instrumentation will allow us to quantify key aspects of the Arctic environment, both physical and biological, over a substantial fraction of the Arctic Ocean and over all seasons. (Abstract ID 10787)

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HORIZONTAL DENSITY STRUCTURE AND RESTRATIFICATION OF THE ARCTIC OCEAN SURFACE LAYER

Ice-Tethered Profiler (ITP) measurements from the Arctic Ocean's Canadian Basin indicate an ocean surface layer beneath sea ice with significant horizontal density structure on scales of hundreds of kilometers to the order 1 km submesoscale. The observed horizontal gradients in density are dynamically important in that they lead to restratification of the surface ocean when dense water flows beneath light water. Such restratification is prevalent in wintertime and competes with convective mixing upon buoyancy forcing (e.g., ice growth and brine rejection), and shear-driven mixing when the ice moves relative to the ocean. Frontal structure and estimates of the balanced Richardson number point to the likelihood of further dynamical restratification by submesoscale baroclinic instability following restratification by isopycnal mixing. Based on the evidence presented in this study it is likely that submesoscale processes play an important role in setting surface-layer properties and lateral density variability in the Arctic Ocean. (Abstract ID 9906)

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OCEAN ACIDIFICATION ALTERS LARVAL PACIFIC OYSTER GROWTH AND PHYSIOLOGY

A recent application of several skill tests to the North Atlantic or if additional skill tests must be developed to assess the true model performance. (Abstract ID 9566)
Larval forms of aquatic invertebrates are thought to be especially susceptible to the effects of ocean acidification due to their morphology, physiology, and biology. Pacific oyster larvae (Crassostrea gigas) were exposed to control (400 ppm) and elevated (700 and 1000 ppm) levels of CO2 from fertilization for 4 days post fertilization. The larvae were assessed for differences in calcification and size throughout the four days. Larvae were found to be smaller in the higher pCO2 treatments, although they did not demonstrate a significant developmental delay. At the end of the experiment, expression levels of four genes involved in energy metabolism, calcification, and oxidative stress were measured across the pCO2 treatments. The oyster larvae showed evidence of increased stress from the elevated pCO2, perhaps an indication of change in energy demand. A stress event may occur in a stressful environment. (Abstract ID 9967)

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LARGE-SCALE NEAR-BED TURBULENT FLOW STRUCTURES UNDER PLUNGING WAVES

The turbulent velocity field created by the breaking of plunging regular waves on a plane slope is studied using particle image velocimetry (PIV). The measurement plane is located within the bottom boundary layer to capture breaking-wave-generated large eddies as they impinge on the bottom. The study examines the flow characteristics in the impingement region. The near-bed flow structure is strongly three-dimensional although spanwise vortices are produced at wave breaking. Near the bottom, a typical large eddy structure consists of two counter-rotating vortices attached to a downburst of turbulent fluid. Preliminary three-component volumetric velocimetry (VSV) measurements reveal that the counter-rotating vortices are stretched obliquely in the wave direction. The downburst and vortices are associated with large turbulent momentum and energy fluxes. The motion of single solid particles along the bottom is also investigated. Unlike spilling breakers in which the net transport over a wave cycle is always offshore, the large eddies in plunging waves can occasionally overcome the effect of the undertow and transport sediment particles onshore. (Abstract ID 9736)

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Zooplankton as Transformers: Fatty Acid Content and Conversion from Seston to Benthos

We sampled seston, zooplankton and sediment trap material for fatty acid (FA) analysis during 5 campaigns spanning four seasons at a coastal site on the west coast of Sweden. Saturated (SAFA) and monounsaturated (MUFA) FAs dominated seston and trap material, while copepods contained 75-90% polyunsaturated FAs (PUFA). Sedimentation of bulk particulate organic carbon did not vary significantly with season, while pigment and in particular faecal pellet fluxes were highly variable as a result of copepod feeding. Copepod feeding, pellet and egg production were all high in summer and after the spring bloom and this resulted in a significant difference in FA composition between seston and sedimentating matter. SAFAs and MUFAs were enriched by 5-10% in sediment traps, while the sedimentation of the most important PUFA, docosahexaenoic acid (DHA), was reduced by up to 15% in summer and autumn. Overall, 5-25% of the sedimenting FAs were affected by copepod transformation with the highest transformation in the summer and autumn. (Abstract ID 10278)

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Seasonal and Long Term North Atlantic Surface pCO2 Variability – A Model Study

A coupled biogeochemical-physical ocean model is used to study the long term variations of surface pCO2 in the North Atlantic Ocean. The model seasonal cycles agree well with recent underway pCO2 observations from the Surface Ocean CO2 Atlas (SOCAT) database in various North Atlantic locations. In most regions, the recent observed trends in pCO2, air-sea carbon fluxes are also simultaneously simulated by the model. Over a long period between 1960–2008, the primary mode of surface pCO2 variability is dominated by the increasing trend associated with the invasion of anthropogenic CO2 into the ocean. The ocean surface circulation and air-sea heat flux patterns can explain the spatial variability of this dominant increasing trend. The North Atlantic Oscillation (NAO) plays a major role in controlling the variability occurring at interannual to decadal time scales. The NAO predominantly influences surface pCO2 in the North Atlantic by changing the physical properties of the North Atlantic water masses, particularly by perturbing the temperature and dissolved inorganic carbon in the surface ocean. We show that present underway observations are valuable for both calibrating the model, as well as for improving our understanding of the regionally heterogeneous variability of surface pCO2. They can be important for detecting any long term change in the regional carbonate system. (Abstract ID 11007)

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Circulation Dynamics and Larval Transport Mechanisms in the Florida Big Bend Region

The goal of this study is to quantify the transport mechanisms in the Florida Big Bend Region (BBR) that contribute to reef fish productivity as a function of the regional physical oceanography. The primary focus of the research is to identify pathways responsible for transporting gregarious larvae into shelf areas conducive to recruitment. We used a hydrodynamic model to investigate the role of Ekman layer dynamics and the role of upwelling in the net across-shelf transport, as well as the role of larval behavior in their horizontal dispersion. The primary tool used to address these goals is a very high resolution (800-900 m) numerical ocean model configured for the BBR and nested within the data-assimilative Gulf of Mexico Hybrid Coordinate Ocean Model (HYCOM). A particle advection scheme is used as a proxy for the larval migration, incorporating behavior in the advective algorithm to assess the impact of biological processes on larval transport. Results from model runs between 2004 and 2010 are presented, and the variability of the flow and unsteady mixing patterns.
transport characteristics on numerous temporal scales is discussed. (Abstract ID 10530)

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TURBULENCE-CONTROLLED FLOCCULATION IN A MACRO-TIDAL ESTUARY

Little is known of the properties of cohesive SPM (particle sizes, densities, settling velocities) and how these impact fine particle entrainment and sedimentation since most SPM is in the form of flocs that are easily modified during sampling (ruptured and/or may aggregate). We therefore lack information on key parameters: pick-up functions and settling velocities, particularly since floc properties change on a range of time scales: tidal (upwind/advection), lunar (spring-neap cycle), and seasonal (storm resuspension and biological production). Turbulence is an important mediator of floc characteristics, promoting particle collision and aggregation at low levels, while high levels result in shear-induced rupture. Accurate turbulence parameterisation is key to understanding relationships between turbulence and particle size, as well as modelling flocculation. The results of a field campaign and SPM flux modelling of the Dee estuary are presented, giving insight into the fates of riverine input and SPM advected from offshore. Using data from acoustics, optics, moored deployments and CTD stations, a 1-D (GOTM) model shows variation across a range of time-scales, and is extended using a recently published flocculation formula to include aggregation. (Abstract ID 10530)

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FINESCALE OBSERVATIONS OF THE MIDDLE ATLANTIC BIGHT SHELFBREAK AND SLOPE

The shelfbreak and slope in the Middle Atlantic Bight (MAB) are highly variable regions that remain poorly understood. Recent glider observations south of Cape Cod provide finescale observations over the upper 1000 m in the MAB. We examine temperature and salinity structure along both isopycnals (i.e., isos) and depth surfaces at scales from O(1) to 100 km to determine how the dominant scales of variability change from shelfbreak to slope. Bidirectional exchange across the shelfbreak front contributes significantly to the thermohaline variability in the region; cool, fresh shelf waters are regularly found over the slope, and warm, salty slope exchange across the shelfbreak front contributes significantly to the thermohaline variability. Tidal and lunar (spring-neap cycle), and seasonal (storm resuspension and biological production) variability is key to understanding relationships between turbulence and particle size, as well as modelling flocculation. The results of a field campaign and SPM flux modelling of the Dee estuary are presented, giving insight into the fates of riverine input and SPM advected from offshore. Using data from acoustics, optics, moored deployments and CTD stations, a 1-D (GOTM) model shows variation across a range of time-scales, and is extended using a recently published flocculation formula to include aggregation. (Abstract ID 10530)

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AMMONIA-OXIDIZING THAUMARCHAEOTA IN THE NORTHERN GULF OF MEXICO OMZ

We studied the distribution of ammonia- and nitrite-oxidizing organisms in the northern Gulf of Mexico, including stations in the recurrent oxygen minimum zone associated with the Mississippi River outflow plume. We examined the distributions of 16S rRNA (rrs), ammonia monooxygenase (amoA) and acetyl-CoA carboxylase (accA) genes. We found up to 10^9 copies L^-1 of Thaumarcheota rrs in our samples (up to 54% of prokaryotes), with maximum abundance at 100-400 m. The relative abundance of Thaumarcheota rrs in pyrosequenced libraries correlated well with qPCR values (r^2=0.79, 95% CL of slope = 0.75-1.05). The abundance of nitrite oxidizing Bacteria rrs in pyrosequenced libraries correlated with that of Thaumarcheota rrs (r^2=0.49, 95% CL of slope = 0.032-0.064); however, their relative abundance was lower than reported by others (slope=0.25-1.00). Variations in ratios of gene abundances and phylogenetic analysis of rrs, amoA and accA genes suggest a strongly stratified Thaumarcheota population structure. Canonical correspondence analysis revealed that Thaumarchaeota rrs abundances were strongly correlated with both distance offshore and with oxygen concentration. The distribution of amoA genes was influenced by salinity, euphotic zone depth, and depth. (Abstract ID 9543)

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SCALE DEPENDENCE OF OCEAN-ATMOSPHERE COUPLING

Previous studies have shown that the convergence of heat in western boundary currents and their associated recirculation gyres have a significant forcing on synoptic and intraseasonal to decadal timescale variability of the mid-latitude atmosphere. We investigate these mechanisms and their role in the global climate system by comparing centennial length simulations using the Community Climate System Model (CCSM) with and without eddy-resolving ocean components. As expected, we see strongly enhanced variability in sea surface temperature (SST) and upper ocean heat content in the eddy-resolving simulation. Less obvious a priori is that the coupling of the atmosphere to the ocean, as measured by the regression of surface fluxes of heat and moisture on SST or sea surface height, also becomes stronger in the sense that indicates ocean forcing of the atmosphere. The magnitude and geographical distribution of the regression coefficients obtained from the eddy-resolving simulation are corroborated with high-resolution observations. The relationships between heat flux convergence, heat content tendency and surface heat fluxes and their scale dependence is examined in the coupled simulation with the eddy resolving ocean component. (Abstract ID 11528)

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A HYDROGRAPHIC CLIMATOLOGY FOR COASTAL WATERS OF THE EASTERN UNITED STATES

Through the use of the World Ocean Database a climatology of presented temperature, salinity, dissolved oxygen, phosphate, nitrate, and silicate for the Atlantic Ocean along the East Coast of the United States. The climatology is monthly and has a spatial resolution of 0.1° for temperature and 0.5° for the other variables. We examine seasonal budgets of heat, salt, oxygen, and nutrients with the climatology and compare them with independent sources, such as surface heat and freshwater fluxes, streamflow, and satellite-based primary production. Preliminary results show strong seasonality in all of the variables in the Mid-Atlantic Bight and the Gulf of Maine. Surface salinity reaches a minimum in these basins in spring and summer, perhaps reflecting the impact of the spring peak in streamflow. These seasons are also the time in which surface oxygen anomaly (the departure from saturation) is a maximum, presumably reflecting the spring bloom and strong surface heating. Spring-summer nutrient drawdowns and oxygen outgassing will be estimated in order to quantify the biological export of nitrogen, phosphorus, silicon, and carbon. (Abstract ID 10889)

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AMMONIA-OXIDIZING THAUMARCHAEOTA IN THE NORTHERN GULF OF MEXICO OMZ

Our analysis with a suite of bias-corrected observations and climate models. Our analysis with a suite of bias-corrected observations of the ocean heat budget and heat content. The examples show how an emulator can be validated and how implausible outcomes from the emulator can be identified when compared to an observational estimate of the metric. In addition, the paper describes how the emulator outcomes and related uncertainty information might inform estimates of the same metric from a multi-model CMIP3 ensemble. We summarise how to 1) construct an ensemble based on design experiment methods, 2) construct and evaluate an emulator for a particular metric or outcome of a complex model, 3) validate the emulator using observational estimates, and 4) contribute to the understanding of uncertainties with a multi-model ensemble. (Abstract ID 9403)

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TOOL FOR THE POTENTIAL SIMULATION OF PLANKTON MICROBIAL COMPOSITIONS

We studied the distribution of ammonia- and nitrite-oxidizing organisms in the northern Gulf of Mexico, including stations in the recurrent oxygen minimum zone associated with the Mississippi River outflow plume. We examined the distributions of 16S rRNA (rrs), ammonia monooxygenase (amoA) and acetyl-CoA carboxylase (accA) genes. We found up to 10^9 copies L^-1 of Thaumarcheota rrs in our samples (up to 54% of prokaryotes), with maximum abundance at 100-400 m. The relative abundance of Thaumarcheota rrs in pyrosequenced libraries correlated well with qPCR values (r^2=0.79, 95% CL of slope = 0.75-1.05). The abundance of nitrite oxidizing Bacteria rrs in pyrosequenced libraries correlated with that of Thaumarcheota rrs (r^2=0.49, 95% CL of slope = 0.032-0.064); however, their relative abundance was lower than reported by others (slope=0.25-1.00). Variations in ratios of gene abundances and phylogenetic analysis of rrs, amoA and accA genes suggest a strongly stratified Thaumarcheota population structure. Canonical correspondence analysis revealed that Thaumarchaeota rrs abundances were strongly correlated with both distance offshore and with oxygen concentration. The distribution of amoA genes was influenced by salinity, euphotic zone depth, and depth. (Abstract ID 9543)

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ATMOSPHERIC RESPONSES TO THE KUROSHIO EXTENSION FRONT OBSERVED BY CROSS-FRONT IN-SITU OCEAN, ATMOSPHERE AND AIR-SEA FLUX OBSERVATIONS

The Kuroshio Extension region is one of the most prominent air-sea interaction area in the world oceans. Previous studies provide climatological view of the effect of the Kuroshio Extension front (KEF) on the atmosphere well. However, each processes to determine air-sea flux and its effect on the ocean and atmosphere is not understood well. We have conducted in-situ observations of ocean, atmosphere and air-sea flux crossing the KEF by R/V Mirai during 8–9 April, 2010. The KEF was observed at the 34.5N and SST changes 5˚C/20km. As a result air-sea turbulent heat flux changes from 200 to 500 W/m^2. Obvious atmospheric responses to the KEF were observed in wind speed, pressure, humidity and cloud base height in the atmospheric boundary layer (about 1500-3000m height). It is interesting that a local maximum in wind speed is found north of KEF rather than south and it results from the interaction in the easterly wind. Physical mechanisms will be discussed. (Abstract ID 10822)

WHAT HAVE WE LEARNED FROM “ROUTINE” IOOS MONITORING?

PacIOOS, with 24/7 all-weather coverage, provides us with immediate, real-time data to investigate the effects of various phenomena including land-based storms and associated runoff, offshore storms, and tsunamis. We have been able to study the temporal and spatial distribution of water quality effects of storm runoff on the nearshore zone with the effects extending several kilometers offshore and for several days, and more subtle salinity effects lasting up to 65 days. These effects differed depending on temporal rainfall distribution, antecedent conditions, and waves associated with these storms. We observed subtle harbor oscillations in our water quality data resulting from offshore storms and we have had the opportunity to study the often overlooked water quality effects of relatively small tsunamis including resuspension and transport of harbor sediments into the nearshore zone. While IOOS may be thought of as primarily a monitoring and early warning system for the coastal ocean, it is also providing scientists with a veritable trove of data that will help us better understand the interaction of the atmosphere, land, and surrounding ocean on the nearshore zone. (Abstract ID 9545)

THE MEDITERRANEAN AND ADRIATIC MARINE FORECASTING SYSTEM

The Mediterranean and Adriatic marine Forecasting Systems (MFS and AF5) produce daily 10-day forecast of the physical variables of the sea. Two different systems for MFS are running in parallel every day. One is stand alone while the other is nested into the global forecasting system from Mercator-Ocean. It is the physical component of the Mediterranean Monitoring and Forecasting Centre of the European MyOcean system and is off-line coupled with the biogeochemical component. MFS has an resolution of ca. 6.5 km and 71 vertical levels. The OGCM code is based on NEMO-OPA code (Oddo 2009) and is off-line coupled with a wave model, WAM. The system uses a variational assimilation scheme, OCEANVAR (Dowdall, 2008) for the assimilation of in-situ and satellite data. AF5 is nested into MFS and has a resolution of ca. 2 km and 31 sigma levels. Tides have been introduced in AF5 through the lateral open boundary on the barotropic velocities. MFS and AF5 are evaluated in NRT in order to provide useful information to the users on the quality of the products. (Abstract ID 12472)

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STATISTICS OF MODEL DRIFT ACCURACY: RESULTS FROM THE DEEPWATER HORIZON AND

The Naval Oceanographic Office maintains a real-time operational ocean model capacity that covers the entire ocean in either a global, regional, or coastal form. These data assimilating, general circulation models provide a wide variety of support to the Navy, including drift prediction products. In an effort to understand the basic question of model drift accuracy, surface and near surface drifters were used to develop regional statistics of model drift accuracy. Model predictions were initialized along drifter paths every three hours. Two time-dependent metrics were computed over a typical model forecast period of 72 hours: distance error and bearing error (measured from the initialization point). Errors from several thousand predictions were then combined to a common axis of hours past initialization. A surprisingly elegant result came from the statistics. While individual trajectory comparisons produced the expected oscillatory behavior in the error time-series, bulk statistical results were remarkably stable. The results from the Gulf of Mexico in the summer of 2010 (Deepwater Horizon) were very similar to results from coastal Japan in spring 2011 (Fukushima). (Abstract ID 10307)

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DISAPPEARANCE OF THE ANTARCTIC SILVERFISH FROM THE WESTERN PENINSULA SHELF—A FISH VULNERABLE TO CHANGING CLIMATE

Pleuragramma antarcticum, the Antarctic silverfish, is the dominant pelagic fish of most regions in the coastal Antarctic. Its pelagic lifestyle makes it important in the diet of apex predators in the coastal Antarctic. Over the last 30 years, silverfish have virtually disappeared in the diets of Adélie penguins nesting near Palmer Station, implying that Antarctic silverfish have disappeared from the foraging areas of Palmer Adélie and perhaps from the entire middle region of the Western Antarctic Peninsula (WAP). To test the hypothesis that silverfish are disappearing over part of their historical range, midwater trawling was conducted at six sites along the WAP shelf bounded on the south by Charcot Island and on the north by Joinville Island. Sampling revealed that silverfish were no longer present in the mid-peninsula region, but were found at the southern (Charcot Island and Marguerite Bay) and northern (Joinville Island) ends of the study area. Otolith microchemistry revealed that the fish at the two ends of the study area constituted two separate populations, a result that was corroborated by genetics analysis using microsatellite DNA. (Abstract ID 9447)

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ALONG-CHANNEL MOMENTUM BALANCE AND TIDAL DISSIPATION IN THE TRANSITION ZONE OF THE SANTÉE RIVER, SC, USA

Tides are subject to the frictional dissipation as they propagate inland through estuaries and river channels. We analyze time series of velocity profiles and bottom pressure that resolve along-channel momentum balance in the transition zone from tidal to fluvial regime of the Santee River, SC, USA. The depth-averaged momentum balance includes inertia, advection, pressure gradient, and bottom friction terms. Pressure gradient and inertia dominate the momentum balance during the flood and subsequent current reversal from flood to ebb. However, during the ebb the pressure gradient is nearly balanced by bottom friction. The dissipative term defined as a residual of inertia, advection and pressure gradient force is found to be comparable with the bottom friction term. Tides in the study area are flood-dominant, but most of the dissipation occurs during the ebb due to a superposition of river and tide currents subject to quadratic bottom friction. There is a convergence of momentum advection in the middle of the study site constituted two separate populations, a result that was corroborated by genetics analysis using microsatellite DNA. (Abstract ID 11540)

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SPATIAL DISTRIBUTION OF PCO2 DO2/AR AND DIMETHYL SULFIDE (DMS) IN POLYNYA WATERS AND THE SEA ICE ZONE OF THE AMUNDSEN SEA, ANTARCTICA

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We report the first simultaneous measurements of surface water pCO2, biological oxygen saturation (DO2/Ar) and dimethylsulfide (DMS) concentrations in the Amundsen Sea, Antarctica. We cross the polynya waters and the sea ice zone, DO2/Ar ranged from -40% to 40% (mean 8.6%), pCO2 ranged from 84 to 560 ppm (mean 250) and DMS concentrations varied from 1 nM to ~350 nM. For all gases, we observed strong sub-mesoscale (<10 km) spatial variability that was tied to underlying gradients in sea surface mixed layer depths, upwelling of modified circumpolar deep water and phytoplankton biomass and species distributions (diatoms vs. Phaeocystis). pCO2 and DO2/Ar were significantly correlated to Chl with a strong correlation and showed a stoichiometric relationship consistent with photosynthetic production with an imprint of air-sea gas exchange. The spatial distribution of DMS was often uncoupled from CO2 and DO2/Ar, with high concentrations possibly reflecting oxidative stress and the onset of Fe limitation in stratified waters. Simple calculations suggest that the Amundsen Sea contributes ~5% of total Southern Ocean CO2 fluxes, and ~1% of DMS fluxes. (Abstract ID 12309)

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DEFINING MARINE HABITATS FOR SOUTHERN ELEPHANT SEALS: JUVENILE RESPONSES TO VARIABILITY

Marine mammals forage in dynamic environments characterized by variables that are continuously changing. The ability of naive animals to forage in these conditions poses interesting questions about how they might perceive their environments. Sea surface temperature, chlorophyll concentrations and sea surface height anomalies all influence movements of juvenile southern elephant seals, possibly by influencing the distribution of prey available to the seals. Seals vary in their responses to these variables, indicating dynamic resource use by these animals. Habitat use for this species is thus best described using multiple variables. Movements were strongly correlated with the interaction between the frontal zones of the Antarctic Circumpolar Current (ACC) and the Andvair Burg Fracture Zone (ABFZ). The relative positions of these frontal zones may influence the interaction between the ACC and the ABFZ, either by enhancing or restricting oceanographic features, thus altering the available foraging areas for elephant seals from Marion Island. The importance of meso-scale eddies for potential juvenile southern elephant seal feeding areas is shown, and provides further evidence of the importance of the eddy fields west of Marion Island for higher predators. (Abstract ID 9837)

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DEEP EDDIES MODULATE FRONTAL MEANDER GROWTH IN THE Kuroshio Extension

During the Kuroshio Extension System Study (KESS) a two-dimensional array of current-change recording inverted echo sounders provided synoptic measurements of upper and deep fluctuations in the Kuroshio Extension between 143°E and 149°E with mesoscale resolution. Downstream-propagating frontal meanders, also called frontal waves, with periods of 3-60 d were always present between June 2004 and September 2005. Most meanders did not grow systematically downstream. Instead, meanders alternately grew and decayed as they propagated over distances of 100-200 km. Interaction with deep eddies, having a nearly depth-independent current structure, caused this growth or decay. These remotely-generated eddies propagated into the region from the northeast and east, thus tending to cross or oppose the meanders in the upper jet. Upper meanders and deep eddies jointly intensified when they encountered each other with the deep eddy offset about a quarter wavelength ahead of the upper meander, which is the orientation favorable to baroclinic instability. Subsequently as the upper and deep features moved apart each other and the vertical offset changed, intensification ceased. (Abstract ID 9442)

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Deep eddies in the Kuroshio Extension are formed on interannual time scales by the offset of the upper jet. This results in the formation of deep meanders (eddies) that propagate downstream into the region of the North Pacific. The North Pacific shows divergence, with westward currents west of the dateline and eastward currents east of it. These currents are opposite to the circulation pattern during the 2004 El Nino Modoki event. EFO analysis of surface currents shows a circulation anomaly pattern similar to that in 2000, 2004 and 2008 in the second EOF. A strong SST gradient in the central and western tropical Pacific is generally observed during both La Nina and La Nina Modoki events and can generate negative wind stress curl anomalies in the western tropical Pacific north of the equator. The northward flows in the equatorial Pacific are forced by the equatorial convergence zone during the 2000 and 2008 La Nina Modoki events even though Nino3 SST is near-normal. (Abstract ID 11807)

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Deep eddies in the Kuroshio Extension are formed on interannual time scales by the offset of the upper jet. This results in the formation of deep meanders (eddies) that propagate downstream into the region of the North Pacific. The North Pacific shows divergence, with westward currents west of the dateline and eastward currents east of it. These currents are opposite to the circulation pattern during the 2004 El Nino Modoki event. EFO analysis of surface currents shows a circulation anomaly pattern similar to that in 2000, 2004 and 2008 in the second EOF. A strong SST gradient in the central and western tropical Pacific is generally observed during both La Nina and La Nina Modoki events and can generate negative wind stress curl anomalies in the western tropical Pacific north of the equator. The northward flows in the equatorial Pacific are forced by the equatorial convergence zone during the 2000 and 2008 La Nina Modoki events even though Nino3 SST is near-normal. (Abstract ID 11807)

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significant interannual variability. In this downwelling system, macronutrients are replenished to the surface waters by winter overturning and vertical mixing events throughout the growing season. Productivity at near-shore stations within the Alaska Coastal Current (ACC) appears to be nitrate-limited in contrast with HNLC zones in the central GOA. A trend toward freshness of the surface layer due to increased glacial melt in this subarctic region may be driving earlier and stronger stratification. Surface production is a major contributor to nutrient drawdown and whith nutrients are closely correlated with salinity, the nutricline is consistently deeper than the pycnocline. Interannual variability in the ratio of silicate to nitrate usage is also observed. (Abstract ID 10731)

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NEARSHORE HYPOXIA IN THE COASTAL WATERS OF LONG BAY, SOUTH CAROLINA

In July 2004, hypoxic conditions were discovered in nearshore (<1km) waters of Long Bay, a resort area including Myrtle Beach which attracts 15 million tourist per year. Hypoxic conditions here are unexpected given the shallow water depths (<10m), sandy seafloor, and lack of nearby rivers. The center piece of the efforts to assess the temporal and spatial dynamics of the low oxygen events is a continuous monitoring platform deployed in 2006 reporting surface (~1m) and bottom (~1m above the seafloor) measurements of temperature, salinity, and DO. We report here the observed unique patterns of variability in DO over time scales of days, seasons, and interannually. Low DO is observed primarily during June through September persisting for periods of hours to days. These events occur following periods of upwelling favorable conditions and coincide with drops in water temperature and increased salinity associated with offshore marine water. The co-occurrence of low DO in the surface and bottom waters suggests that the presence of a very large and active DO sink in the water column, given the opportunity for oxygen to exchange across the air-sea interface. (Abstract ID 11796)

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BUILDING A WATER QUALITY CONSORTIUM IN THE GRAND STRAND OF NORTHEASTERN SOUTH CAROLINA AND SOUTH EASTERN NORTH CAROLINA

Water quality is of great importance to the Grand Strand as its economy is centered on beach-based tourism, hosting 15 million visitors annually. In 2004, Coastal Carolina University established the Waccamaw Watershed Agency (WWA) with the mission to deliver educational, research, and public outreach services to the university and local region. Since its inception, the WWA has built a consortium of local elected and appointed officials, stormwater managers, and academic researchers from varying disciplines to develop unified watershed management plans, consult on stormwater best management practices, and to protect and monitor the local fresh and marine waters. These efforts have resulted in the development of long-term fecal indicator bacteria, regulatory-level water quality, and volunteer water quality monitoring programs. In 2011, the consortium agreed to fund and expand monitoring of nearshore coastal oxygen concentrations to track an emerging issue of local hypoxia. Through these collaborative efforts, the consortium stakeholders have increased their understanding of the value of time series data, the watershed approach, and how to use these data to support management responses that protect and improve coastal water quality. (Abstract ID 11810)

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QUANTIFYING THE FRESHWATER FLUX OF SEA-ICE BETWEEN THE PACIFIC AND THE ARCTIC FROM MOORED ACOUSTIC DOPPLER CURRENT PROFILER DATA IN THE BERING STRAIT

The Bering Strait is the sole pathway linking the Pacific and Arctic Oceans, and carries ~1/3rd of the freshwater entering the Arctic. The contribution of sea-ice to this freshwater flux has not been satisfactorily quantified. We analyze ice-tracking data from an array of five subsurface upward-looking Acoustic Doppler Current Profilers (ADCPs) moored across the Bering Strait in US and Russian waters from 2007-2009. The data yield both ice motion and ice growth information, suggesting end of season ice-drifts of several meters. We use related mooring and atmospheric data to calculate the corrections necessary to obtain accurate ice thickness information from ADCP ice-track range data. These corrections include mooring/ instrument related (instrument tilt, footprint/shadowing, mooring motion) and environmental (sea-level change, sound speed change, sea-ice density, snow/ice efflux) effects. ADCP-derived range, signal correlation, and vertical velocity are evaluated along with satellite Special Sensor Microwave/Imager (SSMI/J) gridded sea-ice concentrations as indicators of ice cover. The work directs us towards a revised estimate of freshwater flux due to sea-ice through the Bering Strait, and demonstrates some limitations of moored ADCPs in providing sea-ice flux information. (Abstract ID 12202)

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OBSERVATIONS OF WAVE BOUNDARY LAYER TURBULENCE AND SEDIMENT SUSPENSION

Recent advances in current meter technology have made field observations of wave boundary layer turbulence and sediment suspension processes, accompanied by measurements of bedform morphology possible. A multi-frequency pulse-coherent Doppler profiler with convergent beam bistatic geometry measured the flow. The geometry and processing allows horizontal and vertical velocity measurements from overlapping sampling volumes, with a range from the seabed to 1 m above the seabed, 1 cm vertical resolution and 16 Hz sampling rate. The multi-frequency processing overcomes the range-velocity ambiguity typically associated with pulse coherent Doppler, and allows up to 1.5 m/s wave velocities. Rotary side scans and pencil beam sonars measured bedform morphology. The instrumented frames were deployed in coarse sand, supporting large bedforms (~1 m wavelength and 15 cm height), and fine sand with small bedforms (~15 cm wavelength and 3 cm height). While the instruments are still in the water, the measurements will be used to test simple models of wave boundary turbulence and sediment suspension over both large and small bedforms. (Abstract ID 10829)

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LIDAR OBSERVATIONS OF OPTICAL AND PHYSICAL PROPERTIES (LOOP)

Light Detection And Ranging (LIDAR) systems have been used most extensively to generate elevation maps of land, ice and coastal bathymetry. There have been space-, airborne- and land-based LIDAR systems. They have also been used in underwater communication. What has not been investigated are the capabilities of LIDARs to measure temperature and optical properties vertically in the water column, individually or simultaneously. The practical use of bathymetric LIDAR as a tool for estimation of inherent optical properties remains one of the most challenging problems in the field of optical oceanography. LIDARs can retrieve data as deep as 3-4-optical depths (e.g. optical properties can be measured through the thermocline for ~70% of the world’s oceans). Similar to AUVs (gliders), UAB-based LIDAR systems will increase temporal and spatial measurements by several orders of magnitude. The LOOP workshop was held at NURC (2011) to review past, current and future LIDAR research efforts in retrieving water column optical/physical properties. This new observational platform/sensor system is ideally suited for ground truthing hyperspectral/geostationary satellite data in coastal regions and for model data assimilation. (Abstract ID 10201)

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PRESENT-DAY DISTRIBUTION PATTERNS AND SOURCES OF METALS IN SEDIMENTS AND SEAWATER FROM THE EASTERN CHUKCHI SEA

Selected metals are being used during the COMIDA Project as tracers of natural biogeochemical processes and variability as well as indicators of impacts from human activities in the eastern Chukchi Sea. At present, sediment metals are predominantly at background concentrations with some natural diagenetic enrichment of As and Mn plus enrichment of Ba and Hg near two 1980s drill sites. Sediment metal ratios for the southeastern Chukchi Sea are consistent with a Yukon River sediment source. Additional sediment sources and transport pathways are indicated for sites north of 71˚N in the eastern Chukchi Sea. Metals in organic-rich particles from the upper water column and clay-rich particles from the lower water column complement sediment data for identifying sources and transport pathways. Concentrations of some dissolved metals in the shallow (e.g., As, Sb) are relatively uniform and track salinity; whereas nutrient-type metals (e.g., Cd, Ni) correlate with dissolved phosphate and bottom water salinity to complement traditional water mass tracers. Collectively, the metal data help define the present-day status of the Chukchi Sea and its links with the Pacific and
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MECHANISMS OF EDDY-MEAN FLOW COMPENSATION IN THE GULF STREAM

Meridional transports of heat and salt in the North Atlantic are important processes for climate. The contribution of transient eddies to these transports is quantified in an eddy resolving North Atlantic model at 1/12 resolution. There is compensation between the transient and the time-mean flow contributions to the heat transport, as shown by previous studies; here we show that this compensation is even more effective for the transport of salt. We examine in detail the eddy contribution at different latitudes. The contribution of the western boundary current to eddy transports is very large at the latitude of the Gulf Stream separation, while the eddy transport at other latitudes of the subtropical gyre is distributed over the basin width. The strong local eddy flux near Cape Hatteras is concentrated in the upper layers and results in a large eddy component of the meridional overturning circulation. This eddy flux could result from the meandering of the stream, in which case the eddy-mean flow compensation may operate on times scales shorter than one year. (Abstract ID 12194)

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LOCAL VERSUS REMOTE FORCING OF INTRASEASONAL-TO-INTERANNUAL SEA LEVEL AND THERMOCLINE VARIABILITY OF THE SOUTHERN INDIAN OCEAN

The relative importance of local versus remote forcing on intraseasonal to interannual sea level and thermocline variability of the tropical south Indian Ocean (SIO) is systematically examined by performing a suite of controlled experiments using an ocean general circulation model and a linear ocean model. Particular emphasis is placed on the Thermocline Ridge of the Indian Ocean (TRIO, 50E-80E, 5S-12S). On interannual and seasonal time scales, sea level and thermocline variability within the TRIO region is primarily forced by winds over the Indian Ocean. Internationally, the variability is primarily caused by the westward-propagating Rossby waves forced by the Ekman pumping velocities east of the region. Seasonally, thermocline variability over the TRIO region is induced by a combination of local Ekman pumping and Rossby waves generated by winds from the east. The adjustment of the tropical SIO at both timescales generally follows linear theory and is captured by the first two baroclinic modes. Remote forcing from the Pacific has significant influence on the seasonal and interannual thermocline variability in the east basin of the SIO, but it has weak impact on the TRIO region. On intraseasonal time scales, strong sea level and thermocline variability is found in the southeast tropical Indian Ocean, and it primarily arises from oceanic instabilities. In the TRIO region, intraseasonal sea level is relatively weak, and it results from Indian Ocean wind forcing. (Abstract ID 11744)

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LAGRANGIAN- AND EULERIAN-MEAN EFFECTS IN PROGRESSIVE INTERNAL GRAVITY WAVES

Nonlinear effects associated with progressive internal gravity waves lead to advection of fluid particles along with suspended mass such as sediment, nutrients, larvae, and contaminants. This wave-induced transport contributes to the development of benthic communities and plays a role in determining the nearshore fate of particulate matter including nutrients, larvae and contaminants. We compute Lagrangian particle trajectories and associated Stokes’ drift by employing both linear and nonlinear velocity fields in uniform and nonuniform stratification. We find that the progressive internal wave field induces a depth-varying mean Lagrangian drift acting in the direction of wave propagation near the surface and bottom, and in the opposite direction at mid-depth. A Navier-Stokes simulation is employed to compute the mean Eulerian velocity which is nonzero for nonlinear waves in nonuniform stratification. The impact of the Eulerian mean drift on the Lagrangian particle transport is assessed, and results show that for nonlinear internal waves the mean Eulerian velocity opposes the mean Lagrangian velocity. The strength of the stratification acts to increase transport at mid-depth while reducing it at the surface and bottom. (Abstract ID 10029)

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NEARSHORE SHEALING OF INTERNAL WAVES

Shoaling of internal waves is an important process affecting mixing of the stratified ocean. In the nearshore this mixing process and runup of dense fluid plays a key role in the transport and mixing of pollutants, nutrients and planktonic larvae. Given shallow depths, interactions with the surface and bottom boundaries are of first-order importance and the process is highly non-linear. Due to the inadequacy of linear or weakly non-linear governing equations, the shoaling process remains poorly understood. While computational models have shed light on the shoaling and resulting mixing processes, most of the work done in this area has focused on the propagation of a single solitary wave. I am using a computational model to look at the net effect of a series of internal solitary waves, as is typically observed nearshore due to the shoaling of internal tide energy. Specifically, I am looking at the interaction of two waves that are initially independent, but interact when the separation time between arrivals of these two waves is less than the time for nearshore stratification to relax to background conditions. (Abstract ID 11299)

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TOWARDS PARAMETERIZING ALONG-ISOPYCNAL DIFFUSIVITY AND FINDING BEST ESTIMATES OF MODE WATER VENTILATION IN THE NORTH ATLANTIC AND SOUTHERN OCEANS

Using a statistical technique called Bayesian model averaging (BMA), two quantities are estimated: ventilation rates of mode waters and a model’s along-isopycnal diffusivity parameter. Hydrographic bottle data along two meridional sections of the Southern Ocean, two meridional sections of the North Atlantic Ocean, and one zonal section of the North Atlantic Ocean are used to generate weights for evaluating which model configuration is closest to reality. An isopycnal-coordinate model that solves the advection-diffusion equation is utilized with six configurations: climatological or hindcast circulation fields, and three different values of a spatially constant along-isopycnal diffusivity. A change in the contribution of along-isopycnal mixing near outcrops for ventilating Subarctic Mode Water and two North Atlantic mode waters is suggested over time. A density-dependent along-isopycnal diffusivity that is smaller for water masses that form by deep convection or subduction than for water masses that form by turbulent processes that mix distinguishable water masses at intermediate depths is suggested and a new parameterization for along-isopycnal diffusivity is tested against previous parameterizations for improvement of model performance. (Abstract ID 9526)

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NEAR-INERTIAL POINCARE WAVES IN LAKE MICHIGAN: SPATIAL AND TEMPORAL STRUCTURE

Near-inertial Poincare waves are a dominant physical mechanism for large lakes during much of the stratified period, controlling horizontal and vertical transport for much of the lake’s interior. This is especially true for Lake Michigan, a large Laurentian Great Lake roughly 450km long. In this talk we present results that quantify the temporal and spatial variability of the near-inertial Poincare wave in Lake Michigan, drawing from both measurements and numerical model results. We examine the seasonal structure of the large-scale Poincare seiche, showing the evolution of the wave-induced velocities and thermocline displacements over the stratified season. We additionally present results on the horizontal spatial structure of the wave, in terms of induced velocities, thermocline displacements, vertical shear, and bottom stress. Finally, these results are discussed in the context of basin-scale mixing and mixing paradigms for very large lakes where the basin-scale seiche is near-inertial. (Abstract ID 9887)

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EFFECTS OF VIRAL LYSIS ON BACTERIAL MORTALITY IN WESTERN SUBTROPICAL PACIFIC COASTAL WATER

This study used a modified dilution method to measure the relative effects of grazer- vs. virus-induced bacterial mortality. Eight modified dilution experiments were conducted between September 2010 and March 2011 in the coastal water of western subtropical Pacific. Various fractions of 10 µm-filtered seawater (grazer- + virus) and 1.0 µm-filtered seawater (grazer-free) were diluted with 10 kDa filtered seawater (virus-free) to set up four gradients for providing less than the time for nearshore stratification to relax to background conditions. (Abstract ID 11299)
OCEAN-ATMOSPHERE INTERACTION KEY ASPECT OF THE MADDEN-JULIAN OSCILLATION

The Madden-Julian Oscillation dominates intra-seasonal climate variability in the Tropics, plays an important role in the E Niño Southern Oscillation, and influences weather around the world. Despite its importance, uncertainties exist in the mechanism for the MJO and it is poorly simulated and predicted by models. Although ocean-atmosphere interaction is believed important to the MJO, no consensus exists. Here we show using an AGCM coupled to a one-column ocean model that ocean-atmosphere interaction is indeed central to the dynamics of MJO, playing an important role in its strength, frequency, zonal wave number and eastward propagation speed. Comparison among observations and models with different degrees of ocean-atmosphere interaction indicate that resolving temperature variations of only the upper few meters of the ocean is essential to accurately simulate the eastward movement of the MJO over Indo-Pacific warm pool. (Abstract ID 11114)

BULK ALKALINE PHOSPHATASE ACTIVITY ASSAY ON PHOSPHORUS DEFICIENCY OF PLANKTON IN THE CHANGJIANG RIVER ESTUARY AFTER TYPHOON DISTURBANCE

Typhoon disturbs the water stability refueling the surface ocean via mixing nutrients from sub-surface, which cause ecosystem metabolism changes. To explore phosphorus (P)-deficiency of plankton in a large estuary system after summer typhoon disturbance, alkaline phosphatase activity (APA) and nutrient (nitrate, nitrite, and phosphate) concentrations were measured during a cruise to the Changjiang River Estuary between August 14 and 24, 2011. An offshore maximum release rate and whole amount of 137Cs directly released from the Fukushima Daiichi Nuclear Power Plant (1F NPP) after the nuclear accident. We employed three boundaries and restored conditions for the simulation of 137Cs concentrations off Fukushima coast by the Regional Ocean Models (ROMS). These conditions are only boundaries used and these plus sponge layer and full domain restored with temperature and salinity interpolated from the HYCOM assimilation data. The maximum release rate and whole amounts of 137Cs released were estimated to be about 250 MBq/s and about 3.5 PBq to minimize the cost function between simulated 137Cs concentration and observed one near Fukushima Daini Nuclear Power Plant (10km south from 1F NPP) and Iwawasa coast (16km south from 1F NPP). In addition, we also employed the ICPEQ2 assimilation data as boundaries and full domain restored data to compare with the results by the HYCOM. (Abstract ID 10581)

ESTIMATION OF THE AMOUNT OF CAESIUM-137 DIRECTLY RELEASED FROM THE FUKUSHIMA DAIICHI NUCLEAR POWER PLANT BY SENSITIVITY ANALYSIS

We estimated maximum release rate and whole amount of 137Cs directly released from the Fukushima Daiichi Nuclear Power Plant (1F NPP) after the nuclear accident. We employed three boundaries and restored conditions for the simulation of 137Cs concentrations off Fukushima coast by the Regional Ocean Models (ROMS). These conditions are only boundaries used and these plus sponge layer and full domain restored with temperature and salinity interpolated from the HYCOM assimilation data. The maximum release rate and whole amounts of 137Cs released were estimated to be about 250 MBq/s and about 3.5 PBq to minimize the cost function between simulated 137Cs concentration and observed one near Fukushima Daini Nuclear Power Plant (10km south from 1F NPP) and Iwawasa coast (16km south from 1F NPP). In addition, we also employed the ICPEQ2 assimilation data as boundaries and full domain restored data to compare with the results by the HYCOM. (Abstract ID 10581)

DISTRIBUTION OF 137Cs FROM THE FUKUSHIMA DAIICHI NUCLEAR POWER PLANT SIMULATED NUMERICALLY BY A REGIONAL OCEAN MODEL

Radioactive materials were released to the environment from the Fukushima Daiichi Nuclear Power Plant as a result of the reactor accident after the Tohoku earthquake and tsunami of 11 March 2011. The two major likely release pathways from the accident site, i.e. direct release of high radioactive liquid wastes and the atmospheric deposition, existed. By analysis of the 137Cs activity ratio, we determined that direct release from the site contributed more to the measured 137Cs concentration than atmospheric deposition did. We then used a regional ocean model to simulate the 137Cs concentrations resulting from the direct release to the ocean off Fukushima and found that from March 26 to the end of May the total amount of 137Cs directly released was 3.5 ± 0.7 PBq. Further, the simulated temporal change in 137Cs concentrations near the Fukushima Daini Nuclear Power Plant site agreed well with observations. Our simulation results showed that 137Cs concentrations decreased to less than 10 Bq L−1 by the end of May 2011 in the whole simulation domain as a result of oceanic advection and diffusion. (Abstract ID 10195)

ISOPTIC FOOD WEB COMPARISONS OF TWO SURVEY SITES IN THE NORTHEASTERN CHUKCHI SEA

The benthic communities of three (Burger, Klondike, and Statoil) proposed oil and gas exploration sites have been sampled annually since 2008. This study, sponsored by ConocoPhillips, Shell Exploration and Production Company, and Statoil USA E & P is being used to establish baseline conditions of these areas prior to exploration and provide information useful for permit applications. Sites differ in their environmental characteristics; Klondike lies in a high flow area and has substrates ranging from mud to gravel, while Burger is primarily a depositional site with muddy-sediments with Statoil reflecting characteristics of both. Preliminary results suggest that there is a 1% shift in the POM δ13C values between the Burger and Klondike survey sites, which appears to be reflected in the δ13C signatures of the benthic epifauna and infauna of these areas. Additionally, animals and POM collected at Klondike appear to have higher δ13C signature variability than Burger, possibly indicating greater variability in food source. The close proximity of the study sites will allow determination of small-scale patterns in benthic food web structure within the region. (Abstract ID 11984)

METABOLIC FATE OF SOIL DERIVED DISSOLVED ORGANIC CARBON IN THE HIGH-LATITUDE KONGSFJORD SYSTEM

As a result of the earth’s changing climate, average surface temperatures in the Arctic are increasing at a rate nearly double that of global estimates (Frey and McClelland 2009). This could have profound impacts on the global carbon budget as it is estimated that up to 50% of soil carbon sequestered from active circulation is in the Arctic Drainage Basin. Organic carbon sources to adjacent waters may derive from permafrost warming and export as well as glacial meltwater during large floods or ice-rafted detritus; however, the fate of these carbon sources along with the fresh water from the river is more complex and dynamic. Sub-surface discharging of soil derived DOC from the inner shelf and the land was detected during our surveys in the Kongshavn system during the summer months from 2009-2011. (Abstract ID 11979)
UK GEOTRACES: COUPLED NITROGEN AND OXYGEN ISOTOPIES TRAVERSE NITRATE MOVEMENT WITHIN SOUTH ATLANTIC WATER MASSES (40S). Stable nitrogen (N) and oxygen (O) isotopes of nitrate (NO3) were measured across the Cape basin at 40S. Depth profiles are used to identify changes to isotope signatures between water δ15N and δ18O values of 5.1 ‰ and 1.6 ‰, respectively, were measured, and deviations are identified in the Antarctic Bottom Water (AABW), North Atlantic Deep Water (NADW) and Antarctic Intermediate Water (AAIW). Lower NADW δ15N values of ~4.5 ‰ correlate with typical low nutrient and high N:P values. This preliminary data may indicate nitrogen fixation in Atlantic surface waters and release of lighter N through sinking particles in the NADW. This depleted isotopic signal may help quantify the extent of nitrogen fixation in the North Atlantic. In contrast, the AAIW and AABW show relative enrichment, indicating partial utilization of NO3 from the Southern Ocean. These results may suggest higher nitrogen fixation rates and trace the transfer of NO3 through the Atlantic. Further samples will be gained on UK GEOTRACES cruise JD08 to complete this transect. (Abstract ID 10248)

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NEW PRODUCTS AND AUTOMATED MATCH-UPS FOR THE COASTAL COLUMBIA RIVER
The Columbia River is the largest river on the West Coast of North America and its input of fresh water, sediments and nutrients dramatically affects the productivity and coastal dynamics of Washington and Oregon coastal waters. Data from new ocean color sensors provide a greatly enhanced view of this complex system. New sensors including HICO, the hyperspectral imager of the coastal ocean providing 95 meter hyperspectral data, MERIS full resolution (300 m) data now available for almost a decade, and the recently launched VIIRS, a hyperspectral imager of the coastal ocean providing 95 meter hyperspectral data, MERIS full resolution (300 m) data now available for almost a decade, and the recently launched VIIRS, the newest generation of US ocean color sensors. The new views also include new products from derivative spectroscopy methods applied to HICO radiance data to help unravel the complexities of coastal waters. To validate these products we use new match-up tools for West Coast waters using a web portal and SQL backend. Taken together the tools allow a new integrated view of the Columbia River and its interaction with the Washington and Oregon coastal waters. (Abstract ID 11435)

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AMOC, THE MANN EDDY AND RECONSTRUCTING 20TH CENTURY AMOC VARIABILITY FROM DATA
We review evidence which suggests that decadal variability in AMOC is primarily associated with upper ocean density anomalies on the western margin of the basin, in the region of the Mann Eddy. These anomalies modulate the trajectory and strength of the North Atlantic Current. The importance of the western margin is a direct consequence of the thermal wind relation and is independent of the mechanisms that create those density anomalies. Density anomalies in this key region are part of a larger-scale pattern that propagates around the subpolar gyre and likely acting as a ‘pacermaker’ of AMOC variability. Finally, we reconstruct AMOC back to 1955 using historical subsurface ocean temperature data (from NOAA) in the region of the Mann Eddy. This proxy approach is first compared against the ECCO ocean state estimation system from 1990 onwards. The reconstructed AMOC exhibits a downward trend from 1955 through to 1990, falling by about 10% of its initial strength, followed by a small recovery from 1990 onwards. Prospects for projecting AMOC further backwards in time using sea surface temperature records are also discussed. (Abstract ID 11689)

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THE CARRON BUDGET OF THE CALIFORNIA UPWELLING SYSTEM
To quantify the carbon budget of the central California Upwelling System (CUS), we made an eddy-resolving simulation using ROMS coupled to an NPZD ecosystem model, including a formulation of the carbon cycle. We evaluated our model by comparing modeled surface pCO2 to a seasonal climatology based on several observational databases. Our model results show a net outgassing of CO2 of 2 TgC/yr in the first 10km offshore of the central CUS (42.5N-42.4N), compared to an upwelling of dissolved inorganic carbon (DIC) of 382 TgC/yr. This upwelling, together with alongshore advection make up a total DIC supply of 642 TgC/yr, of which 11 TgC/yr is biologically converted to organic matter (OM), and the rest is transported offshore. Roughly half of this OM is exported vertically, while 7 TgC/yr is transported offshore. These results demonstrate i) a locally significant decoupling between vertical export and production due to large offshore fluxes and ii) that the biological uptake of carbon and the air-sea CO2 exchange represent only a small component of a very dynamic carbon cycle dominated by large lateral and vertical DIC fluxes. (Abstract ID 11150)

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SUMMERTIME PCO2 IN THE CUMBERLAND SOUND IN THE EASTERN ARCTIC
The Arctic Ocean is estimated to contribute roughly 10% of the global annual uptake of CO2 in the ocean. Studies show this appears to be particularly sensitive to environmental changes. However this estimate as well as the impact of environmental conditions on the sources and sinks of carbon dioxide is based on limited data currently available in the Arctic. Here, we present the first measurements of water CO2 in the Cumberland Sound during the summer of 2011. Cumberland Sound is a major inlet, 300 km long, with an average width of 65 km, in the east coast of Baffin Island connected the Labrador Sea and affected by multiple freshwater sources. Measurements were performed during the ice-free season using a SAMI-pCO2, and collecting profiles of discrete water samples in the upper 50m. The pCO2 measurements are combined with physical observations and satellite chlorophyll estimates. Results are described and discussed in the context of other pCO2 observation in the Canadian Arctic Archipelago and Labrador Sea. Our data presents a start of 5-year field effort conducted by the Ocean Tracking Network (OTN). (Abstract ID 11495)

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NITROGEN FIXATION AND THE DIVERSITY, ABUNDANCE AND NITROGENASE (NIFH) GENE EXPRESSION OF DIAZOTROPHS IN THE EASTERN TROPICAL SOUTH PACIFIC
Recent studies have hypothesized that the Eastern Tropical South Pacific (ETSP) may support high rates of N2 fixation, which would have significant implications for the global N budget. We measured bulk N2 fixation rates and characterized the diazotrophic community in the phytic zone along transects from the Chilean upwelling zone to the oligotrophic waters of the South Pacific Gyre. Averaged N2 fixation rates were highest in oligotrophic waters at 100W and 20S at 175 monolN m-2 d-1, but were also significant in upwelling regions. Quantitative PCR (qPCR) assays did not detect the presence of cyanobacterial diazotrophs such as Trichodesmium, Crocosphaera, or UCYN-A. The characterization of diazotrophs from this region, using PCR amplification and sequencing of nifH, revealed primarily gamma-Proteobacteria. We developed qPCR assays targeting two gamma-proteobacterial phyotypes, one of which can be detected expressing nifH at several stations, but is low in abundance and unlikely to be solely responsible for the measured rates. This data implies that the microbial community responsible for N2 fixation in the ETSP is not comprised of the typical cyanobacteria described in oligotrophic oceans. (Abstract ID 11562)

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BIOGEOGRAPHIC EFFECTS OF THE GULF OF MEXICO RED TIDE DINOFLAGELLATE KARENIA BREVIS ON THE MEDITERRANEAN CCOPEOPS CALANUS HELGOLANDICUS AND TEMORA STYLIFERA
Zooplankton sympatric with toxic phytoplankton may have evolved toxin defenses, whereas grazers may be affected by exotic phytoplankters. We compared feeding, reproductive success and survival of Mediterranean Calanus and Temora feeding on Gulf of Mexico Karenia, versus non-neurotoxic Mediterranean strains of Alexandrium tamaense and Procentrum minimum. Both copepods fed, reproduced and survived on diets of Karenia, but not as well...
as on diets of dinoflagellates from the Mediterranean. Egg hatching success on Karena diets declined over time. Karena contained no brevetoxins, but contained another compound that was antimitotic to human pulmonary cancer cells. Alexandrium contained no saxitoxins, but contained another compound that inhibited egg fertilization. Although a Karena diet was adverse to one copepod, Mediterranean Alexandrium was adverse to the other. Karena was less adverse to Temora with which it co-occurs in the Gulf of Mexico, than Calanus with which it does not. Biogeographic effects of copepods feeding on exotic versus sympatric dinoflagellates were unclear. Since both dinoflagellates contained unknown chemicals other than neurotoxins, understanding of the biogeography must await defining the biochemistry of harmful alga-eater interactions. (Abstract ID 9385)

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RIVER DIVERSIONS IN THE MISSISSIPPI DELTA MAKE MARCHES MORE VULNERABLE

The creation of large diversions of Mississippi River water into coastal marshes is done under the presumption that the influx of nutrients and sediments would spur marsh plant growth and benefit marsh accretion. We examined, using LandSat Thematic Mapper imagery, changes in the percentage of vegetation and overall area marsh in three diversions that began in the early 1990s. The diversions yielded no discernible changes in either the nominal vigor of the marsh vegetation or overall marsh area in three diversions that began in the early 1990s. The diversions yielded no discernible changes in either the nominal vigor of the marsh vegetation or overall marsh area after Hurricane Katrina, and sharp declines in vegetation and marsh area after Hurricane Katrina. Marsh vegetation in two reference sites adjacent to the diversions, however, was much less severe. The results of field experiments indicate that nutrient enrichment may lead to lower root and rhizome biomass, belowground production, organic accumulation and soil strength. These results are consistent with the high land loss post-Katrina/Rita in the Caernarvon river diversion outflow path. We conclude that sustaining and restoring coastal emergent marshes is more likely if they receive a lower, not a higher, nutrient load. (Abstract ID 10865)

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CROSS-SHORE THERMALLY-DRIVEN EXCHANGE ON TWO CORAL REEF SHORELINES

The dynamics of cross-shelf circulation influence the exchange of water masses and the distribution of heat, salt, nutrients, contaminants, sediment, and planktonic organisms like larvae or phytoplankton in the nearshore coastal ocean. In addition, in the case of coral reefs, the horizontal redistribution of heat by cross-shelf circulation moderates the daily variations in temperature experienced by coral polyps, thus potentially reducing thermal stress. We describe observations from two reefs at Elat, Israel and Oahu, Hawaii that highlight the role of thermally forced baroclinic exchange in cross-shore transport. At each site, daytime conditions are characterized by offshore flow at the surface in response to increased temperatures in shallower water nearshore. Nighttime cooling results in offshore flow near the bed. Significant differences in flow response at the two sites indicate distinct dynamic regimes, however. While a steady thermal balance provides a good description of the flows observed off Elat by Monismith et al. (2006), it appears from the phase differences between the heating, the thermal response and the cross-shore flows that the thermal energy balance for KNO is in the unsteady regime. Time series data from Oahu further indicate that the exchange provides a first order contribution to the overall cross-shore exchange. (Abstract ID 12597)

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HOW DOES SURFACE SALINITY AND RAIN AFFECT THE NORTH ATLANTIC OCEAN CIRCULATION?

Salinity variations in recent decades have been linked to the Atlantic Meridional Overturning Circulation (MOC) strength, and the tropics/subtropics are considered important regions in relation to the reversal of northern N Atlantic freshening and MOC recovery. This study focuses on the controlling mechanisms, particularly the influence of freshwater fluxes (Evaporation minus Precipitation, E-P), on sea surface salinity (SSS) and upper ocean salinity (OUS) variability in the Atlantic region 30°N-5, which includes two dynamically different regimes, the P-dominated tropics and the E-dominated subtropics. Analysing various datasets for each variable (NCER GPPC, WOA09, etc) on different time-scales, in addition to new SSS maps from the European Space Agency Soil Moisture and Ocean Salinity (SMOS) satellite, helps us to consider the role of E-P on the formation, magnitude and maintenance of the subtropical Atlantic SSS maximum, the small seasonal cycle in SSS compared to that of E-P, and propagation pathways at these latitudes. This examination will contribute to a regional validation of SSS from the SMOS and Aquarius satellites in E- and P-dominated regions, and an improved definition of the variability of SSS in this region. (Abstract ID 101252)

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INTERANNUAL VARIATIONS IN THE DENSE SHELF WATER IN THE SEA OF OKhotsk

The interannual variations in the dense shelf water (DSW) in the Sea of Okhotsk are studied through the use of the hydrographic dataset including the unpublished Russian observation data. Less (more) saline DSW precedes the temperature rise (drop) in the Okhotsk Sea Intermediate Water (OSIW) in the Kuril Basin by 2 to 4 years and lags behind lower (higher) salt content at the upper layer in the eastern Okhotsk by 1 year. There is also a deepening-long-term trend in the upper-layer salinity of the eastern Okhotsk as well as DSW. These facts suggest that less salt transport at the upper layer can contribute to the warming trend of OSIW through forming less-dense DSW. It is suggested that the salinity anomaly at the upper layer in the eastern Okhotsk can be originated from the winter mixed layer in the Bering Sea. This anomaly can be supplied from the Bering Sea to the eastern Okhotsk by the Eastern Kamchatka Current and tidal current through the Kuril Straits. (Abstract ID 10132)

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DAILY VARIATION OF TURBULENT KINETIC ENERGY OBSERVED AT A FIXED POINT NORTH OF THE KUROSHIO EXTENSION.

Recently the Kuroshio-Oyashio Extension Region attracts attention as a hotspot for climate change owing to extremely large heat release from the surface sea. This region, however, is very rich in ocean mesoscale phenomena such as warm or cold-core rings and ocean fronts including the Kuroshio Extension, it is not necessarily clear how these ocean mesoscale phenomena in this region affect the air-sea interaction. We conducted the 5-day-time series observation for the air-sea interaction at a fix point north of the first crest of the Kuroshio Extension in October 2009, and got time-series data of turbulent energy dissipation rate and atmospheric forcing. According to analyses of these data, variation of vertical integrals of the dissipation rate in the ocean mixed layer does not necessarily correspond to sea-surface energy flux by the wind. Instead the large dissipation rates were observed in response to the down-front winds. Considering that our observation point was located at a small ocean front, this suggests involvement of frontal instability induced by the lateral density gradient and the down-front wind. (Abstract ID 10745)

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HANDLING OF SUBGRID SCALE TOPOGRAPHIES IN AN OCEAN-TIDE MODEL

In oceanic regions such as the western Pacific, the Caribbean Sea, and the Arctic Ocean, there are many topographic features practically unfeasible to be resolved in numerical models but are expected to play crucial roles on the formation of ocean tides. This study introduces an ocean-tide model equipped with a modified advective scheme to consider the effect of tidal waves propagating through sub-grid scale topographic features. Preliminary test runs applied to the western Pacific Ocean indicate improved performance without employing finer spatial grids. (Abstract ID 12570)

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WIND-EVAPORATION-SEA SURFACE TEMPERATURE FEEDBACK IN THE
WESTERN TROPICAL PACIFIC

The wind-evaporation-sea surface temperature (WES) feedback in the western tropical Pacific during the mature phase of El Niño has been demonstrated based on observed data derived from satellite and ocean-atmosphere coupled model output. The observation revealed anomalous distributions of the sea surface temperature (SST), wind, and latent heat flux during the mature phase of strong El Niño such as 1982-83 and 1997-98 events. Especially, nearly equatorially anti-symmetrical SST distribution and strong northerly cross-equatorial wind with relatively weak easterly wind are characteristics of the WES feedback. The dominance of WES feedback in the western tropical Pacific also appeared in ocean-atmosphere coupled model. Using relatively longer time series of the model output detailed processes was investigated. In addition to investigation of the associated processes, influence of the WES feedback for the El Niño termination and basin-scale warming in the tropical Indian Ocean was also considered. These speculations will be confirmed a number of ocean-atmosphere coupled model experiments. (Abstract ID 11684)

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AN ITERATIVE METHOD FOR ESTIMATING OBSERVATION ERROR COVARIANCE MATRIX

We propose an efficient algorithm for the maximum likelihood estimation of the observation noise covariance. The algorithm is based on an analytical derivation of the derivative of the ensemble-approximated likelihood with respect to the observation noise covariance, and forms an iterative updating procedure for estimating the optimal covariance parameters. The algorithm works with the ensemble-based filters in which the likelihood can be approximated with the ensemble. Since the algorithm does not require evaluating likelihood for every combination of the covariance parameters as done in Ueno et al. (2010), it can estimate many elements in the observation noise covariance matrix. (Abstract ID 11527)

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MODIFICATION OF A KENAI EDDY ALONG THE ALASKAN STREAM

A Kenai eddy was studied through analyses of satellite altimetry data and hydrographic data from shipboard and Argo float observations. This eddy formed in December 2006 in the area south of the Kenai Peninsula and propagated southwestward along the Alaskan Stream. The eddy held horizontally uniform warm core water in January 2007. In late winter 2007, this core water was cooled from the top and a subsurface temperature maximum formed around 26.5 °C. Two years later, in summer 2009, warm and low-dissolved-oxygen (low-DO) water characterized by the temperature maximum around 26.5 °C was observed again in the eddy core, which was likely to be the remnant of the original core water. At the same time, cold and high-DO water intrusions occurred in the eddy core, suggesting that strong modification of core water was ongoing. (Abstract ID 9923)

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LATERNAL AND INTRATIDAL VARIABILITY IN CURRENTS, HYDROGRAPHY, AND VERTICAL MIXING IN A WIDE ESTUARY

Residual currents in estuaries can arise through a variety of non-linear mechanisms involving the covariance on tidal time scales between currents, stratification, and mixing. These processes are hypothesized to occur in the eastern portion of Long Island Sound (LIS), a wide, relatively deep estuary where tidal currents are strong. Measurements of currents from a tidal-averaged ADCP and hydrography and conductivity microstructure from a towed undulating profiler along a repeated cross-estuary section show significant variability in current shear and stratification both laterally and over the tidal cycle. These observations and estimates of the gradient Richardson number and the vertical turbulent diffusivity will be presented in the context of assessing the tidal-period covariances among the variables and how these covariances change with lateral position. Results from a numerical simulation of the study area will be analyzed in the same fashion and compared to the observational results. An assessment of the relative importance of several different residual current generation mechanisms will be made for this region of eastern LIS. (Abstract ID 11571)

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Population genetic diversity and structure of the copepod Calanus finmarchicus across the north atlantic basin

The calanoid copepod Calanus finmarchicus shows significant geographic variation in life history traits across subarctic zones of the North Atlantic Ocean. Basin-scale population genetic structuring of the species was investigated by examining allelic variation at 24 Single Nucleotide Polymorphism (SNP) sites in three nuclear protein-coding genes. The results from hierarchical analysis of molecular variance for samples assigned to 10 genetic clusters show significant genetic structuring among these clusters, which is consistent with large-scale population differentiation consistent with two, three, or four distinct populations, and the distinctive status of the Barents Sea population. The results also confirmed that C. finmarchicus as a high-gene flow species and revealed small but significant sub-regional scale structuring among area populations, which may reflect ecologically-important, short-term variation driven by geographic variation in life history traits. Patterns of gene expression of samples collected from the Gulf of Maine were examined using an Expressed Sequence Tag (EST) microarray, and groups of high-responder genes that may control critical life history processes were identified.
VIBRIO IN THE CHESAPEAKE BAY

The Chesapeake Bay is the largest estuary in the United States, and home to an increasing number of harmful marine species including Vibrio bacteria. While routine water monitoring has been successful in preventing Vibrio outbreaks in the Chesapeake Bay, there is a pressing need for advanced technology to prevent the future spread and severity of this public health problem. The objective of this research is to apply the power of near real-time satellite-derived observations to the problem of Vibrio spp. monitoring and prediction in Chesapeake Bay. Remotely sensed SST and empirically derived surface salinity are presented focusing on an outbreak in the vicinity of Wrangell Island. Since both the coastal ice belt and the intermittent sea ice has appeared along with some frequency since 1849 but has not been present since 1998. Its appearance is linked to northwesterly winds and varies on synoptic to decadal time scales. Its recent disappearance is probably due to decreases in the multi-year sea ice fraction in the vicinity of Wrangell Island. Since both the coastal ice belt and the intermittent Siberian Coastal Current (SCC) can be related to similar wind fields, it is possible that our index may be a proxy for the SCC. Documenting longer-term variations in sea ice distribution allows us to show how unusual current ecosystem changes may be. (Abstract ID 12549)

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Zooplankton fecal pellets are found throughout the world’s oceans and they serve several different but important functions in carbon cycles. Over the years, our knowledge of organic carbon flux has evolved from a simple model based on the export of large particulate organic matter from the surface to the sediments to a complex model involving the interaction between dissolved and particulate organic carbon. Zooplankton fecal pellets can be a major vector for the transport of both particulate and dissolved organic carbon from the surface waters to the sediments and deep water. In February 2009, I launched an internet-based zooplankton fecal pellet guide (www.zfpguide.com). The ZFP Guide is the result of collaboration between Dr. Karin Beaumont from the University of Tasmania and I. Our vision was to create an on-line resource that illustrates a variety of fecal pellet types from different zooplankton species and, where possible, provide information on the diet, collection method, depth and location. The ZFP Guide is designed to be both a resource and tool for scientists and a source of information for educators. (Abstract ID 12779)

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REMOTELY SENSED ESTIMATES OF SURFACE SALINITY AND ENVIRONMENTAL VIBRIO IN THE CHESAPEAKE BAY

The Chesapeake Bay is the largest estuary in the United States, and home to an increasing number of harmful marine species including Vibrio bacteria. While routine water monitoring has been successful in preventing Vibrio outbreaks in the Chesapeake Bay, there is a pressing need for advanced technology to prevent the future spread and severity of this public health problem. The objective of this research is to apply the power of near real-time satellite-derived observations to the problem of Vibrio spp. monitoring and prediction in Chesapeake Bay. Remotely sensed SST and empirically derived surface salinity are presented focusing on an in-depth spatial and temporal comparison within the Chesapeake Bay estuary. Results show that sea surface salinity can be accurately predicted via 1km L2 MODIS color products with an accuracy that is more than sufficient for many physical and ecological applications. Spatial analysis of remotely sensed SST and SSS is performed to quantify patterns and association of Vibrio spp., applicable environmental parameters, as well as distribution and spread of future Vibrio disease transmission. Successful execution of the methods listed above will advance our ability to predict, via continuous remote sensing data, the presence of Vibrio spp. in the Chesapeake Bay. (Abstract ID 10078)

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SPATIAL AND TEMPORAL TRENDS IN SOLUBLE, COLLOIDAL AND LABILE PARTICULATE IRON IN THE ATLANTIC OCEAN.

The varied iron biogeochemistry of the surface Atlantic Ocean is of great interest due to its proximally to high magnitude sources, such as aerosols from the Saharan Desert, highly productive upwelling areas and continental shelves. To understand how iron is processed and utilised in the upper water column, it is important to consider the physico-chemical transformations that occur in situ. These transformations include the partitioning of iron between molecular and non-particulate (often termed soluble, <0.02 μm), colloidal (0.02 – 0.4 μm) and particulate (>0.4 μm) fractions. In this presentation, iron size speciation data from (i) FeATMISS and FeAST’ cruises in the Sargasso Sea and (ii) the Atlantic Meridional Transect, are compared. The data show the (i) inter-annual consistency of vertical soluble, colloidal and labile particulate iron profiles in the Sargasso Sea and (ii) the extreme spatial variation of these species over the Atlantic Ocean. The partitioning can give empirical clues to understanding the biological utilisation and residence times of iron and raises the question of whether regional ‘biomes’ are adapted to the seasonal fluxes. (Abstract ID 11597)

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LONG-TERM VARIABILITY OF THE KUROSHIO LARGE MEANDER

This study investigates long-term variability of the Kuroshio path using an ocean data assimilation system. Sensitivity experiments, in which observations of the 2004 large meander (LM) are assimilated into model states with different strength of the Kuroshio, indicate that the LM exhibits long (short) duration in the case of the weak (strong) Kuroshio. This relation can be seen from Sverdrup transport during the past large meanders estimated from the linear baroclinic, Rusby model. The Sverdrup transport indicates that the transport increases in the end of the LM period, suggesting that the increase in the transport leads to the decay of the LM. This study also focuses on a relation between the LM and the Kuroshio Extension (KE) path. It is revealed that the LM tends to occur during the stable state of the KE path when the Kuroshio path on the Izu Ridge is set to go through a northern gate around 34N, which is considered as one of the necessary conditions for the occurrence of the LM. (Abstract ID 10747)

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A NEW OVERTURNING LOOP FOR THE FORMATION OF DENMARK STRAIT OVERFLOW WATER

The Deep Western Boundary Current constitutes the lower limb of the Atlantic Meridional Overturning Circulation, and, as such, is a crucial component of the Earth’s climate system. The largest and densest of the overflow plumes that feed the current is the Denmark Strait Overflow Water (DSOW). The primary source of DSOW is commonly thought to be the East Greenland Current (EGC). Here we show, using multiple high-resolution shipboard hydrographic and velocity measurements, that a recently discovered current known as the North Icelandic jet (NIJ) advects overflow water into the Denmark Straits and constitutes a pathway distinct from the EGC. The current is situated on the Iceland continental slope and supplies both the densest overflow water and approximately half of the total overflow transport. Model simulations suggest that the process forming the NIJ is dependent upon the import of warm, salty water from the northward-flowing North Icelandic Irminger Current in conjunction with transformation in the interior Iceland Sea. This overturning loop represents a new scenario for the formation of DSOW. (Abstract ID 10162)

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TIME SCALES OF PHOTOACCLIMATION IN PHYTOPLANKTON OF THE WESTERN ANTARCTIC ZONE

As part of the Southern Ocean Gas Exchange Experiment (SO GasEx) we measured the carbon dioxide uptake kinetics of phytoplankton in a patch of ocean water using photosynthesis-irradiance experiments and indirectly by variable fluoroscent. The water mass was tracked using SF6 as tracer techniques, which allowed us to observe the changes in carbon.
 uptake (photosynthesis vs. irradiance, P vs. E) parameters over a 12-day period, and also over a shorter diel time scale in the same and nearby “outside” phytoplankton patches. We relate the observed changes in maximum carbon uptake, photosynthetic efficiency, light absorption by pigments, photosynthetic quantum yield, and variable fluorescence yield, and variable fluorescence parameters to the observed changes in the optical (e.g., Apsa surface PAR irradiance) and physical properties (e.g., mixed layer depth) of the water column that occurred during these two different time periods. We relate the time scale of physical variations in the environment to the rate at which biological productivity can respond and acclimate. (Abstract ID 10123)

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THE NATIONAL UNDERSEA RESEARCH PROGRAM (NURP); RECENT DISCOVERIES

Created in 1982, NOAA/NURP has leveraged expertise, skills and resources of academic partners to meet NOAA’s and the Nation’s ocean needs for nearly 30 years. NURP supports and facilitates underwater exploration, research and technological innovation necessary to further the discovery, understanding, and wise management of ocean ecosystems and processes, living and non-living resources, and the impacts of natural and anthropogenic changes on critical ecosystems. Four regional centers and two institutes have been established to pursue these efforts.

The theory of the meridional overturning circulation and associated deep stratification in an interhemispheric ocean with a southern circumpolar channel is presented. The theory includes the effects of wind, eddies, and diapycnal mixing, and predicts the deep stratification and strength of the MOC. The theory and relies on a matching among three regions: the circumpolar channel in the Southern Hemisphere, a region of isopycnal outcrop at high latitudes in the Northern Hemisphere, and the ocean basin between them. The conceptual model underlying the theory is very different from Stommel-Arons or abyssal recipes type descriptions. Rather, it quantifies and provides a theoretical framework for more recent ideas concerning the importance of Southern Ocean winds in the interhemispheric MOC. The theory suggests that whereas the strength of the mid-depth overturning cell is primarily set by the wind stress, stratification at intermediate depths results from a balance between the rate of wind-driven upwelling in the ACC and the rate of deep water formation at high northern latitudes. The abyssal cell is intrinsically diachronic and controlled by a balance between the mixing-driven upwelling in the abyssal ocean and the residual between the wind-driven and eddy-induced circulations in the Southern Ocean. Overall, the stratification below the main thermocline is critically dependent on the dynamics occurring in the ACC. (Abstract ID 10662)

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CHEMICAL SIGNALING BY ULVLOID GREEN ALGAE

Ulvdio green macroalgae produce at least three natural products that can be used as signals in mediating interactions with other organisms. Dimethyl sulfide (DMS) and acryl acid (AA), which are generated from the breakdown of dimethylsulfoniopropionate (DMSP), reduced
feeding by some species of sea urchins when incorporated into artificial diets in laboratory experiments. In *Lithaster testaceus*, airborne DMS, which can be generated by the breakdown of DMS in during grazing by snails (*Littorina littorea*) and urchins (*Strongylocentrotus droebachiensis*), triggered significant increases in concentrations of DMS in the tissues of conspecific individuals in field and laboratory experiments. Dioxin, which is produced only by *Lithaster testaceus* and fed to sea urchins, snails, and mepods when incorporated into artificial diets. It also may function as an allelopathic agent when it is released into seawater by *Ulva obscura*, because it can reduce growth rates of macroalgae and phytoplankton. (Abstract ID 9794)

van den Berg, C. M., Liverpool University, Liverpool, United Kingdom, vandenbergliv@lanc.ac.uk Casteletti, A., Liverpool University, Liverpool, United Kingdom, castelet@gmail.com METAL COMPETITION FOR LIGANDS IN SEAWATER Constant M.G. van den Berg and Alessio Casteletti School of Environmental Sciences, Liverpool University, UK Vandenbergliv@lanc.ac.uk: Previous work has shown that iron and copper are complexed with land-derived humic substances (HS) added to seawater[1, 2]. Subsequently it was shown that several metals compete with iron for complexation with the HS[3]. In this work we demonstrate that ligands in seawater, with characteristics similar to terrestrial HS, show competing reactions between iron and copper. We use cationic stripping voltammetry to measure the signal for Fe bound with marine HS in seawater and subsequently we add Cu. The experiments show that iron is released from the natural complexes when the copper is added to the seawater. The metal competition has implications to availability of iron and copper to marine microorganisms. 1. Laglera, L.M., Battaglia, G. & van den Berg, C.M.G. Determination of humic substances in natural waters by cationic stripping voltammetry of their complexes with iron. Anal Chim Acta 599, 58–66 (2007). 2. Kogut, M.B. & Voelker, B.M. Strong Copper-Copper Binding Behavior of Terrestrial Humic Substances in Seawater. Environ Sci Technol 35, 1149–1156 (2001). 3. Yang, R. & den Berg, van, C.M.G. Metal Complexation by Humic Substances in Seawater. Environ Sci Technol 43, 7192–7197 (2009). (Abstract ID 9700)

Van Dijken, G. L., Stanford University, Stanford, USA, gertvd@stanford.edu Mitchell, B. G., Scripps Institution of Oceanography, La Jolla, USA, gmtichell@ucsd.edu Seegers, R., University of Southern California, Los Angeles, USA, bseegers@spg.ucsd.edu Mills, M. M., Stanford University, Stanford, USA, rmills@stanford.edu Brown, Z. W., Stanford University, Stanford, USA, zebrown@stanford.edu Lowry, K. R., Stanford University, Stanford, USA, lowryk@stanford.edu Arrigo, K. R., Stanford University, Stanford, USA, arrigo@stanford.edu SUMMER PRIMARY PRODUCTION IN THE CHUKCHI SEA DURING ICESCAPE 2010-2011 The Arctic Ocean has become a region of high scientific interest because of a warming climate that has greatly reduced sea ice cover over the last three decades. We will present primary production data measured on two summer cruises in the Chukchi Sea (Pacific sector). Production estimates in this region based on satellite derived surface chlorophyll range locally from <10 to over 150 g C m⁻² day⁻¹. Unexpectedly we found some of the highest production values and growth rates beneath the solid pack ice. (Abstract ID 12510)

van Dongen-Vodnas, V., Flinders University, Adelaide, Australia, vand0267@flinders.edu.au Seymour-JR, R., University Technology Sydney, Sydney, Australia Paterson, J., Flinders University, Adelaide, Australia Middleton, J. E., South Australian Research & Development Institute, Adelaide, Australia Mitchell, J. G., Flinders University, Adelaide, Australia Seuront, L., Flinders University, SARDI, Centre National de la Recherche Scientifique, Adelaide, Australia HYDROCLIMATIC FORCING AND TEMPORAL DYNAMICS IN MICRORIAL AND VIRAL ABUNDANCES: LINKAGES AMONG THE MICRORIAL FOODWEB COMPONENTS IN SOUTH AUSTRALIAN SHELF WATERS Hydroclimatic conditions influencing the microbial foodweb were investigated from 2008 to 2010 for the surface, fluorescence maxima, and bottom depths of a South Australian shelf station. Flow cytometry enumerated populations of Prochlorococcus, *Synechococcus*, picocyanobacteria, heterotrophic bacteria, and viruses. Local and global climatic forcing affecting temporal behaviors in *Prochlorococcus*, *Synechococcus*, picoeukaryotes, heterotrophic bacteria, and viruses. Local and global climatic forcing affecting temporal behaviors in picophytoplankton and heterotrophic bacterial abundances were observed while only viruses significantly decreased in abundances. Linkages among viral and bacterial populations peaked with time and depths. Results indicated a vertical decoupling between heterotrophic bacteria and viruses during upwelling under El Niño and weak southeasters, when viruses significantly correlated to only cyanobacteria at the upper depths. The rational of this decoupling may be explained by four hypotheses. The relative importance between the local wind field and the Southern Oscillation Index helped explaining the variability in heterotrophic bacterial abundances and prokaryotessaykaryotes ratios. This study has critical implications for the long-term understanding of the biogeochemical cycling of this region where microbes and productivities remain poorly understood. (Abstract ID 12838)

Van Dower, C. L., Duke University, Beaufort, USA, chv@duke.edu Boudreau, D., Duke University, Beaufort, USA, danielle.boudreau@duke.edu Kemm, M., Duke University, Beaufort,., melissa.kemm@duke.edu Kovacs, K., Duke University, Beaufort, USA, katlin.kovacs@duke.edu Vidal, R., Duke University, Durham,., vidar@duke.edu RESTORATION SCIENCE IN THE DEEP SEA: A CALL FOR A ROADMAP TOWARD REALISTIC GOALS AND EXPECTATIONS Resources of the seabed in the area beyond the limits of national jurisdiction are administered by the International Seabed Authority, which is engaged in developing regulatory and management activities to preserve and protect marine ecosystems while promoting resource use. Use of resources in the deep sea has the potential to cause decline in ecosystem conditions and services. In terrestrial systems, attention has focused on using ecological restoration to enhance the natural capital of landscapes and habitats after disturbance. Ecological restoration is assuming an increasing role in global environmental policy and is referenced in several of the 2020 Headline Targets recently developed by the Convention on Biodiversity. There is a window of opportunity to engage stakeholders in discussion of restoration approaches and strategies that should or could be implemented in deep-sea habitats before policies related to environmental management for extraction of minerals, including manganese nodules, cobalt crusts, and polymetallic sulfides is in place. A science of deep-sea restoration does not exist. Should it? (Abstract ID 9777)

van Haren, H., NIOZ, Den Burg, Netherlands, hans.van.haren@nioz.nl Gostiaux, L., CNRS/Grenoble-1NP/UJF-Grenoble 1, Grenoble, France, louis.gostiaux@legi.grenoble-inp.fr DETAILLED INTERNAL WAVE MIXING ABOVE A DEEP-OCEAN SLOPE Turbulent vertical eddy diffusivity (Kz) and dissipation rate (εps) are estimated between 0.5 and 50 m above a slope of Great Meteor Seamount, Canary Basin, using 101 moored temperature sensors, 1-mk precision, sampling at 1 Hz. Detailed observed time-depth temperature images are split into two: a statically stable and a turbulence image. Averaged over a fortnight, the observed overall time-mean depth Kz=3±1x10⁻³ m² s⁻¹ and εps=1.5±0.7x10⁻⁷ W kg⁻¹. Variations with time and depth are large, by up to four orders of magnitude. Although tidal variations do occur, shorter-scale variations are more intense. A particular tidal period shows multiple vigorous overturning events, the largest found away from the bottom during the downwelling phase but just prior to arrival of an upslope moving, equally vigorous bore. The strength of the bore may be controlled by the intensity of the mixing just prior to it. The bore itself is turbulent from the bottom upward, up to some 40 m above it. Its mixing is most efficient providing large fluxes in extremely thin layers. (Abstract ID 10997)

van Heuven, S., University of Groningen, Groningen, Netherlands, svheuven@gmail.com Hoppema, M., Alfred Wegener Institut, Bremerhaven, Germany, maria.hoppema@awi.de de Baar, H., Netherlands Institute for Sea Research, Texel, Netherlands, debaar@nioz.nl Meijer, H., University of Groningen, Groningen, Netherlands, h.a.meijer@rug.nl QUANTIFYING THE RATE OF STORAGE OF ANTHROPOGENIC CARBON IN THE SOUTHERN ATLANTIC OCEAN: A WATERMASS-BASED ESTIMATE FROM 35 YEARS OF INTERIOR OCEAN CARBON DATA. Quality controlled compilations of over three decades of interior ocean carbon-relevant data (GLODAP CARINA) in principle allow for the determination of the rate of increase of the amount of anthropogenic carbon (Cₐ) in the ocean. To practically perform such determinations, approaches must be devised that perform robustly despite the sparsity of data in certain regions, both in space and time, and additionally are insensitive to hydrographic and biogeochemical variability. We present the Time Series Residuals (TSR) approach that, to these ends, relies on a combination of water mass separation by optimum multiparameter analysis and detection of Cₐ trends by multivariate linear regression. Application in the South Atlantic Ocean reveals high rates of accumulation of Cₐ in outcrop regions, with progressively lower rates deeper into the ocean interior, both in accordance with expectations. Extrapolating and integrating these watermass characteristics yields an accumulation of ΣCₐ=0.46±0.01 Pg C a⁻¹ for the complete South Atlantic Ocean. A notable result of this study is the non-negligible storage of Cₐ in the NADW and AABW, which together contribute 0.16±0.01 Pg C a⁻¹ to the total storage. (Abstract ID 12316)
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QUALITATIVE VARIATION OF PHYTOPLANKTON BIOMASS AND COMMUNITY STRUCTURE OF THE SARGASSO SEA BASED ON PIGMENT ANALYSIS
Although specific pigments can serve as an indicator of phytoplankton species quantifying the phytoplankton community is difficult since it requires well defined pigment ratios which tend to be unavailable. To help assess seasonal and long-term variability in phytoplankton distributions of the Sargasso Sea we investigate the HPLC data from the Bermuda Atlantic Time-series Study Site (1990-2010). The focus here is on analyzing the individual pigments and to provide qualitative information on the phytoplankton groups. In particular we detail the relative interplay of these pigments as separate values and as a fraction of chlorophyll a. over three depth regions: surface to deep chlorophyll maximum (DCM); DCM and below DCM. For the DCM, strong seasonality is exhibited by all the primary pigments with some showing marked deviations from chlorophyll a (e.g., 19-butanoyloxyfucoxanthin and chlorophyll b). Significant long-term changes are evident in the majority of the primary pigments, most notable 19-butanoyloxyfucoxanthin and carotenoids (~50% change). However, most striking behavior is shift in many of the pigments which do not necessary covary with these pigments and thus, at times suggest complete changes in the phytoplankton community. (Abstract ID 10483)

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INTERPRETING CARIBBEAN GREEN TURTLE FORAGING ECOLOGY USING BULK CARBON AND NITROGEN STABLE ISOTOPE ANALYSIS AND NITROGEN ISOTOPE COMPOSITION OF AMINO ACIDS
We investigated feeding patterns of green turtles from a nesting site and multiple foraging regions in the Caribbean using bulk and amino acid compound specific nitrogen isotopic (AA-CSIA) compositions of epidermis as well as seagrass. Green turtle trophic position was calculated using 1) glutamic acid and phenylalanine and 2) a combination of available trophic and source amino acids (AAAs). Carbon and nitrogen bulk isotope values of turtles differed among foraging grounds, and each range was smaller than that of the nesting aggregate. Bulk isotope values of seagrass from across the Caribbean and AA-CSIA in green turtles indicate baseline differences in the primary producer, not trophic differences, cause variation in nesting green turtle isotope values. AA-CSIA of seagrass revealed that seagrass AA biosynthesis is more consistent with that of C3 plants rather than macroalgae and phytoplankton. Taking these differences into account, green turtles in the Caribbean are primary consumers with no isotopic evidence of carnivorous foraging. Information about foraging patterns and habitat use is critical to protecting sea turtle high-use areas. (Abstract ID 11394)

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SEASONAL DISTRIBUTION OF FE, Mn AND ZN IN THE SARGASSO SEA IN RESPONSE TO ATMOSPHERIC INPUT
Synchronous samples of atmospheric deposition were collected with sediment trap and suspended particles (July 1999 - April 2000) at the AEROC tower on Bermuda and Off Mooring in the Sargasso Sea. Seasonal fluxes of Fe, Mn and Zn at the 500 m, 1500 m, and 3200 m traps suggest extrinsic and intrinsic, abiotic and biotic processes with depth. Increasing fecal pellets with depth in summer reveals rapid processing and transport of trace elements to the deep ocean. Winter mixing increases aggregation and scavenging of trace elements, reflected in suspended particles and trap fluxes at all depths. Spring bloom evidences trace element uptake by phytoplankton and subsequently processed by zooplankton grazers. Lithogenic and biogenic redistribution based on crystal and Redfield ratios in trap and suspended particles reflect decreasing Corg with depth. Biogenic Zn decreased in trap but increased in suspended particles; biogenic Fe to Corg ratio increases with lithogenic component; and Fe to Corg ratio increases with lithogenic component (AA-CSIA) compositions of epidermis as well as seagrass. Green turtle trophic position was calculated using 1) glutamic acid and phenylalanine and 2) a combination of available trophic and source amino acids (AAAs). Carbon and nitrogen bulk isotope values of turtles differed among foraging grounds, and each range was smaller than that of the nesting aggregate. Bulk isotope values of seagrass from across the Caribbean and AA-CSIA in green turtles indicate baseline differences in the primary producer, not trophic differences, cause variation in nesting green turtle isotope values. AA-CSIA of seagrass revealed that seagrass AA biosynthesis is more consistent with that of C3 plants rather than macroalgae and phytoplankton. Taking these differences into account, green turtles in the Caribbean are primary consumers with no isotopic evidence of carnivorous foraging. Information about foraging patterns and habitat use is critical to protecting sea turtle high-use areas. (Abstract ID 11394)

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COMMUNITY GROWTH PHYSIOLOGY AND NUTRIENT CHEMISTRY IN AN ESTUARINE COASTAL ENVIRONMENT IN THE NORTHERN GULF OF MEXICO

The measurement of Net Primary Production (NetPP) is the difference between gross production and respiration (RESP) and is a direct indicator of trophic status and health of an ecosystem. The Mississippi coastal estuarine system is characterized by extensive fluvial input, terrestrial runoff, and high benthic sediment fluxes, resulting in an abundance of inorganic and organic substrates fueling biochemical activity. Seasonal changes in light availability and nutrient chemistry have a significant effect on NetPP and community RESP. On a community level, the netPP:RESP ratio can affect biogeochemical regeneration and alter nutrient availability, thus affecting plankton growth physiology. In this study, surface in-situ measurements of NetPP and RESP were determined in the Mississippi Sound and the Mississippi Bight by time-course detection of dissolved oxygen using novel optode technique. Rate measurements from two different stations are compared to a time-series record of several biogeochemical parameters from the course of one year. In this study we demonstrate how nutrient chemistry and incident solar radiation may affect growth physiology and determine ecosystem metabolism in the estuary. (Abstract ID 12333)

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COASTAL WATERS OPTICAL CLASSIFICATION: INTEREST FOR MONITORING WATER MASSES QUALITY AND OPTIMIZING BIO-OPTICAL INVERSION ALGORITHMS

The high optical complexity of the coastal ocean prevents the development of general open ocean-like inversion algorithms needed to derive in-water bio-optical and biogeochemical parameters from satellite information. To overcome this issue, regional algorithms are generally used in order to focus on the range of optical variability specific to a defined coastal region. This regional approach presents however various limitations including its high dependency on the data set used for its development as well as its limited applicability for large scale applications. Another and more universal approach consists in classifying coastal waters according to their optical properties (independently of their location) and then in applying a class-specific algorithm (empirical or semi-analytical). The framework associated with the development of such classification-based approach is detailed from an in situ data set collected in contrasted coastal waters of the eastern English Channel, north Sea and French Guyana. The advantages of defining an optical typology of the coastal domain for monitoring coastal water masses optical quality and improving the performance of the inversion procedure is further illustrated. (Abstract ID 11915)

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LOW CARBON TO NITROGEN RATIOS IN THE EUPHOTIC ZONE OF THE ARCTIC OCEAN

The molar ratio of particulate organic carbon to nitrogen (C:N) is assumed to approximate the Redfield ratio of 6.6 in ocean waters, but here we report on low C:N ratios in the euphotic zone of the Beaufort Sea and Canada Basin measured during the IPY Canada’s-Three-Oceans program in 2007 and 2008. In the northeastern subarctic Pacific, Bering & Chukchi Seas, Canadian Archipelago, and Baffin Bay & Labrador Sea, average (per region) depth-integrated particulate C:N ratios were low (13.9-5.6), but within previously reported ranges. In the Beaufort Sea & Canada Basin, however, the average was 2.6 with values at some stations as low as 1.9. Lower particulate C:N ratios were driven by a relatively greater decrease in POC than PON. This study looks at C:N ratios that have implications for models on the influence of ice retreat on arctic primary productivity and on estimates of new production extrapolated simply from phytoplankton uptake of NO3. (Abstract ID 12304)

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INSTRUMENTATION

OCEAN OBSERVATORIES INITIATIVE SAMPLING STRATEGY AND CORE INSTRUMENTATION

The Ocean Observatories Initiative (OOI) is a multi-decadal, NSF-funded program that will provide continuous, real-time (cabled) and near real-time (telemetered) measurements of climate variability, ocean circulation, ecosystem dynamics, air-sea exchange, seafloor processes, and plate-scale geodynamics. The OOI will be composed of seafloor sensors, fixed moorings, and mobile assets containing over 700 operational instruments, in the Atlantic and Pacific oceans. Here we provide an overview of the OOI sampling strategy, and a discussion of the “baseline” and “pivotal” sampling schemes for the various platforms and their associated, diverse instrument suites. While the cabled regional and coastal platforms have essentially unlimited power and bandwidth, the uncabled nodes have power, internal data storage, telemetry bandwidth, physical capacity, and buoynancy limitations, making it essential to prioritize the sampling by OOI instruments to fulfill the science objectives. The OOI sampling strategy must also consider event-driven sampling responses, mitigation of between-sensor interference, data products that require multiple sensors, the need for physical sampling to validate and calibrate OOI sensors, and the eventual incorporation of non-core sensors into the network. (Abstract ID 10396)


A PROTOTYPE ELEVATION DATA GEOPORTAL FOR USE IN OCEAN AND COASTAL MAPPING

Ocean and coastal elevation data support a diverse range of research disciplines, including coastal inundation and ocean current modeling. The federal interagency ocean and coastal mapping working group, responding to the Ocean and Coastal Mapping Integration Act, has developed a prototype inventory of existing elevation data and planned acquisitions for the U.S. The inventory uses ESRI Geoportal Server to harvest metadata from Web Accessible Folders (WAFs), to perform federated searches, and to deliver integrated search results. The WAFs are maintained by federal agencies responsible for stewarding the various mapping data, including the National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey, and U.S. Army Corps of Engineers. NOAA’s National Geophysical Data Center modified the “out-of-the-box” Geoportal software to enable easier keyword and date searches based on common FGDC and ISO metadata fields and improve search results. The technology will undergo a period of review before consideration for public use. (Abstract ID 12257)

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FITNESS AND PHENOLOGY: PLANKTON ADAPTATIONS TO SEASONAL CYCLES
What shapes the phenology and annual routines of plankton? What explains intra- and inter-specific variation in phenology? How should we interpret shifts in phenology as a result of environmental change? These questions are all major challenges in plankton ecology, and currently there is timely application of this research because observed and predicted responses to climate change involve altered phenology. Here I present some of the theory behind the timing and scheduling of activities over the year, and the theory for some of the ecological consequences of timing, particularly the issue of match and mismatch between predator and prey. I will also attempt to answer two more specific questions: 1) What is the role of ice algae and phytoplankton phenology for the optimal annual routines of high-latitude herbivorous copepods? 2) What is the role of visually searching predators in shaping the phenology of their zooplankton prey? (Abstract ID 12288)

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FLOW VARIABILITY AND ITS IMPACT ON CONNECTIVITY FOR THE ISLAND OF HAWAII
Understanding population connectivity driven by the transport of early life stages is a contemporary challenge in marine ecology. Connectivity results from a combination of biological traits and physical mechanisms. Here we investigate the latter in an oceanic island, asking: i) how physical environment variability affects transport patterns? and ii) what mechanisms play a role in transport? Particle dispersion is determined using a biophysical model and flow fields from a global and a regional implementations of HYCOM. To understand the underlying processes of transport, we locate coherent structures by calculating the Finite Size Lyapunov Exponents, identify recurrent physical features and observe the relationship to particle transport. Our results show that the eddying flow increases connectivity, that both the flow field and dispersal patterns are highly variable. Eddy events influence transport in distinct ways and the timing of release plays an important role in dispersal. Comparing the two model implementations yields differences in the emerging connectivity patterns. Our results highlight the need for modeling studies to use hydrodynamical model flows that represent the scales of variability affecting transport and dispersal. (Abstract ID 12080)

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A COMPARISON OF SET GRADIENTS OFF THE PERUVIAN COAST: THE IMPACT OF GOING TO HIGHER RESOLUTIONS
The Peruvian Coastal Upwelling System (PCUS) is one of the most productive fisheries in the world. Major upwelling events are closely related to changes in the location and magnitudes of SST fronts. SST gradients from the Multi-scale ultra-high resolution (MUR) 1km SST data set is compared with five other lower resolution products in two test areas off the PCUS: Pata de Perico. Off Pisco SST gradients derived from the MUR data set shows greater magnitudes and seasonal cycle. The seasonal cycle of SST 100km in MUR is twice as large as those derived from the lower resolution data sets. All data sets reproduce the known phase of the seasonal cycle as maximum are seen in late autumn and early fall. Sub-sampled MUR data at the 25km, 9km, and 4km resolutions compare well in magnitude and phase with the lower resolution products. Agreement in gradient magnitude between the lower resolution data sets and the MUR sub-sampled at their respective resolutions imply that the pixel-to-pixel analysis noise in MUR is at a similar level as the other data sets. (Abstract ID 11736)

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LOOKING THE BEST ROUTE FOR A THERMAL GLIDER IN THE NORTH ATLANTIC
Glider, together with other systems as ARGO buoys, have mean a great improvement to the ocean presence due to the high resolution data obtained during a relative long time periods with some level of manoeuvrability and position control by reprogrammable routes. Their operability can vary from some weeks to several months depending on the type of sensors installed, they can record physical and biochemical parameters during dives. Their autonomy can be improved with the use of renewable energy in the glider; this is the case of the thermal glider (Slocum model, Teledyne Webb Research). This is a simple concept of a heat engine which provides the buoyancy changing propulsion energy to drive the engine itself between the source and sink the heat at a useful speed. Thermal energy was chosen since it is reliably and predictably available at all hours, it can be harnessed while underway, and it exploits a reasonable triple engine design. Thermal propulsion has limitations; the most important is that the temperature gradient is not available globally. For studying the factor of temperature gradient in the North Atlantic it was done a study using ARGO data to evaluate the best route that a thermal glider must take between North America and Canary Islands (Spain). (Abstract ID 11249)

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DEVELOPING HIGH-RESOLUTION THERMAL STRESS INDICES TO ENHANCE REGIONAL CORAL BLEACHEING FORCASTS THROUGH NOAA'S CORAL REEF WATCH DECISION-SUPPORT-SYSTEM
Temperature-induced coral bleaching is thought to be one of the most important environmental parameters responsible for the demise of coral reefs. A collaborative effort between NASA, NOAA, and University of South Florida seek solutions to enhance the NOAA's Coral Reef Watch (CRW) sea surface temperature data products. This program currently uses operational, near-real-time nighttime AVHRR sea surface temperature (SST) data to produce SST climatologies and various thermal stress indices that include SST anomalies, HotSpots and Degree Heating Weeks. Similar indices are going to be generated with higher-resolution AVHRR and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery by using data at 1 and 4 km spatial resolutions. Anomalous cold temperature can also lead to significant stress and cause widespread mortality in coral reefs, such as observed in the Florida Keys in January 2010. This project is studying this test case to develop 1 km spatial resolution cold-stress indices. In situ data collected around the Florida Keys in January 2010 is being used to validate these prototype products, together with efforts to discriminate cold water from clouds. (Abstract ID 9561)

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NUMERICAL MODELING AND FIELD OBSERVATIONS OF NEARSHORE HYDRODYNAMICS IN RINCON, PUERTO RICO
Coastal areas of Rincón, Puerto Rico have suffered from severe erosion problems during the past several decades. Previous studies by Thieler et al. (2007) document the drastic changes in Rincón’s shoreline. The purpose of this study is to carry out numerical simulations and field observations of the nearshore hydrodynamics which have led to the erosion and sedimentation problems in Rincón. The numerical model used for the study is BOUSS2D, which is a fully nonlinear, phase-resolving Boussinesq wave model. The model is able to reproduce nonlinear wave transformation in the surfzone as well as unsteady wave-induced currents. After a validation process where wave buoy data and surf zone drifters were used, the model was used to simulate critical scenarios. Results from the BOUSS2D model are used to examine regions in which the wave-induced bottom shear stresses are large enough to suspend sediment, which is then transported by wave-induced currents. The critical shear stress was determined from sediment grain analysis and seabed roughness estimates determined by field studies. It is expected that this study will provide us with a better understanding of the nearshore hydrodynamics of Rincón, which will allow us to propose potential solutions to alleviate the area’s erosion problems. (Abstract ID 10866)

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Eddy-Induced Kuroshio Intrusions in the East China Sea Shelf

The northeast shelf of Taiwan is an energetic ocean area since the East China Sea shelf circulations and the Kuroshio confluence at the lee of Taiwan. The Kuroshio has been observed to intrude at the northeast shelf of Taiwan. This study demonstrates that some of these Kuroshio intrusions are induced by mesoscale activity coming from the western Pacific. Intrusions are identified from trajectories and velocity measurements at 15 m from drifters of the Global Drifter Program historical database and weekly deployments between August 2008 and June 2009 north of Green Island (Taiwan). Altimeter sea level anomaly and sea surface temperature data are used to identify the trajectories of the eddies inducing the intrusions. A proxy for the Kuroshio transport, created from satellite sea level anomaly data, indicates that intrusions are more frequent during the Kuroshio low transport phase. In conclusion, cyclonic eddies generated in the Subtropical Countercurrent and the North Equatorial Current induces meandering in the Kuroshio, intruding in the northeast shelf of Taiwan, and modifying the Kuroshio transport thought the East Taiwan Channel. (Abstract ID 10067)

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COUPLED VARIABILITY IN PHYSICAL AND BIOLOGICAL PROCESSES IN AN ANTARCTIC PENINSULA TIME SERIES

Year-round, approximately weekly, observations in northern Marguerite Bay since 1997 show significant variability in the phytoplankton bloom between years. This monitoring, part of the Rothena Oceanographic and Biological Time Series (RoBTS), is conducted 4km from the base from a small boat or skid. The five-fold variability in chlorophyll, from approximately 4 mg m^-2 to over 20 mg m^-2, is linked to recent reductions in the winter fast ice duration at the time series site and which are occurring along the Antarctic Peninsula. Winters with limited fast ice have significantly deeper mixed layer depths, resulting from brine rejection and the surface of the ocean being exposed to the wind and low air temperatures. These deep mixed layer depths reduce the overall stratification through the following season. Summer-time mixed layer depths are consequently less stable, leading to weaker and more variable blooms than in years when sea ice remains well into the spring. This effect is despite glacial runoff, sea ice melt and summertime warming lead to a similar increase in stratification and high light availability in all years. (Abstract ID 9475)

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MIXING IN STRATIFIED TURBULENCE

Quantifying diapycnal mixing in stably stratified turbulence is fundamental to the understanding and modeling of geophysical flows. Direct numerical simulations (DNS) are used to study mixing in stratified turbulence from a Lagrangian perspective. The relationship between the diapycnal diffusivity and vertical dispersion coefficients is found to be strongly dependent on stratification. Models for mixing following fluid particles are investigated. The time scale for the density changes due to small-scale mixing is shown to be approximately independent of N and instead remains linked to the energy decay time scale T_n, which is relatively insensitive to stratification. Data of diapycnal mixing from DNS studies and grid turbulence experiments are analyzed to investigate the scaling of the diapycnal diffusivity K_n. Our results show that the Eliison overturning length-scale L_n and T_n can explain most of the variations in K_n over a wide range of shear and stratification strengths. (Abstract ID 10058)

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MULTIDISCIPLINARY STUDIES IN OXYGEN MINIMUM ZONES: ADVANCES FROM THE MI_LOC0 PROJECT

The Microbial Initiative in Low Oxygen areas off Concepcion and Oregon project is an integrated multidisciplinary effort between researchers at Oregon State University, Universidad de Concepción, Aarhus University, Massachusetts Institute of Technology, and Pennsylvania State University, funded by the Gordon & Betty Moore Foundation. Its goal is to explore and compare the microbial response to spatial and temporal variability of the OMZs along both the Oregon-USA and the central coast off Chile by placing metagenomic and metatranscriptomic results in the context of physical, biogeochemical, and paleoceanographic observations. From January 2009-December 2010 temporal/vertical evolution of paleoceanographic oxygen proxies, hydrographic properties, nutrients, genomics and transcriptomic were used to place microbial responses in the context of OMZ dynamics. Thus, similarities and distinctions between the microbial assemblages inhabiting both regions in response to physical and biogeochemical seasonal patterns in the development and maintenance of hypoxic zones over both shelves, and long term changes in the seasonal fluctuation of oxygen concentration over the shelves have been studied. Properties monitored in both regions reveal similarities and differences in the strength and duration of hypoxic conditions in these two productive eastern boundary current leading to quantifiable differences in microbial activity and associated biochemical transformations between these two sites. (Abstract ID 11883)

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MODELING OF SUBMESOSCALE PROCESSES AND BARRIER LAYER FORMATION IN THE TROPICAL SOUTH ATLANTIC

The emergence of submesoscale processes in the tropical (8-18S) South Atlantic Ocean is investigated using the Regional Ocean Modeling System (ROMS) to model the circulation at increasingly high horizontal resolution. In particular, the ROMS-AGRIF nesting capability is adopted, using four nested domains with resolution ranging between 27 and 1 km. Previous results from satellite-tracked drifter data (Griffa et al 2008) identified the tropical South Atlantic as a region rich in cyclonic submesoscale-like structures. This is also an area where thick barrier layers, i.e. subsurface layers of enhanced salinity beneath the mixed layer depth, form in the astral winter season (Jul-Sep). Our model results confirm the presence of prevalently cyclonic, high-Rossby number eddies with scales compatible with the submesoscale regime (1-10 km radius), and occurring mostly in the astral winter-early spring. This seasonal cycle is similar to that of barrier layer thickness, BLT, calculated as the difference between the isothermal layer depth (IL) and the isopycnal layer depth (ML). Possible reasons for the seasonal variability are investigated, along with the effects of submesoscale processes on the vertical stratification and BLT evolution. (Abstract ID 10011)

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AN OVERVIEW OF TECHNIQUES USED TO DETECT AND CHARACTERIZE OCEANIC EDDIES

Eddies of all sizes are a ubiquitous feature in the surface- and possibly subsurface- ocean. Various studies in the last 40 years have demonstrated the importance of large and mesoscale eddies on the distribution of energy, heat and biogeochemical tracers. More recent studies have investigated the role played by smaller, submesoscale eddies, especially in regards to their ability to restructure the upper ocean and redistribute tracers in the vertical direction. Nonetheless, detecting and characterizing eddies, particularly over large domains and extended periods of time, can be a daunting task, and various techniques have been adopted over the years to accomplish that. In this talk we summarize the main methodologies, based on both the Lagrangian and Eulerian perspective, which are used up to date to identify eddies from observational and numerical data. (Abstract ID 11422)

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HIGH RESOLUTION SAR/ECOETY DYNAMICS AT THE BERMUDA ATLANTIC TIME-SERIES STUDY SITE

Advances in next generation sequencing technology are providing longer read lengths, making it possible to apply phylogenetic analyses to high throughput surveys of microbial diversity. We developed a bioinformatics pipeline based on the algorithm palmer and used it to analyze
929,036 partial 16S rRNA gene sequences from samples collected over a nine-year period at the Bermuda Atlantic Time-series Study (BATS) site. To test the pipeline, sequences from the V1-V2 region of 16S genes were filtered for quality and redundancy and passed to a comprehensive phylogenetic reference tree for Alphaproteobacteria. Evidence emerged for spatiotemporal partitioning of the environment by several new SAR11 ecotypes in addition to those previously described at BATS. Phylogenetic placement offers multiple theoretical advantages as a scheme for assessing microbial diversity. Coupled with improvements in sequencing technology, the new analytical methods may make it easier for researchers to agree on criteria for measuring microbial diversity. This is needed to facilitate comparisons between studies and to identify fundamental units of microbial diversity that can be assigned environmental functions.

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DIETHYLSULFONIOPROPIONATE (DMSP) RELEASE DURING MESOZOOPLANKTON GRAZING: A GRAZING DETERRENT?

The effect of copepod grazing on algal DMSP production was investigated using A. tonsa, and two algal species that produce high and low concentrations of DMSP (Emiliania huxleyi, and Thalassiosira weissflogii, respectively). Results suggest that grazed cells released a significant proportion of the particulate DMSP (DMSPp) into the dissolved state (DMSPd), whereas controls remained constant. Additionally, the average particulate cell quotas of remaining cells decreased in cultures exposed to grazers, suggesting that DMSP release is not solely a product of cell lysis. Results also suggest that increased DMSP release is not significant. Copepods in experiments where DMSP was artificially added to cultures of E. huxleyi at concentrations below 1 µM. This study suggests a negative feedback loop between metazoan grazing pressure and algal DMSP, where grazing pressure results in higher proportions of dissolved DMSP, which in turn deter further grazing. (Abstract ID 9561)

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DMSP IN HOLOCENE SEDIMENTS AS A PROXY FOR OCEANIC PALEOPRODUCTIVITY

DMSP (DimethylSulfonioPropionate) is an organic sulfur compound produced by phytoplankton. It is the precursor to DMS (DimethylSulphide), a climate-relevant gas that, after atmospheric oxidation, produces H2S (Hydrogen Sulfide), a commonly used biogeochemical proxy in ice cores. DMSP measured in surface sediments has been used to study phytoplankton export from the euphotic zone or the cycling and metabolism of DMS in sediments. An 850 cm jumbo piston sediment core, spanning approximately 7500 years, was collected during a cruise to Barlari Bay in the western Antarctic Peninsula as part of the LARsen Ice Shelf (LARISSA) project. Significant DMSP concentrations were observed throughout the core (~2 nmol/g dry weight), suggesting high preservation at depths > 30 cm, with highest concentrations at the sediment surface. Low DMSP concentrations correlated with abundant diatom valves, as extrapolated from published water column results, and its variability was in accordance to other measured paleoproductivity indices. Assuming sedimentation processes in the water column are the main source of DMSP in sediments, we are proposing DMSP as a new paleoceanographic proxy of phytoplankton abundance. (Abstract ID 12574)

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MEASURING HOURLY CALCIFICATION IN LIVING PLANKTONIC FORAMINIFERA USING LA-ICPMS

Recent research using laser ablation ICPMS has documented intrashell trace element heterogeneity in planktonic foraminifera from depth profiles through chamber walls with sub-mµm resolution. Despite such phenomenal resolution, rates of calcite addition and chamber thickening cannot be quantified from specimens growing in the natural environment. Here we utilize LA-ICPMS to visualize calcite secreted during 3-6 hour periods. We grew the planktonic foraminifera Orbulina universa in the laboratory at 22°C and transferred individual foraminifera between ambient seawater and seawater that contained a divalent cation tracer. Specimens were grown in “Ca-spiked seawater for 3-6 hours, then transferred into seawater with elevated [Ba] for 3-6 hours, then into seawater with elevated [Sr]. With this experimental procedure, individuals precipitated multiple layers of calcite, each with a unique trace element label. Results show that 3 hours of day calcification increases shell thickness 2-3 µm, and demonstrate that variations in seawater cation concentrations are incorporated into shell calcite in this species on timescales of hours or less. These results highlight the application of LA-ICPMS for resolving and visualizing foraminiferal shell heterogeneity at spatial scales <1 µm. (Abstract ID 12583)

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CONTRIBUTION OF DYNAMIC AND THERMODYNAMIC PROCESSES TO SEASONAL AND LONGER VARIATIONS IN SST

Sea surface temperature (SST) is one of the important indicators of upper-ocean variability and is essential for understanding air-sea interaction and climate dynamics. To investigate the nature and magnitude of large-scale SST changes on seasonal and longer time scales, we examine a 13-year long ocean state estimate, produced by combining numerous satellite and in situ observations with a general circulation model in a least-squares fit. Using closed SST budgets, we diagnose how SST tendencies relate to advective, diffusive and surface heat fluxes, focusing on ocean transport processes. The results show that advection is an important mechanism in redistributing heat at the surface and is a function of both location and time scale. Depending on ocean region, the amplitudes of advective tendencies range from 20–60% of total SST tendency at sub-annual scales to more than 80% at inter-annual scales, indicating that variations in SST are largely affected by the dynamics of the ocean and implying more than a passive role of the ocean in its interaction with the atmosphere as traditionally thought. (Abstract ID 11269)

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ALGORITHM, DATA PROTOCOL AND MERGING FOR HYPERSPECTRAL FREE FALLING RADIOMETERS

A data processing protocol and a software is presented for hyperspectral radiometric data from free-falling profiling systems whose acquisition can be strongly affected by surface perturbations. The presented data processing protocol focuses on: 1) the minimization of high frequency fluctuations on the incident radiant field with data filtering and normalization techniques and 2) reduction of wave-induced uncertainties with best fit radiometric data in the surface layer of the water column. Processing methodologies are presented for data acquired in single cast mode, long deep radiometric profiles, and multi-cast mode, consisting on a series of short shallow consecutive profiles for best radiometric data in the top layer of the water column. The algorithm presents the possibility of merging single and multi-cast acquisitions when both are available and reasonably coincident in space and time. The merging procedure generates full depth radiometric profiles with significant reduction of wave induced uncertainties in the surface layer of the water column. (Abstract ID 12244)

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CHANGES IN NEAR-BOTTOM LABRADOR SEA OUTFLOW?

From 1997 to 2011, and currently ongoing, moored observatories have been deployed at 53°N over varying time intervals and spatial coverage near the western exit region of the Labrador Sea. The most recent installments of the moored array places greater emphasis on current and water mass measurements in the core of the Denmark Strait Overflow Water (DSOW) as it exits the Labrador Sea. The analysis of this data set indicates primarily two modes of variability: one pulsating mode (covering 31% of the variability) which strengthens and weakens the flow at the central core location, and one meandering mode (covering 44% of the variability) with the core moving up and down the shelf break, stretching and thinning during the process. We present transport estimates for the density range greater than 27.80 (temperatures less than 4°C) for two time periods more than 10 years apart. These are also compared with those from other locations in the western subpolar North Atlantic, specifically from further upstream at Cape Farewell (Greenland) and downstream at the Grand Banks off Newfoundland. (Abstract ID 11104)

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THE ROLE OF SUBMARINE GROUNDWATER DISCHARGE IN DEVELOPMENT OF NEARSHORE HYPOXIA

Development of hypoxic conditions often involves excess nutrient loading that ultimately results in net biological oxygen consumption. Though nutrient sources associated with overland transport often correlate well with hypoxic zones, groundwater discharge is an additional nutrient source that has been gaining attention in recent years for its mobilization of nutrients from the subtropical estuary. Submarine groundwater discharge can be a ubiquitous process across sandy beaches throughout the passive margin of southeastern North America and may be an important source of nutrients to the coastal ocean and the development of hypoxia. In the case of nearshore hypoxia observed in Long Bay, South Carolina, overland flow sources are sparse in the hypoxic zone, and groundwater sources may influence the nutrient budget. Here we present continuous time-series measurements of dissolved oxygen and radon-222, a proxy for groundwater discharge in the coastal zone. Comparison of the signals reveals a strong inverse correlation, suggesting that groundwater may be a contributor to coastal hypoxia. We speculate that groundwater is a source of nutrient rich, colder water that feeds a periodically resuspended nepheloid layer. (Abstract ID 11891)

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GRID RESOLUTION REQUIREMENTS IN MODELING INTERNAL WAVES

Internal waves can represent a dynamical balance between nonlinearity and nonhydrostaticity (dispersion). Most ocean model discretizations are second-order accurate, inducing numerical dispersion generated from odd-order terms in the truncation error. Numerical dispersion is problematic because it mimics physical dispersion due to nonhydrostaticity. Comparing the numerical dispersion coefficient (associated with common modeling discretizations) to the physical dispersion coefficient from the Boussinesq equations or KdV equation, the results show that, to lowest order, the ratio of numerical to physical dispersion is F = K2/Ω, where K is an (OU) constant dependent on the discretization of the governing equations and Ω is the grid leptic ratio, Ω = h1/h2, where h1 is the horizontal grid spacing and h2 is the depth of the internal interface. To ensure relative dominance of physical over numerical effects, simulations require Ω > 0(1) or Δx < h2. When this condition is not satisfied, numerical dispersion overwhelms physical dispersion, and modeled internal waves behave non-physically, existing with a dynamical balance between nonlinearity and numerical dispersion. (Abstract ID 12494)

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VARIABILITY OF THE ACC TRANSPORT ACROSS THE KERGUELEN PLATEAU

The Kerguelen Plateau is a large topographic obstacle barring the way of the eastward flowing Antarctic Circumpolar Current (ACC). Whilst approximately two thirds of the ACC transport is diverted to the North, most of the remaining flow engulfs in the Fawn Trough, the only deep passage across the Plateau. As part of the TRACK (TRansport ACross the Kerguelen plateau) project, three mooring lines of current meters were deployed in the Fawn Trough for one year in February 2009, underneath ground-track 94 of the Jason-2 satellite altimeter. Full depth CTD-LADCP casts carried out during the deployment cruise were previously analyzed to provide a comprehensive description of the regional circulation (Park et al., GRL, 2009), featuring in particular a transport of about 40 Sv across the Fawn Trough. Here we present estimates of the transport variability across the Fawn Trough from current meter data. In addition we analyze to what extent the transport can be directly monitored from along-track satellite altimeter data, which would enable to study the variability of the current from a now 19-year long archive. (Abstract ID 11866)

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SOUTHERN HEMISPHERE WELTHERIES IN THE MID-LATE HOLOCENE

Tierra del Fuego is the world’s southernmost landmass outside of Antarctica and represents a unique location to study three major oceanic and atmospheric features: Southern Hemisphere Westerly winds (SHW), Southern Ocean circumpolar flow and the South Pacific Gyre. In particular, Tierra del Fuego, together with southernmost Patagonia, is the only landmass directly influenced by the SHW. These prevailing winds strongly influence precipitation in western South America, in part because of the orographic effect of the Andes. To infer variation of the SHW during the Mid-Late Holocene we analyzed sediments spanning the last ~6000 cal yr BP (core LF06-PC8) from Lago Fagnano, the large lake in the world. These sediments are dominated by hemipelagic facies characterized by millimeter-scale laminations and a few 2-3 mm thick turbidites. After creating a hemipelagic age model, we observed that the laminations are not annual but decadal. The main differences throughout the lamination 482
are found on Fe, S, and Mn. These elements depend on oxidation processes, which are likely controlled by the Westerlies. In this study we present the SHW variability during the Mid-Late Holocene. (Abstract ID 12734)

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BIODEGEOCHEMISTRY OFFRONTAL ZONES
Frontal zones are dynamic exchange regions where chemical gradients may lead to important chemical transformations. At frontal boundaries researches have observed changes in vertical and horizontal exchange rates, the aggregation of biota, aggregation/disaggregation of detrital organic material and potentially shifts between organic (DOC, POC) and inorganic carbon (DIC) pools. This study addresses field observations from two fronts (a shelf/slope front and Gulf Stream front) in 2010 in the southern Mid-Atlantic Bight and a second shelf/slope front off the Oregon shelf in 2011. Enhanced vertical exchange at the frontal boundaries is apparent and chemical shifts in DOC, POC, DIC and C/N ratios allude to some of the transformation processes that may occur. (Abstract ID 11969)

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AN INVESTIGATION OF FINE-SCALE SPATIAL VARIABILITY OF NEAR-BOTTOM CURRENTS ALONG THE SIEGSEE ESCARPMENT
In May 2009, Shell Oil Company and its partners on the Stones Prospect initiated a comprehensive 2-year measurement campaign along the Siegsee Escarpment. The program objective was to characterize energetic current processes for use in engineering design of production facilities. To help understand the interaction of local topography on the near-bottom currents, four current meter moorings were deployed along distinct features in the region, including the Escarpment top, base, and an intersecting canyon in the vicinity of 90° E.

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MAREDAT - TOWARDS A WORLD ATLAS OF MARINE PLANKTON FUNCTIONAL TYPES
The distribution of marine plankton functional types (PFTs) is important for the cycling of major elements in the Earth System, such as carbon, nitrogen and phosphorus. To assess the effect of climate change on marine ecosystems and ocean biogeochemistry, marine ecosystem modelers are moving towards increased model complexity. Since little is known about the distribution and relative abundance of different PFTs in the present ocean, validation data for these models is scarce. The MARINE Ecosystem Data (MAREDAT) project compiled global carbon biomass data for 8 PFTs, i.e. silicifiers, calcifying phytoplankton, nitrogen fixers, DMSP-producers, picophytoplankton, bacteria, meso- and macrozooplankton, and for two types of calcifying zooplankton (planktonic foraminifers and pteropods). We show spatial and temporal patterns in PFT biomass and the correlation between biomass concentrations of different PFTs for different latitudinal bands and depth ranges. We discuss patterns of PFT diversity, and show how biomass data can be used to validate the definition of ocean biomes. The database is intended to facilitate the validation of marine ecosystem models and to be used in applications of biological oceanography. (Abstract ID 11513)

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STRONG CALIFORNIA COASTAL DEL 15N ISOESCAPE GRADIENT INVESTIGATED USING COMPOUND-SPECIFIC DEL 15N-AMINO ACIDS IN MYTILLUS CALIFORNIANUS
Biogeochemical isotopic signatures of the Northeast pacific coast reflect the interplay between local upwelling intensity vs. large-scale transport within the California Current System (CCS). We used filter-feeding intertidal mussels (Mytilus californianus) to construct 15N and 13C isoscapes of the California coast, presumably reflecting the year-long integration of coastal suspended particles. The bulk 15N isoscape shows a strong linear relationship, with 15N values decreasing markedly with latitude (North to South: ~7‰ to ~12‰), consistent with slowly attenuating northward transport of 15N-depleted nitrate via California Undercurrent (CUC). However, as with any bulk record, the relative roles of trophic position vs. 15N source is unclear. We therefore measured compound-specific amino-acid 15N values (15N-AA), to decouple trophic position from bulk 15N values, and in particular to examine trends in the 15N values of Phenylalanine, indicative of 15N at the base of the food web. To our knowledge this study is the first to generate a compound-specific 15N isoscape for the coastal Northeast Pacific, specifically delineating the relative role of CUC transport on isotopic values of coastal production with latitude. (Abstract ID 11334)

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TOPOGRAPHIC WAVES IN THE NORWEGIAN SEA OBSERVED WITH SATELLITE ALTIMETRY
The variability of ocean circulation is dominated by mesoscale signals represented by vortices, current meanders, planetary waves, and fronts. Satellite altimetry data are used to study the characteristics of horizontal propagation of mesoscale sea surface height (SSH) signals in the Norwegian Sea. The largest mesoscale variability of SSH with standard deviations exceeding 15 cm is found in the Lofoten Basin - a topographic depression with depths exceeding 3000 m. A space-time lagged correlation analysis of satellite altimetry records is used to estimate the speed and direction of the maximum correlations as they propagate in space and time. The method reveals a cyclonic wavelet motion around the Lofoten Basin with speeds reaching 2-4 km/day. The cyclonic wave propagation is also determined by the Complex Empirical Orthogonal Functions (CEOF) analysis and the wave-number-frequency spectrum. Using the CEOF analysis we identify two major modes with wavelengths of about 500 km: CEOF-1 shows a dipole pattern and CEOF-2 shows a quadrupole pattern of wave propagation. The amplitude of waves associated with CEOF-1 and CEOF-2 varies from 1 to 8 cm and peaks over the deepest part in the center of the Lofoten Basin. The analysis of the dispersion relation suggests that the observed propagating signals are possibly related to baroclinic topographic waves. (Abstract ID 11164)

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A CASE STUDY OF TWO DENMARK STRAIT OVERFLOW WATER EDDIES AND THEIR IMPACT ON SHELF-BASIN EXCHANGE
Denmark Strait Overflow Water (DSOW) eddies are ubiquitous along the Greenland slope where they play a crucial role in the formation of North Atlantic Deep Water. To date there have been no comprehensive in-situ measurements of these cyclones. Here we use data from an array of tall moorings across the outer shelf and slope 300 km south of the Denmark Strait sill to present a case study of two DSOW cyclones. While the diameter of the two eddies was different, both contained a >2000 m thick bottom layer of DSOW that was actively entraining ambient water. The mass and velocity structure of the two eddies is consistent with previous model studies of eddy formation via vortex stretching. The leading edge of the eddies fluxed dense water off the shelf which adjusts and mixes on the slope. The trailing edge of the larger eddy advected ambient Irminger Water onto the shelf, implying a significant net cross-slope flux of heat and salt due to the passage of the features. The seasonal occurrence of DSOW eddies over the year-long deployment is addressed. (Abstract ID 9705)

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ESTIMATION OF GLOBAL OCEAN INDICATORS FROM ARGOS WITH FOCUS ON REGIONAL AND DEEP OCEAN CONTRIBUTIONS
Argo temperature and salinity measurements during the period 2005 to 2010 are used to estimate global ocean indicators (GOIs) such as global ocean heat content (GOHC), global
ocean freshwater content (GOFc) and global steric sea level (GSSL). This work is part of the MyOcean in situ TAC Research and Development activities. A method based on a simple box averaging scheme is developed to estimate GOFc, with together with an error estimation due to data sampling and processing and climatology uncertainties. Trends of GOFc and GSSL are 0.55±0.1 W/m2 and 0.09±0.14 mm/yr during 2005–2010. Interannual variability at global scale can be observed, especially for GOFc. These results are valid under the assumption that no systematic errors remain in the global observing system. Regional and deep ocean (700–2000m) contributions to the Argo GSSL estimation are analyzed. Previously neglected deep ocean and salinity effects have a significant impact on estimations of GSSL. Density changes due to salinity effects compensate temperature changes in large areas of the global ocean. Steric sea level increase down to 2000m depth due to salinity effects alone occur as well. A comparison of Argo steric sea level to total sea level from satellite altimetry (AVISO) reveals that largest regional contributions to both GSSL and global total sea level can be observed in the global tropical basin. (Abstract ID 11215)

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INVESTIGATION OF NONLINEAR INTERNAL WAVE (NLIW) MOTION IN THE SOUTH CHINA SEA

The South China Sea harbors some of the largest nonlinear internal waves in the worlds oceans. These waves are of interest in ocean mixing processes and naval operations. Through the processing and analysis of previously collected marine seismic reflection data, where NLIWs were discovered, we have addressed appropriate processing of a moving target to determine velocity, and visualized NLIW motion over time. Offset specific stacks with an accompanying velocity depth model were produced, followed by the application of a processing flow to track NLIW reflections. These tracks represent the progression of the wave over time, allowing for the animation of NLIW motion. We find velocities to be around 0.6 m/s and intend to investigate sensitivity issues or the occurrence of an unusually slow moving wave that may account for slower than normal velocity measurements. (Abstract ID 12496)

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MEASUREMENT OF INNER SHELF WAVES AND CURRENTS USING VERY HIGH FREQUENCY (VHF) WELLEN RADAR

The application of remote sensing radar technology for high resolution wave and current measurements in the nearshore is presented. A single VHF (86 MHz) Wellen Radar (WERA) 12-antenna radar system was used on a sandy shoreline, north of Cape Point (NC, USA). In addition, in-situ hydrodynamic measurements were acquired using acoustic current profilers. A comparison of HF Radar derived velocities and in-situ data show a very good agreement. Furthermore, the radar internally calculated current velocity error provides an accurate representation of the natural variability/error. In addition, the ability of the VHF radar for measuring surface waves is evaluated using forward modeling of the radar signal. First and second order radar cross-sectional areas are estimated using the in-situ measured wave directional spectra as input. These estimates are compared with the Doppler spectra obtained by the radar system and the differences are discussed. Inversion techniques for recovering waves from the radar signal will also be presented. This study demonstrates how VHF radars can enhance nearshore studies by providing data with a spatial resolution similar to that obtained by numerical models. (Abstract ID 10653)

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FERRY MONITORING CAPTURES DELAWARE BAY RESPONSE TO SUMMER VARIABILITY AND TO HURRICANE IRENE AND TROPICAL STORM LEE

In the summer, the biogeochemistry of the lower bay portion of the Delaware Estuary is controlled by coastal upwelling and large river discharges, moderated by tidal flux. The cold pool in the adjacent coastal waters is a source of nutrient enriched waters. Persistent summer wind-driven coastal upwelling drives these cold bottom waters to flow onshore. From decades of our research and a local agency monitoring program, we have seen occasional nutrient enrichment at the bay mouth caused by the cold pool upwelling into the lower bay. Large river discharges can cause unusual stratification and nutrients influx in the lower bay leading to phytoplankton blooms. In June 2011, we started monitoring on the Cape May–Lewes ferry that crosses the mouth of the Delaware Bay multiple times daily. An automated monitoring system helped us characterize and quantify how river discharge and coastal upwelling influenced nutrient enrichment and biological production. The ferry also captured major biogeochemical changes before and after Hurricane Irene, and Tropical Storm Lee, including a very large plankton bloom, with chlorophyll concentrations 15 times larger than normal summer levels. (Abstract ID 10418)

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MULTI-DIMENSIONAL CHARACTERIZATION OF HYDROCARBON FLUORESCENCE EMISSION IN MARINE ENVIRONMENT

The in-situ detection of dissolved or suspended hydrocarbons in natural marine environment is limited by the ability to remove the ambiguities in the measured fluorescence emission signal. The spectral property of inelastic molecular scattering process permit the observation and in limited cases the identification and quantification of specific hydrocarbon molecules in the measurement medium. The validity of the method relies largely on the ability to isolate the spectral response of hydrocarbon molecules in the presence of naturally occurring fluorophores abundant in natural fresh and salt water environment. In addition to a defined excitation-emission spectrum and quantum yield characteristics, certain anthropogenic hydrocarbons, specifically Polycyclic Aromatic Hydrocarbons (PAHs), also have distinguished fluorescence decay time. The present study focuses on the development of novel sensor architectures and modulation and demodulation signal processing techniques that utilize multidimensional matrices including fluorescence lifetime to eliminate the environmental noise. Both the experimental and simulated results provide a framework for a novel small form-factor, highly efficient field instrument. (Abstract ID 12869)

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WIND-DRIVEN STORM SURGE AND SEICHING IN THE CURRITUCK AND ALBEMARLE SOUNDS DURING HURRICANE IRENE

In August 2011, the eye of Hurricane Irene passed directly over North Carolina’s sounds, causing extensive erosion of estuarine shorelines. A suite of instruments were deployed prior to Irene in Currituck Sound at the Field Research Facility, Duck NC. Observations and model results indicate that water was forced into northern Currituck and western Albemarle sounds while the eye was south of Duck, creating “dry bed” conditions at Duck. After the eye passed, water levels rose rapidly (= 0.67m/hr) and then slowed and stabilized with a maximum water level of 2.3m. Post-peak water levels dropped rapidly for several hours, and then more slowly over the next 3 days, and are characterized by 5 stable “plateaus” lasting for ~4 hours followed by continued drops in water level. Preliminary calculations suggest that these plateaus may be due in part to basin-wide seiching limiting the flow of water out of Currituck Sound. Current measurements clearly show strong (up to 80cm/s) wind-driven flow and will be further examined to better elucidate the role of seiching on water level variability in the shallow and narrow estuary. (Abstract ID 11231)

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THREE-DIMENSIONAL ANALYSIS OF PARTICLE TRANSIT AT FLUID INTERFACES BY MNEOMOPSIS

Mneomopsis spends about 40% of its life on the sediment interface in a down mood and a larger fraction of time at the air-water interface in an up mood (Welsh et al, in prep). Mneomopsis draws in water from the interface surface and ejects it mainly as a jet at the aboral end. Jets project multiple body lengths into the water column. 4 to 5cm by a 1cm-long animal and more than 20cm by a 5cm animal under quiet conditions. The jets are projected to a greater length at the bottom than at the surface. Three-dimensional analysis of the water flow is achieved by transport of a 0.1mm thick laser sheet at 0.66mm s^-1 through the animal to illuminate neutrally buoyant glass and fluorescent spheres. Particle image velocimetry analyses of 30 fr s^-1 high definition movies of the moving particles reveals the flow field, which varies with chorophore size. A 1cm animal produces a peak water flow of ~300 mm^2 s^-1 while a 5cm animal, produces a peak flow of ~3000 mm^2 s^-1. Funding: NSF MCB 0948327 and AU URIFR (Abstract ID 12575)
THERMAL VARIABILITY WITHIN A COMPLEX BRANCHING ESTUARINE SYSTEM

Branching tidal channel systems confound simple modeling efforts for resolving small-scale advection and mixing processes within them. These processes determine the creation and breakdown of gradients of ecologically important scalars (e.g., salt or temperature). We present advection and mixing processes within them. These processes determine the creation and breakdown of thermal gradients, both vertically and horizontally, on a variety of time scales within Cache Slough. Principal component analysis indicates that although much of the vertical gradients are due to local heating and cooling, fluxes of thermal gradients from adjoining channels and from shallow habitats are also important. Surprisingly, wind events dominate the lateral momentum budget despite the relative narrowness of the channel. The regional thermal dynamics will also be discussed. (Abstract ID 9378)

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studies and can be used to classify water types. From Lee's model (Lee, 2005) for Kd, we can
easily get the Kd from our in-situ Ed. According to the big noise of Ed, the regression analysis
is used to preprocess Ed for getting more accurate Kd values. Since 2010, the short expeditions
have been conducted in the Tokyo Bay. The stations of these expeditions cover almost all kinds of
different water types from Case 1 to Case 2. Through these expeditions, waters are sampled to
determine chlorophyll-a concentrations, nutrients, CDOM, SS, as well as the CTD profiling of
temperature, salinity, and photo-synthetically available radiance. From the relationship
between Kd from Lee's model and in-situ CDOM, SS, we can find that different stations with
different water types make several groups. The data analysis reveals that this method can
classify water types of the Tokyo Bay. (Abstract ID 10218)

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The production and remineralization of marine dissolved organic carbon (DOC) is of primary
importance in the modern global carbon cycle. Radiocarbon (\Delta 14C) represents a central tool
to track the surface oil and the currents impacting its motion with a focus on an offshore
entrainment event from 2 to 18 M. A detailed study of this circulation event was performed
using image animations and in-situ data from drifters and ADCP crossings of the Loop
Current. It revealed the merger of three Loop Current frontal cyclonic eddies into a larger and
more vigorous eddy, enhancing offshore motion. On 18 May, SAR images revealed the
presence of the oil dispersant mixture over 33,753 square km extending from the submerged
well-head towards the LC and into the cyclonic eddy where it accumulated. The offshore
entrainment event of surface oil was closely replicated using a simple particle-tracking model
based solely on advection by geostrophic currents computed from satellite altimetry; however,
the model did not show the main accumulation within the cyclonic eddy. (Abstract ID 12182)

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MOLECULAR SIZE AS A MASTER VARIABLE GOVERNING THE AGE OF THE MARINE DISSOLVED ORGANIC CARBON RESERVOIR

The production and remineralization of marine dissolved organic carbon (DOC) is of primary
importance in the modern global carbon cycle. Radiocarbon (\Delta 14C) represents a central tool
for understanding persistence and turnover of DOC, however, mechanisms controlling the
\Delta 14C values. These findings suggest that molecular size is a major determinant, likely in
concert with chemical composition, controlling the reactivity and turnover of global DOC.
(Anatle ID 9773)

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ASSESSMENT OF A CYCLONIC EDDY MERGING EVENT ALONG THE LOOP CURRENT FRONT AND ITS ROLE IN THE OFFSHORE ENTRAINMENT OF DEEPWATER HORIZON SURFACE OIL

The 2010 Deepwater Horizon oil spill highlighted the risks inherent in deepwater drilling
as well as the need for accurate predictive models of circulation and oil motion. This study
employs satellite data from passive (optical, infrared) and active (SAR, altimetry) sensors
to track the surface oil and the currents impacting its motion with a focus on an offshore
entrainment event from 2 to 18 M. A detailed study of this circulation event was performed
using image animations and in-situ data from drifters and ADCP crossings of the Loop
Current. It revealed the merger of three Loop Current frontal cyclonic eddies into a larger and
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SEASONAL CHANGES IN THE OPTICAL PROPERTIES OF DISSOLVED ORGANIC MATTER (DOM) IN LARGE ARCTIC RIVERS

Arctic rivers deliver over 10% of the annual global river discharge yet little is known about the
seasonal fluctuations in the quantity and quality of terrigenous organic matter (DOM). A good constraint on such fluctuations is paramount to understand the role that
climate change may have on DOM input to the Arctic Ocean. To understand such changes
the optical properties of colored DOM (CDOM) were studied. Samples were collected over
several seasonal cycles from the six largest Arctic Rivers as part of the PARTNERS project.
This unique dataset is the first of its kind capturing seasonal trends in Arctic river CDOM
composition. Parallel Factor Analysis was used to decompose the combined CDOM fluorescence signal into five independent model components. The relationship of individual
fluorescence components to dissolved organic carbon, lignin phenol concentrations, and the
14C-DOC age were explored. This study demonstrates the usefulness and limits of CDOM as a
proxy to understand seasonal and longer term changes in the quantity and quality of Arctic
tidal DOM. (Abstract ID 12416)

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AN ASSESSMENT OF BIOGEOCHEMICAL VARIABILITY OF THE GALICIAN CONTINENTAL SHELF ON WEEKLY TIMESCALES USING A SEAGLIDER

Summertime upwelling events along the Atlantic Coast of the Iberian Peninsula help
fertilize one of Europe's most productive oceanic regions. In 2010, we deployed a Seaglider
to investigate the temporal and spatial variability of these upwelling events over the summer
season. The Seaglider completed 113 days sampling a 50 km east-west transect, transversing
the Iberian shelf, continental slope and open ocean at 42° N. Onboard instruments enabled the
measurement of temperature, salinity, pressure, 660 nm backscatter, chlorophyll-a fluorescence and oxygen. Seaglider data elucidated previously unobserved water column features, missed
by satellite observations and infrequent ship-based sampling, such as the quadrupling of
chlorophyll measurements over a 10 day time period during a strong localised upwelling event.
Oxygen and chlorophyll measurements from the Seaglider also showed deeper bloom events
unobservable by satellite imagery, suggesting that the region is more productive than indicated
by satellite data. (Abstract ID 11335)

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SHALLOW-DEPTH CALCIUM CARBONATE DISSOLUTION: FACT OR FICTION?

The concept of supralysocline dissolution of calcium carbonate within the water column
was introduced by Milliman (1999). An apparent excess of alkalinity well above the aragonite

saturation horizon was the basis for the proposal. This excess has been referred to variously as a "perplexing observation" (Wilson et al., 2009) and "mysterious alkalinity" (Seibert and Diersen, 2009). However both the existence of, and explanations for, this apparent excess alkalinity have been challenged. Additional evidence for the process has been proposed ranging from observations of particles through measurements of excess calcium in marginal seas. I will attempt a critical review of evidence for this still-controversial process based on the null hypothesis that there is no significant influence of shallow density boundary in the water column on ocean carbonate chemistry. (Abstract ID 12747)

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CHARACTER AND VARIABILITY OF SHELF EVENT STRATA ON THE WAIPAOA AND MISSISSIPPI RIVER MARGINS

Floods and storms are key events driving sediment supply and transport in shelf depositional systems. Although the general stratigraphic patterns of many dispersal systems are reasonably well understood, the emplacement and preservation of individual layers by discrete events has been less studied. Therefore, our ability to relate specific beds to their formative processes is limited. Research has been undertaken on the Waipaoa and Mississippi river margins to determine the character of layers deposited in response to flood and storm events as well as how their stratigraphic composition changes with time. The Waipaoa River margin, New Zealand, affords the opportunity to study how the signal from a relatively small but mud-rich river (15 Mt/y) propagates into a morphologically complex and energetic shelf system. In contrast, the Mississippi River discharges an order of magnitude more sediment annually (~200 Mt/y), but the oceanographic environment is considerably calmer, except during powerful tropical cyclones, e.g., Hurricane Katrina. X-radiographs, grain-size and radiochemical data reveal significant spatial variability in both event types and systems, but layers are locally preserved. (Abstract ID 12173)

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INTERNAL BORE-LIKE FEATURES AND TURBULENT MIXING ON THE INNER SHELF OF SOUTHERN MONTEREY BAY

Internal bore-like features were observed on the inner shelf of southern Monterey Bay using high spatial and temporal resolution measurements. Bore-like events were characterized by strong onshore velocities, step-like drops in temperatures, trailing internal waves, and stratification of the water column. Conversely, as these bores relaxed in the form of a warm front, we measured strong offshore velocities, step-like increases in temperatures, and mixing of the water column with gradient Richardson numbers (Ri) dropping below 0.25. Directionality and propagation speeds of the bores/relaxations suggest a generation source near the canyon mouth; however, their timing and arrival was extremely erratic and unpredictable. Statistical models, computed using empirical orthogonal functions, suggest these events account for 58.1% of the total variance in cross-shore velocities, indicating their importance in cross-shelf exchange. Turbulent dissipation was estimated for the relaxations using the novel technique of isopycnal slope spectra. Turbulent intensities were inversely proportional to the local Ri, demonstrating the potential for turbulent mixing by these features. Further work is needed to address the variability and propagation of these bores with implications for vertical mixing and cross-shelf exchange. (Abstract ID 9891)

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EFFECTS OF DROUGHTS AND FLOODS ON SUPTROPICAL ESTUARIES RECORDED BY HIGH FREQUENCY RECORDS OF STABLE ISOTOPE RATIOS IN OYSTER SHELL CARBONATE

Oyster shells contain geochemical records in hinge growth increments, and high frequency stable isotope ratio profiles of δ13C and δ18O can be used as proxies for local temperature and salinity fluctuations. Shell isotope ratios were used to identify the fluctuations in local salinities following successive drought and flood regimes. Isotope time series were compared from two locations that experienced distinctly different environmental fluctuations. Shell values of δ13C responded primarily to salinity while δ18O responded to both temperature and salinity. Clear flood signals were evident in both isotope ratios for shells from one location, reflecting the significant drop in local salinity after the flood. Profiles in shells from the other location lacked flood signals, indicating stable isotope analysis of increments in biogenic structures is a useful method to reconstruct flood events in estuarine environments. The combined use of carbon and oxygen isotopes strengthens the ability to tease out temperature and salinity variations in these dynamic and spatially heterogeneous habitats. (Abstract ID 9525)

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PANMIXIA OF A MESO/BATHYPELAGIC GELATINOUS ZOOPLANKTER: POPULATION DYNAMICS AND DISTRIBUTION OF POEOBIUS MESERES

Poebius meseres is an abundant, gelatinous, holopelagic polychaete and an important detritivore in the bathypelagic zone. In situ video observations of P. meseres from twenty years of remotely operated vehicle (ROV) dives off central California illustrate a bimodal distribution centered around 400 and 1800 meter depths. To determine population structure between these depths, we sampled 169 individuals from three discrete depths (400, 1200, and 1800 meters) using samplers mounted on the ROV Doc Ricketts, in the fall of 2010. Observations were made on sex, maturity, and body size. Larger individuals and sexually mature males increased in abundance with depth while juveniles were more abundant at 400 meters. Reproductive females occurred at all three depths. Population genetic analyses were performed using mitochondrial COI and 16S sequences from all individuals in addition to a few specimens from the Oregon coast and Gulf of California, Mexico. This study reveals a panmictic population throughout the full depth of their water column distribution off Monterey Bay. Preliminary results indicate that populations in the Gulf of California differ substantially in both these genes from populations off California and Oregon. (Abstract ID 12375)

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MEASUREMENT OF THE STRUCTURE OF TURBULENCE IN A WIND WAVE BOUNDARY LAYER WITH AN IN SITU PIV SYSTEM

High resolution free floating PIV measurement in the wave boundary layer of the coastal zone of Lake Michigan was conducted in order to resolve turbulence structures beneath the air-water interface. Vertical profiles of dissipation rate of turbulent kinetic energy in the surface layer were investigated under different wind shear conditions. The PIV result shows the dissipation rate decay following power law with the distance below the water surface. (Abstract ID 12565)

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THE WEAK INFLUENCE OF THE TIDAL RESIDUAL CURRENTS ON LAGRANGIAN TRAJECTORIES IN THE SOUTHWESTERN YELLOW SEA

The influence of the tidal residual currents on Lagrangian trajectories is investigated by a high-resolution circulation model of the southwestern Yellow Sea in comparison to the wind-driven circulations. The simulated tidal harmonic constants and the patterns of Eulerian tidal residual current in this region agree with the observation and previous studies very well. However, the results of the model show that the influence of tidal residual currents on Lagrangian trajectories is weak at the presence of southerly wind. It means that the Lagrangian trajectories are dominated by wind driven currents in the southwestern Yellow Sea. This result is also confirmed by the northeastward ARGOS surface drifters released in the southwestern Yellow Sea in the summer of 2009 (Li, 2010). Further analysis suggests that the quadratd bottom friction scheme is the crucial factor for the weaker influence of the tidal residual currents on Lagrangian trajectories in the southwestern Yellow Sea. This study demonstrates that Lagrangian trajectory could be different from the linear estimation of Eulerian fields at shallow coastal regions due to nonlinearity of the bottom friction. (Abstract ID 9675)

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PROPERATION SPEEDS OF STRONGLY NONLINEAR NEAR-SURFACE INTERNAL WAVES IN THE STRAIT OF GEORGIA

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A novel observational method for studying internal features in the coastal ocean is developed and tested in a study of large nonlinear internal solitary-like waves. Observations were carried out in the Southern Strait of Georgia. By quantitatively combining photogrammetric all-rectified oblique photo images from a circling aircraft with water column data we track a number of internal wave packets for periods of up to one hour and obtain a more complete view of internal waves and measurement of wave propagation speeds. The measured wave speeds enable us to differentiate between classic internal wave models. The applicability of various weakly nonlinear theories in modeling propagation of these large waves is tested. The linear, KdV, and BO models are applied with and without background shear currents. After background shear currents are included, it is found that a continuously stratified BO equation can be used to model propagation speeds within observational error, and that this is not true for other theories. (Abstract ID 10111)

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EARLY DIAGENETIC PROCESSES OF MOLYBDENUM UNDER REDUCING ENVIRONMENTS

It has been well known that the transition element Mo is an essential micronutrient for plants, animals and microorganisms. Mo has a very rich redox chemistry (+II to +VI), and forms part of the active sites of metalloenzymes that execute key transformations in the metabolism of nitrogen, sulfur, and carbon compounds. Generally Mo is relatively abundant in the present ocean, with Mo(VI) dominating in oxygenated conditions, while Mo(V) is expected to exist as in the suboxic forms under reducing conditions. We developed a new method of measuring these reduced Mo, Mo(V), in seawater, and by applying the new methods to examine Mo(V) in reducing waters and sediment porewaters, and also to further analyze the possible sources of these reduced elements. These field investigations confirmed the existence of and Mo(V) in the study waters. Statistical analyses further showed that Mo(V) were formed favorably under reducing conditions with low pH and oxygen. The reduced element may result from several sources in the study waters; sediment pore water diffusion may an important source of Mo(V) in natural waters; besides, release from organic decomposition, and cell exudates, may also directly or indirectly contribute to the pool of reduced Mo. Dynamic dialytic cycling and the existence of Mo(V) as a dissolved reaction intermediate must be accounted for in models of Mo fixation and associated isotope fractionation in sulfidic deposits. (Abstract ID 10203)

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INTERACTIONS OF MESOSCALE SSH FEATURES OBSERVED BY SATELLITE ALTIMETRY

Rosby waves and eddies are dominant mesoscale features in the sea surface height (SSH) fields of world oceans. It is widely believed that the mesoscale variability are driven by baroclinic instability of the large-scale mean flow. After formation, however, these mesoscale features evolve and interact remains to be understood. Based on the altimeter SSH anomalies, spectral energy fluxes are calculated over the subtropical basin of Northwest Pacific as well as the Southern Ocean. Preliminary results show that an energy sink at 11°N, characterized by wave activity, and an energy source at 22°N, characterized by eddy activity, imply different cascade paths for the eddies and the Rosby waves, while both source and sink exist in the Southern Ocean eddy cascade. (Abstract ID 11292)

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VARIATIONS OF CURRENTS OFF MINDANAO FROM A SUBSURFACE ADCP MOORING

Currents off the Mindanao, as part of the recirculation of the tropical gyre, are composed of the Mindanao Current flowing southward, one of the major low-latitude western boundary currents, and the Mindanao Undercurrent below and opposite to the surface current. The latter was revealed based on hydrographic observations during late 1980s and early 1990s, and controversally recognized owing to less direct measurement. Taking advantage of the Open Sharing Cruises sponsored by the National Natural Science Foundation of China (NSFC), a subsurface Acoustic Doppler Current Profiler (ADCP) subsurface mooring was deployed at 8N, 127E in December 2010 and retrieved in July 2011. Two 75kHz ADCPs mounted on the main float ball of the mooring measured velocities with a vertical range of about 700 m for more than 7 months. Driven by strong and jumpy current, the main float ball moved vertically between 400 m and 1200 m depth. The maximum of velocity measured during the observing period is from 100 cm/s near the surface to 40 cm/s below 600 m depth. Oscillations with tidal, near-inertial and intra-seasonal frequencies presented in time series offer rich information about variations and dynamics of the surface and subsurface currents there. (Abstract ID 11044)

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SEASONAL VARIATION OF EDDY KINETIC ENERGY IN THE SOUTH CHINA SEA

Mesoscale eddy activity and its modulation mechanism in the South China Sea (SCS) are investigated with newly re-processed satellite altimetry observations and hydrographic data. The eddy kinetic energy (EKE) level of basin-wide averages show a distinct seasonal cycle with the maximum in August-December and the minimum in February-May. Furthermore, the seasonal pattern of EKE is mostly determined by regions offshore of central Vietnam (OCS), southwest of Taiwan (SWT), and southeast of Luzon (SWL), which are also the breeding grounds of mesoscale eddies in the SCS. Instability theory analysis suggests that the seasonal cycle of EKE is modulated by the baroclinic instability of the mean flow. High eddy growth rate (EGR) is found in the active eddy regions. Vertical velocity shear in the upper 30-50 m is crucial for the growth of baroclinic instability; leading to seasonal EKE evolution in the SCS. (Abstract ID 11463)

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THE CONTRIBUTION OF ATMOSPHERIC FORCING TO DECadal VARIATIONS OF THE NORDIC OVERFLOWS

Dense water flows out from the Nordic Seas in the form of overflows through the Denmark Strait and the Iceland-Scotland Channels. Observations show that these dense overflows supply much of the transport of the Deep Western Boundary Current (DWBC), the lower limb of the Atlantic Meridional Overturning Circulation (AMOC). Thus the variability of the Nordic overflows may influence the AMOC, especially on the time scale of decades. In this study, the variability of overflows, the forcing mechanisms for this variability and the downstream influence on the DWBC and AMOC are examined, using GFDL's climate models CM2G and CM2M. Results show that in CM2G the Denmark Strait overflow, which is largely barotropic, has variability on the time scale of 10 years. This barotropic transport is influenced by the wind forcing, which however, does not show a 10-year periodicity. The Iceland-Scotland Channels overflows, which are largely baroclinic, are correlated to anomalous heat flux, and do not have a clear periodicity. The 10-year variability is also evident in the DWBC and AMOC. Similar variability is found in CM2M, where the time scale is about 15 years. (Abstract ID 11521)

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RECENT CHANGES OF SEDIMENT FLUX TO THE WESTERN PACIFIC OCEAN FROM MAJOR RIVERS IN EAST AND SOUTHEAST ASIA

The five largest rivers in East and Southeast Asia (Yellow, Yangtze, Pearl, Red and Mekong) are important contributors of terrigenous sediment to the western Pacific Ocean. Although they have annually delivered ~200 million tons (MT) of sediment to the ocean since 1000 yr BP, they presently contribute only ~60 MT/yr; a level below the human activities at year 2000 BP. During the last 10 years, human climate change and human activities have reduced the sediment flux to the ocean. Time series (1950-2008) data indicate that the short-term variability of sediment flux is controlled by the wind forcing, which however, does not show a 10-year periodicity. The freshwater from the long-term (decadal scale) decrease in sediment flux. In contrast to the relatively low historical increase in sediment flux during 2000–1000 yr BP the recent sediment flux has been decreased at an accelerating rate over centennial scales. The alterations of large river systems present severe environmental challenges in the coastal ocean, including the sinking of deltas and declines in coastal wetland areas due to the decreasing sediment supply. (Abstract ID 10988)

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THE INFLUENCE OF DISCHARGE, WIND AND TIDES ON NEAR- TO MID-FIELD PLUME DYNAMICS

A series of moored acoustic Doppler current profilers (ADCPs) combined with temperature and salinity sensors were deployed to study the factors affecting plume dynamics during the spring freshets of 2007, 2010 and 2011. Wind is a major factor influencing surface velocity in the coastal area. Offshore wind drives an upwelling of cold salt water to the surface, where it...
interacts with the coastal current and plume water masses, which are pushed further offshore. Near the river mouth, a high frequency ADCP was used to get turbulence information. Significant variations in plume thickness and TKE production were observed from ebb to ebb. Both the plume energy and thickness are related to environmental exchanges for biological carbon and oxygen fluxes. (Abstract ID 11313)

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SULFIDE REDUCTION MAY PREVENT OYSTERS FROM STIMULATING INDIRECT NITROGEN REMOVAL IN MOBILE BAY, AL

Oysters can directly remove nitrogen from the water column by integrating it into biomass, but may also stimulate coupled nitritation/denitrification in the benthos which could lead to nitrogen removal. Using hanging cages, oysters were deployed at two locations in Mobile Bay to quantify the impact of oysters on nitrogen removal. Surface sediments were collected monthly throughout the summer to measure potential nitritation and denitrification and to quantity copy numbers of specific gene related to these processes. Potential nitritation and denitrification were low at all time points, but there were significant differences between the two sites. Relatively low numbers of nirS/K (denitrification) and archael/bacterial amoA (nitritation) genes were detected, suggesting the low rates measured are due to a lack of capable microbes. Sulfate reducing dsb genes were 10 to 100 times more abundant than nirS/K and amoA genes, and increased over time suggesting that sulfatereducing were favored in this environment. As hydrogen sulfide generated by these organisms inhibits nitritation and denitrification, oyster biodiversities may reduce rates of nitrogen removal in Mobile Bay, by stimulating the growth of sulfatereducers. (Abstract ID 12424)

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THE AGOSTROPHIC INSTABILITY OF A VERTICAL SHEAR IN A BOUSSINESQ MODEL

Large-scale flows in the ocean, strongly influenced by the rotation and stable stratification, are mostly balanced in momentum (geostrophic and hydrostatic). They generate mesoscale eddies through baroclinic or barotropic instabilities, but most of the energy is inhibited to transfer towards small scales due to the “inverse cascade” of geostrophic turbulence. The ageostrophic instability, an unbalanced instability occurring only for a finite Rossby number (Ro), is a possible route for the breakdown of balance, which leads the energy to cascade towards small scales. We study the linear instabilities of a baroclinic interior shear flow, with non-uniform interior potential vorticity, in a rotational and stable stratified Boussinesq model, for a board range of Ro, with Burger number (Bu) – 1. Besides the classical instabilities, including baroclinic instability (balanced), centrifugal and Kelvin-Helmholtz instabilities (unbalanced), a new type of ageostrophic instability is found for a moderate Ro. Its growth rate increases with Ro, and the fluctuation field is highly unbalanced, with a large vertical velocity compared to the classical instabilities. The occurrence of this instability is associated with the third criterion proposed by McWilliams et al. (1998) for the breakdown of the balanced equations, i.e., A-S = 0 with A the Eliot potential vorticity and S the horizontal strain rate. (Abstract ID 10089)
though the Antarctic sea ice pack has remained stable. Impacts of sea ice on the iron cycle and marine ecosystems in the past decades are studied with the modified Biogeochemical Elemental Cycling (BEC) model, which runs within coupled ocean circulation and sea ice components of the Community Earth System Model. The modified model involves multiple processes, including the capture of iron from atmospheric deposition and ice formation, iron transport by, and the release of its river discharge during ice melt. Simulations are conducted using interannual varying reanalysis forcing data. The impacts of sea ice on primary production, ecosystem structure and biogeochemical cycle at high latitudes are examined on seasonal and interannual timescales. (Abstract ID 11396)

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**REGIONAL SEA LEVEL ANOMALY PROCESSING IN THE GULF OF MEXICO**

Sea level anomaly from satellites and tidal gauges are combined to produce a daily regional product with a horizontal resolution of 0.25 deg in the Gulf of Mexico. Similar to the global sea level anomaly processing conducted by AVISO, the regional sea level processing including the following steps: 1) Quality control and editing of altimetry observation, 2) Repeat track analysis, 3) Filtering the noise, 4) Optimal interpolation to merge satellite data and tidal gauge data. Two innovative improvements are introduced in the regional sea level anomaly processing. First, the Hilbert-Huang Transform method is used to filter the noise in the along track data. The Hilbert-Huang Transform separates the original data into intrinsic modes based on the characteristics of the data. When only higher modes are combined to conduct filtering, the high-wave number noise is effectively removed. Second, the regional sea level anomaly processing makes use all the available observations instead of sub-sampling the along track data. Without including the tidal gauge data, the RMS (Root Mean Square) error of regional sea level product in 10% less than that of the AVISO product in the northern part of Gulf of Mexico. When the tidal gauge data are included to produce the regional product, the RMS error against the tide gauge data, although not independent, is reduced from 10-11 cm to 2-3 cm. (Abstract ID 12018)

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**A MODEL STUDY OF THE COPPER RIVER PLUME AND ITS EFFECT ON THE NORTHERN GULF OF ALASKA**

The Regional Ocean Modeling System coupled with the Carbon, Silicate, Nitrogen Ecosystem model has been configured to study the effects of the Copper River run-off on the coastal current and nutrient dynamics in the northern Gulf of Alaska (GoA). This coupled model runs in three nested domains with the highest level boundary conditions coming from the lower levels. By comparing the model results from runs with and without the river discharge, three levels of the model show different features as well as similarities. The plumes spread the excess nutrients from the Copper River, which generally enhances the seasonal signal of nitrogen and silicate as well as phytoplankton production in the northern GoA but with different lags in the three levels. The coupled model is forced with the predicted wind from the NCEP's North American Mean Grid model, and wind-driven responses of the plumes in three levels are compared. Furthermore, the effect of eddies embedded in the Alaska Coastal Current on the nutrient budget and how the eddies interact with the plumes are also discussed. (Abstract ID 11396)

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**STUDY ON RAPID RESPONSE OF RIVER PLUME TO ABRUPT CHANGES IN RIVER DISCHARGE**

Rapid response of river plume to abrupt changes in river discharge was investigated at the Yellow River Estuary of China via field observations and model simulations. The Yellow River is a typically seasonal river but its river discharge in summer has changed abruptly due to artificial managements since 2002. Three surveys were conducted around the Yellow River mouth before, during and after a water adjustment event in 2009. Low salinity water was observed to concentrate in the river outflow direction when the river discharge was largest. The Hilbert-Huang Transform method is used to filter the noise in the along track data. The Hilbert-Huang Transform separates the original data into intrinsic modes based on the characteristics of the data. When only higher modes are combined to conduct filtering, the high-wave number noise is effectively removed. Second, the regional sea level anomaly processing makes use all the available observations instead of sub-sampling the along track data. Without including the tidal gauge data, the RMS (Root Mean Square) error of regional sea level product in 10% less than that of the AVISO product in the northern part of Gulf of Mexico. When the tidal gauge data are included to produce the regional product, the RMS error against the tide gauge data, although not independent, is reduced from 10-11 cm to 2-3 cm. (Abstract ID 12018)

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**THE EFFECTS OF PHYSICAL PROCESSES ON DAILY TO SEASONAL VARIABILITY OF MESOPELAGIC FISH LAYERS FROM ADCP BACKSCATTER INTENSITY DATA**

Acoustic backscatter intensity (ABI) data collected over more than 20 months were used to investigate the temporal occurrence and spatial distribution of mesopelagic fish layers (MFL) and their relation to variations in physical processes in the northern Arabian Sea. Data were obtained from 75-kHz upward-looking ADCPs on three cabled deep moorings deployed by Lighthouse R & D Enterprises, Inc. in coordination with the Oman Ministry of Agriculture and Fisheries Wealth. The ABI data document substantial diel vertical migrations of mesopelagic fishes into multiple layers. Two mesopelagic daytime layers (200-450 m) and one surface nighttime layer (50-150 m) are typically found. Daytime layers are located at the interfaces of saltier Persian Gulf water; while nighttime layers follow the seasonal variations of the mixed layer. Short-term variations (daily-monthly) are mostly driven by light changes: sunrise, sunset, moonrise, moonset, moon phase and sky coverage all have strong impact on layer thickness, depth and intensity. Seasonal variations are mostly related to monsoon winds, local circulations and hydrographic conditions. This study emphasizes the importance of sustained observations of moored ABI data to monitor and assess stocks of other environmentally important species as well as related to variations in physical processes in the northern Arabian Sea. (Abstract ID 11433)

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**TEMPORAL AND SPATIAL VARIABILITIES OF THE RIVERINE INORGANIC CARBON SYSTEM IN THE MACKENZIE RIVER AND BEYOND**

The inorganic carbon system of the Mackenzie River (MR) was measured monthly in the delta as well as across the basin. Total dissolved inorganic carbon (DIC), total alkalinity (TA), pH, and pCO2 showed strong seasonal and diel variations. River discharge has a dilution effect on DIC and TA year-round except near the freshet. DIC and TA also increase significantly along the main channel downstream, consistent with the distribution of bedrock geology. Annual DIC flux was estimated to be 5.41x1011 mol C yr-1. Speciation of the carbonate system indicates that on average bicarbonate (HCO3-) accounts for ~95% in the DIC flux, while dissolved CO2 (CO2*) represent a small but significant (~5%) and previously unaccounted inorganic carbon in the total DIC flux. Temperature exerts a significantly positive control on the DIC yield in the basin. The first-order estimate suggests that the DIC flux from the MR could increase by 20% at the end of century due to warming alone. The finding of the inorganic carbon system in the MR may also have global implication based on recent measurements from other river basins. (Abstract ID 12379)

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**IN SITU MEASUREMENTS OF VOLATILE CONCENTRATIONS AND STABLE ISOTOPIC COMPOSITION: LINKING BIOGEOCHEMISTRY AND MICROBIAL ECOSYSTEMS IN THE DEEP SEA**

Here we present how advances in membrane inlet applications for the analysis of volatile species, including both quadrupole mass spectrometry (QMS) and laser absorption spectroscopy (ICOS), have enabled real-time investigation of biogeochemical processes in a host of deep-sea marine environments. Such advances contribute to our understanding of the interactions between macro- and microbial communities and the geochemical milieu in which they thrive. For instance, real-time in situ measurement of dissolved volatile has enabled mapping of both direct relationships between speciation and deep-sea macrofaunal assemblages as well as indirect geochemical trends revealing activity of the hydrothermal subsurface biosphere. Specifically, at hydrothermal vents along the mid-Atlantic Ridge, use of ISMS helped provide the first demonstration of H2 oxidation by the subsurface biosphere. At cold seeps in Monterey Bay, in situ ICOS was used to survey carbon isotopic composition of methane within both advective and pore fluids, with substantial isotopic differences reflecting anaerobic oxidation of methane in pore fluids. (Abstract ID 11957)

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CHANGES IN DEEP-WATER CO2 CONCENTRATIONS OVER THE LAST TWO TO THREE DECADES

Anthropogenic signals are manifesting themselves in the deep ocean (depths > 2000 m). Here we determine the changes in deep water inorganic carbon (DIC) content along meridional transects in the Atlantic and Pacific Ocean on decadal time. No significant changes in total dissolved inorganic carbon (DIC) content are apparent in the interior but there is measurable change in the partial pressure of CO2, a parameter that has a greater dynamic range than DIC. In order to attribute the changes to natural variability or anthropogenic CO2 invasion, changes in oxygen and chlorofluorocarbons (CFC) are used, along with an ocean model. The model output shows lower CFC levels at depth suggesting that ventilation of deep water is underestimated in some models. This implies that anthropogenic CO2 levels in the deep ocean are underestimated as well. The measured changes in the deep ocean, that comprises about 50 % of the total ocean volume, argue for an improved deep ocean observing strategy to determine the evolution of inorganic carbon and tracers and the role of the deep ocean in mitigating atmospheric CO2 increases. (Abstract ID 16800)

RESPONSE OF UPPER OCEAN TO FORCING PARAMETERS

The upper ocean boundary layer, here described as the upper 10m, responds to surface atmospheric forcing parameters, primarily wind speed, heat flux. Measurements of turbulence using the autonomous, upwardly-seeing Air-Sea Interaction Profiler return estimates of dissipation and microstructure temperature from mixed-layer depths to the surface. This allows us to estimate the response time of the upper ocean to the forcing parameters, which is important for air-sea exchange studies. We use data several recent cruises in the Labrador Sea, North Atlantic, and Lofoten Islands in Norway. (Abstract ID 12456)

WHAT HAPPENED TO THE OIL? CHASING OXYGEN ANOMALIES IN THE GULF OF MEXICO

In 2010, an estimated five million barrels of oil and gas were released into the Gulf of Mexico during the Deepwater Horizon disaster. The ensuing consumption of these hydrocarbons by bacteria resulted in "anomalous" decreases in dissolved oxygen (DO) concentrations. These DO anomalies are treated as proxies for the hydrocarbon plume's location before the oil and gas was metabolized. To search for DO anomalies, two autonomous Lagrangian profilers were deployed in the Gulf of Mexico between August and December of 2010, where they measured 318 oxygen profiles with a 2-meter resolution from the surface to 1200m. Profiles with abrupt changes in slope between 600m and 1200m were deemed potentially anomalous. The magnitude of DO anomalies was calculated by comparing each profile to a mean of neighboring non-anomalous profiles. DO anomalies of up to 0.585 mL/L were discovered at distances of up to 317 km from the wellhead and as late as 100 days after the wellhead was capped. A three-dimensional map of the locations and magnitudes of the detected anomalies is presented. (Abstract ID 10742)

PARAMETERIZING ENERGY CONVERSION ON ROUGH TOPOGRAPHY USING BOTTOM PRESSURE SENSORS TO MEASURE FORM DRAG

Dissipation of energy as ocean currents flow over undersea topography is a complex process that has been studied extensively but is still not completely understood. One tool that has yet to be commonly used in the ocean to quantify this process is form drag. In this study, sensitive bottom pressure recorders (PPODs) were used to measure form drag as tidal currents flowed back and forth around Three Tree Point, a headland with sloping side walls located in the Puget Sound. Since PPODs are new instruments, methods for data analysis and form drag calculations had to be developed. These bottom pressure measurements were then combined with detailed velocity and density measurements in an effort to not only measure the form drag but to describe the flow field and the physical processes that create the form drag. When integrated over the entire topography, the form drag was found to be 100 times larger than friction drag over an equivalent area of flat bottom. On average, Three Tree Point dissipates about 0.3 MW of power with peaks as high as 0.2 MW during strong flood tides. While the dissipation of energy at Three Tree Point is only a small fraction of the total energy dissipated in Puget Sound or the world's oceans, it is hoped that the results will help lead to a more general understanding of form drag in the ocean and better parameterizations of topographic drag in models where the grid resolution is not sufficient to capture the dynamics that occur. (Abstract ID 9952)

USING DENSITY TANKS IN THE CLASSROOM TO DEEPLY STUDENTS UNDERSTANDING OF ESTUARINE CIRCULATION

During the 2010–2011 school year, I developed and taught a course for non-science-major undergraduates called "A Citizen's Guide to the Science of Puget Sound." The goals of this course were threefold. First students learned about the environmental issues affecting the Puget Sound by reading newspaper articles. They then learned about the underlying oceanography behind these issues through lectures and hands-on experimentation and problem solving. Finally, they learned how the Puget Sound affects us—citizens of the Puget Sound watershed—by volunteering for 20 hours with organizations that do work aimed at achieving a healthier Puget Sound. Of the many hands-on activities used in this course, one of the most successful was the density tank experiment. Density tanks are foot-long, inch-wide Plexiglas tanks with a removable divider in the middle, in which students can see how fluids of different densities interact. In this class, students used density tanks to learn about how estuarine circulation works. The benefit to this activity is that it can be done in a normal lecture classroom without special equipment except for the density tanks, water, salt and food coloring.
I hope to do a live demonstration of this density tank lesson as part of this session. (Abstract ID 10042)

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NITROGEN FERTILIZATION EFFECTS ON N O FLUXES AND POTENTIAL DENITRIFICATION RATES IN GULF COAST BALDCYPRESS SWAMPS

Freshwater diversions are used to decrease salinity, increase sediment delivery to promote land building and/or to push oil away from coastal wetlands (as occurred in 2010 in Louisiana), but can also increase nutrient delivery to downstream ecosystems, potentially influencing wetland N and N O fluxes. We quantified net N O fluxes and assessed denitrification potential for soils from three baldcypress swamps: one downstream of a diversion (LA) and two control swamps (TX and FL). Net N O fluxes were quantified using the static chamber method and potential denitrification rates were assessed for control and amended (C, P and one of three N addition levels) soils using the acetylene inhibition method. Total potential denitrification rates exhibited a wide range (15.6 – 99.7 nmol N O/d dry soil/h) with rates varying greater than a factor of 3 in each park. Unamended soils exhibited lower rates and did not consistently increase beyond the lowest N amendment. Total rates did not correlate with soil water content, but the N O flux ratio did. These results represent some of the first measurements of rates and controls on baldcypress swamp denitrification. (Abstract ID 10117)

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QUANTIFICATION OF ZOOPLANKTON PREY ABUNDANCE AND THE BEHAVIOR OF NORTH ATLANTIC RIGHT WHALES IN CAPE COD BAY

Acoustic backscatter, net, and video data were used to quantify the abundance (numerical density) and distribution of calanoid copepods in Cape Cod Bay during the spring of 2010. Sampling occurred in close proximity to North Atlantic right whales which had DTAGs placed on them. The behavior of these endangered whales was closely correlated with the distribution of high abundances of their copepod prey and differs from previous studies of right whales in nearby areas where the prey species, abundances and distributions differ. By quantifying the numerical density of copepods near feeding right whales, we can estimate energetic consumption by these animals and gain a better understanding of zooplankton and baleen whale ecosystem interactions. Additionally, the shallow feeding behavior of the right whales during this study increased their risk of injury from ship strikes suggesting that monitoring prey distribution may be useful information for management of the endangered North Atlantic right whale. (Abstract ID 11875)

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SUPPLY AND DISPERSAL OF RIVER SEDIMENT ALONG THE SOUTHERN CALIFORNIA COAST

The small watersheds of southern California drain a steep landscape influenced by active tectonics and human impacts. Supply of sediment from these watersheds is ephemeral, and most of the sediment discharge occurs during 1-2 day floods with recurrence intervals greater than 10 years. Because of the infrequency of sediment discharge, tracking the dispersal and fate of this sediment can be challenging. Recent observations by the USGS during and after the Santa Clara River floods of 2004 and 2005 reveal that river sediment supply can produce sand and gravel deltas that extend 100’s of meters offshore of the shoreline. Fine sediment discharge has been observed to produce hyperpycnal sediment gravity currents immediately offshore of the river mouths. Combined, this suggests that these brief, infrequent floods result in substantial changes to the morphology and sediment transport processes along the southern California coastal margin. (Abstract ID 11746)

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Water mass subduction and eddy effects on phytoplankton distributions in the Santa Barbara Channel, California

Observations using towed, undulating vehicles obtained during 16 cruises from 2001 to 2006 as part of the Santa Barbara Coastal Long Term Ecological Research project (SBC-LTER) show that phytoplankton layers occur well below euphotic zone depths in the Santa Barbara Channel (SBC). The deep layers are typically found where density surfaces slope steeply suggesting that isopycnal mixing and advection cause downward transport of the phytoplankton. Significant correlation between salinity and chlorophyll along isopycnals supports this interpretation. Our ongoing analysis focuses on the role of cyclonic eddies and shelf processes in forcing this downward isopycnal transport. Other sampling during the cruises reveals that eddies and wind-driven upwelling largely control the spatial patterns of phytoplankton primary productivity in the SBC. Cyclonic eddies increase productivity by uplifting isopycnal surfaces and associated nutrients and by occasionally entraining phytoplankton and nutrients from water upwelled near Point Conception. Our analysis suggests that isopycnal processes transport a significant fraction of this enhanced productivity to depth and thus increase the efficiency of the biological carbon pump in the western SBC. (Abstract ID 10112)

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A NOVEL MOLECULAR APPROACH FOR THE IDENTIFICATION OF DISSOLVED METAL-ORGANIC COMPLEXES IN NATURAL WATERS

Essential trace metals, such as Fe or Cu, often occur in trace amounts in aquatic ecosystems due to their low solubility and particle-reactivity. Through complex formation, dissolved organic matter (DOM) can influence trace metal solubility and thus have a significant impact on trace metal fluxes. Previous attempts at molecular identification of natural metal-organic complexes were often hampered by the high complexity of DOM. In this study, coastal seawater and porewater samples were collected to investigate a new combination of analytical methods to identify Fe- and Cu-complexation. Competitive liquid equilibration and subsequent adsorptive stripping voltammetry (AdSV) were applied to determine the amount of complexed Fe and Cu in the samples. Solid-phase extraction tests with different solvents and pH settings were conducted, and measurements of the metal-DOM extracts by high-performance liquid chromatography high resolution inductively-coupled plasma mass-spectrometry (HPLC- HR-ICP-MS) and ultra-high resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR-MS) revealed specific compound classes and molecular formulae. The developed method thus provides a promising tool for studies of metal-DOM complexes in the future. (Abstract ID 11275)

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SEASONAL VARIABILITY OF THE SUBSURFACE COUNTERCURRENT UNDER THE COASTAL BRANCH OF THE TSUSHIMA WARM CURRENT IN THE JAPAN SEA

The current structure and its seasonal variability of the subsurface countercurrent (SSCC) under the coastal branch of the Tsushima Warm Current (TWC) were directly observed by moored upward-looking ADCPs. A total of four ADCPs were moored each for approximately a year in the strait between the Noto Peninsula and the Sado Island in the central Japan Sea. In the surface layer the coastal branch of the TWC flowed southward along the east coast of the Noto Peninsula in all seasons except winter. On the other hand, in the subsurface layer the obvious northerly countercurrent with the velocity of approximately 20cm/s was observed at the depth of between 100m and 200m on the edge of the continental shelf from the spring to the summer. Using a data assimilation model for the Japan Sea, similar seasonal variability of the SSCC can be reproduced. The simulation results suggest that such seasonal SSCC can be considered as the nearshore part of the seasonal anti-cyclonic eddy which occurs on the edge of the continental shelf. (Abstract ID 11028)

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MODELING STUDY ON THE WESTERN ARCTIC PRIMARY PRODUCTIVITY REGULATED BY SHELFBREAK WARM EDDIES

Phytoplankton response to the Beaufort shelf-break eddies in the western Arctic Ocean is examined using an eddy-resolving coupled sea-ice-ocean model including a lower trophic marine ecosystem formulation. The phytoplankton bloom depletes a great part of nitrate

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content over the shallow Chukchi shelf before the eddy-generation period, and the warm eddies then transport nutrient-poor shelf water to the Canada Basin. At the same period, the large biomass of phytoplankton increased in the Chukchi shelf layer, taken into the warm eddies. In the eddy-developing period, the phytoplankton bloom gradually decreases because of the limited primary production due to nutrient depletion and the grazing of zooplankton. In the eddy-maturity period, the local upwelling flow along the outer side of an individual eddy transports a significant amount of nitrate in the intermediate layer to the surface euphotic zone and enhances the primary productivity in the subsurface layer. The time lag between the phytoplankton bloom in the shelf region following summertime sea ice retreat and the eddy generation along the Beaufort shelf break is an important index to determine biological regimes in the Canada Basin. (Abstract ID 9809)

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GLOBAL PATTERNS OF MIXING FROM DIRECT AND INDIRECT MEASUREMENTS OF DISSIPATION

Here we present a comprehensive view of global measurements of diapycnal mixing in the ocean using a combination of microstructure data, Thorp scale estimates, and finescale inference. Data are being consolidated as part of a multi-PI, multi-year Climate Process Team, the ultimate goal of which is to improve the representation of mixing in global climate models. Direct measurements of dissipation come from more than 300 microstructure profiles from various oceanic regimes from all major US microstructure groups. Indirect measurements, used in the finescale parametrizations, are obtained from 5 years of ship-board observations of upper ocean shear as well as dissipation based on Thorpe-scale overturns from moored profilers. Comparisons between the finescale dissipation to measured dissipation (and diffusivity) are used to determine which physical processes are affecting validity of the parameterization in a statistical sense. (Abstract ID 12396)

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OBSERVATIONS OF INTERNAL WAVES AND TURBULENCE IN THE ANTARCTIC CIRCUMPOLAR CURRENT

We report on microstructure and finescale observations of the turbulent kinetic energy dissipation rate, epsilon, and internal wave scale properties in a standing meander of the Antarctic Circumpolar Current (ACC) north of the Kerguelen Plateau. We characterize the intensity and spatial distribution of epsilon and the derived turbulent mixing, and consider underpinning mechanisms in the context of the internal wave field and the processes governing the waves generation and evolution. Epsilon and the derived diapycnal diffusivity are reliably spatially variable with systematic depth dependence. Epsilon is high in regions where internal wave energy is high, consistent with the idea that interior dissipation is related to a breaking internal wave field. However, the rates of turbulent dissipation and mixing are generally lower than anticipated from the observed internal wave energy levels. Large background shears characterize the ACC may result in wave-mean flow interactions that are important in determining wave evolution, and in the case of upward propagating waves, may compete with thednscale energy cascade promoted by wave-wave interactions thereby suppressing the turbulent dissipation. (Abstract ID 11156)

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THE SLOWLY VARYING MEAN KUROSHIO EXTENSION CURRENT TRANSPORT FROM SEA SURFACE TO SEAFLOOR

Centered near 35N, 146E east of Japan, the Kuroshio Extension System (KESS) moored a 550 X 550 km grid of current-and-pressure-recording inverteo sounders. The array observed the time-varying horizontal current structure along its mean path and within the neighboring recirculations. Mapped total-transport streamlines distinguish the through-flowing portion of the Kuroshio from closed recirculations. An anticyclonic southern recirculation gyre (SRG) is centered near 345N, 144E. The northern recirculation gyre is downstream from the KESS array, and within KESS a northern local cyclonic recirculation exists within the trough but is not treated further here. Six-month and ten-month mean transport-maps are calculated respectively over stable and energetic-meandering intervals (units Sverdrup). Stable-regime combined total transport is 133, comprising 57 throughflow and 76 SBC; the baroclinic components are respectively 98, 69 and 29. Unstable-regime combined total transport is 106, comprising 55 throughflow and 51 SBC; the baroclinic components are respectively 78, 41 and 37. Total transport, SBC strength, and baroclinic total and throughflow decrease in the unstable regime. (Abstract ID 9898)

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DECADAL CHANGES IN VENTILATION OF SOUTHERN OCEANS INFERRED FROM CFC MEASUREMENTS

Measurements of transient tracers made along sections in the southern oceans sampled in the early 1990s (WOCE) and reoccupied in the mid to late 2000s (Repeat Hydrography program) are used to examine possible changes in ocean ventilation. It is found that observed changes in CFC-12 are not consistent with steady transport, and that these measurements indicate a decrease in the age of intermediate waters (SAMW, AAIW) in the subpolar gyres but an increase in the age of circumpolar deep waters (CDW) at the similar depths. These inferred changes are qualitatively consistent with the observed increase in the circulation in the southern subtropical gyres over the period considered here, as well as with climate models simulations. The possible cause of these changes as well as the impact on uptake of heat, carbon and other tracers will also be examined. (Abstract ID 9599)

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Bacterioplankton community response to gradients in dissolved organic matter bioavailability in a coastal upwelling system

Twenty-six dissolved organic matter (DOM) remineralization experiments were conducted to assess bioavailability and bacterial community response during an upwelling event and the subsequent phytoplankton (diatoms and Phaeocystis sp) bloom in the Santa Barbara Channel, CA, USA. We observed a striking increase in the bioavailability of DOM as the bloom developed. 7-day remineralization of dissolved organic carbon (DOC) increased from unetectable drawdown to greater than 7%, and 10-week remineralization from <2% to 15%. Final DOC concentrations in experiments initiated from within the bloom remained ~2 to 5 μM higher than those from recently upwelled waters, indicating that a portion of the DOC produced by the bloom was not bioavailable over a ten week incubation. Bacterial growth efficiencies increased slightly during the bloom but remained generally ~30%. Bacterial communities responding to DOM within incubations varied systematically with in situ particulate organic carbon and nitrate concentrations. These experiments document a shift in DOM liability during a natural phytoplankton bloom and illustrate that some blooms-produced DOM resists degradation over days to months, increasing its probability of horizontal and vertical export through physical processes. (Abstract ID 11818)

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GLOBAL STOKES DRIFT AND CLIMATE WAVE MODELS

The Stokes drift is an important vector component that appears often in wave-averaged dynamics, such as Langmuir turbulence. Inclusion of this unresolved turbulence via a surface wave model in climate models has the potential to correct a well-known, shallow mixed-layer bias in the Southern Ocean. However, recent research has found that unidirectional Stokes drift estimates between different wave models vary drastically (30-50% of the period 1994-2001). This is in contrast to the generally good agreement found among model calculations of significant wave height and can be attributed to errors in calculating the third spectral moment versus the zeroth. In addition, the commonly-used unidirectional wave approximation tends to overestimate the Stokes drift by 33%, illustrating a need for a coupled, two-dimensional spectral wave model or directional empirical spectrum in climate studies. Current work on coupling WAVEWATCH III to CESM will be presented as well as progress on developing a prototype wave mode using radial basis functions. This unstructured node method is parallelizable and has the benefit of removing the pole singularity and spreading the computational cost equally.
across the globe. (Abstract ID 9780)

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SpatiaL VARIATION IN NUTRIENTS, PIGMENTS, PARTICLES, AND PHYTOPLANKTON ABUNDANCE IN THE AMAZON RIVER PLUME

The Amazon River forms an extensive surface plume that extends well offshore into the equatorial Atlantic Ocean. During cruises to the Amazon Plume in spring 2010 and fall 2011, we used shipboard underway seawater systems to sample nutrients, pigments, phytoplankton abundance, and stable isotopic natural abundance ($\delta^{15}N$, $\delta^{13}C$) as part of the multidisciplinary ANACONDA program. We sampled surface waters ranging in salinity between 18 and 35 PSU extending over some 450,000 km$^2$ of the shelf and offshore waters. We found a strong inverse correlation between salinity and silicate concentrations, with frequent depletion relative to a conservative mixing line in the mesohaline and oceanic salinity regions, reflecting significant biological consumption of Si in the aging plume. In contrast, nitrate was mostly absent from surface waters, while phosphate was highest in the low salinity-mesohaline waters. $\delta^{15}N$ tended to decrease with increasing salinity, whereas $\delta^{13}C$ generally increased, patterns that are consistent with an increasing contribution of N from large diazotrophs (e.g., Trichodesmium and diatom-diazotroph associations). Additionally, nutrient amendment experiments show clear evidence for N and P co-limitation of biomass in fall plume waters. (Abstract ID 10963)

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REGULATION OF THE OCEAN NITROGEN RESERVOIR BY STOCHIOMETRICALLY DIVERSE PLANKTON

The average elemental composition of marine plankton is closely matched to the availability of the major nitrogen (N) and phosphorus (P) nutrients. This is understood to arise from biological control over the ocean's N budget, in which removal of N by denitrification selects for diazotrophic phytoplankton that add new N to the ocean when it limits the growth of other species. We show that in the context of a realistic ocean circulation and a uniform N:P ratio of plankton biomass, this feedback mechanism consistently yields too little N relative to observations. When plankton N:P varies systematically between major ocean biomes, with high ratios in oligotrophic gyres where diazotrophs are favored, a realistic N inventory can be achieved. Despite large-scale variations in the stoichiometry of plankton communities, diazotrophs raise the ocean's N reservoir to support the global mean plankton because ocean circulation transports stoichiometric anomalies across ocean biomes. A combination of local ecosystem dynamics, plankton biogeochemistry, and large-scale patterns of ocean circulation controls the availability of fixed nitrogen in the ocean, and thus ocean fertility and carbon storage over millennial timescales. (Abstract ID 9406)

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FLUVIAL SEDIMENT DISPERSAL THROUGH AN INSULAR SEA: MODERN SEDIMENTATION ASSOCIATED WITH THE SKAGIT RIVER DELTA, PUGET SOUND, WA

The Skagit River carries 1-4 million tons of fine-grained sediment annually, however most of the active topset is a sandy flat and the delta front has no measurable growth. Spatial water-column surveys and cores collected seasonally are used to examine how basin geometry and marine processes (tidal-seasonal) can dictate distal depositional patterns (seasonal-decadal). Results indicate the delta has little active deposition on the sandy topset due to strong tidal processes or on the delta front due to land construction and vigorous tidal currents. Radiocarbon, documents that sediment is rapidly transported over 10 km into two different basins, southward to Saratoga Passage and northward outside Deception Pass, with accumulation rates reaching 1 cm/yr. About 0.5 million tons/yr of fine-grained sediment are accumulating annually in Saratoga Passage. And although accumulation rates outside Deception Pass cannot be constrained, sediment deposition is reflected in ‘Be that was found in cores following high river discharge. Overall, basin geometry as well as river discharge and physical processes should be considered in order to understand the mechanisms controlling sediment dispersal and depositional patterns within complex insular seas. (Abstract ID 11441)

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BIOGEOGRAPHY AND BIODIVERSITY OF THE MICROBIAL COMMUNITIES ASSOCIATED WITH CENTRAL PACIFIC CORAL ATOLLS

The Line Island archipelago consists of eleven atolls spanning a latitudinal gradient from 6° North to 11° South. The coral reefs surrounding these remote atolls represent some of the most pristine reefs in the world. To investigate the variance between microbial communities associated with healthy coral reefs, metagenomes were constructed from the microbes directly overlying the reef. Samples were collected from at least two sites per atoll (N=30). Taxonomic profiles of the microbial communities reflect nutrient availability, where sites located in regions with higher nutrients have elevated abundances of Bacteriodes and Gammaproteobacteria. Oligonucleotide signatures were used to investigate whether there was genomic pattern for these microbial communities based on location. This analysis demonstrated that microbial communities from the same atoll clustered closest together; likewise, communities from atolls in close proximity to one another were often similar. Furthermore, communities collected from the same atolls, but after a time span of five years clustered together. These results suggest that marine microbes from a particular location maintain similar genomic signatures and that these signatures may be consistent amongst different taxonomic profiles. (Abstract ID 12586)

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SPRING-NEAP VARIATION IN FECAL PELOTL PET PROPERTIES WITHIN SURFICIAL SEDIMENT OF THE YORK RIVER ESTUARY, VIRGINIA

Fecal pellet abundance was measured within the upper seabed of the York River Estuary as part of a larger study investigating relationships between fine sediment aggregates and bed erodibility. Sedimentological surveys were conducted twice a month during the spring and summer of 2011 to coincide with spring or neap tidal cycles. Particle size distributions were determined by sieving the sediment using three methods: 1) typical grain size analysis, 2) gentle agitation with seawater, 3) gentle agitation with deionized water. Each method used four sieves (150, 90, 63 and 45 µm) to constrain the size abundance of the particles. The study found that resilient fecal pellets comprised up to ~30% of the total sediment within the top centimeter of the seabed, and abundance was not directly related to spring-neap tidal cycles. There was a tendency, however, for larger pellets to persist around neap tide, perhaps because stronger currents at spring tide were more likely to break apart the largest pellets. Also, a greater mass of pellets was preserved when seawater rather than deionized water was used during sieving. (Abstract ID 10115)

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UPWELLING FRONTS AROUND HAINAN ISLAND IN THE NORTHWESTERN SOUTH CHINA SEA IN SUMMERS OF 2002-2010

In this paper we present the satellite images of SST around Hainan Island and discuss the characteristics and influencing factors for the upwelling fronts in three areas: the northeast (A), south (B), and west (C) of Hainan Island. Three datasets are used for the analysis: the MODIS-A L3 mapped SST data from 2002 to 2010, QuikSCAT wind product from 2002 to 2009, and cruise measurements in summer 2006. Multyear-averaged monthly-mean SST shows that the upwelling fronts around Hainan Island (UAHF) form in June when the southwesternly monsoon prevails, develop to their strongest in July, and gradually disappear from August to September. SST images of each July from 2002 to 2010 are also presented to show the year-to-year variation of the UAHF the upwelling front in Box A is always strong in 2002-2010, the front in Box B is stronger in the years of 2002, 2006, and 2009, and the front in Box C is weaker in the years of 2002, 2003, and 2006. The summer monsoon, cold eddy, and background current in the South China Sea all contribute to the strong upwelling front in Box A. The upwelling front intensity in Box B has a good correlation with the local eastward wind stress, namely, the offshore Ekman transport by alongshore wind intensifies the upwelling in this area. Low SST pattern in Box C is not adjacent to the west coast of Hainan Island, and tidal mixing may be the main reason for the low SST in this area. (Abstract ID 10953)

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DYNAMICS OF THE CURRENTS SEPARATION AROUND DONGSHA ISLANDS

Based on the observation of the velocity field near Dongsha islands in summer, it is found that the current flows across the isobaths and towards deep water in the middle and deep sea level when going over the Dongsha islands. Using high-resolution model, the dynamic mechanism of the currents’ separation round Dongsha Island has been analyzed. The separation behaves seasonal variability, strongest in fall and weakest in winter. The vorticity balance analyses show that Jebar (joint effect of baroclinicity and relief) forcing drives the water column across the isobaths. Analyses on the momentum field indicate that the position alongshore pressure gradients provide the momentum constraint for the separation round the Dongsha Island. Key words: separation; ocean model; Dongsha Island; Jebar (Abstract ID 12290)

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TRANSFORMATION OF SUPRAGLACIAL DISSOLVED ORGANIC CARBON FROM THE COTTON GLACIER, ANTARCTICA

Disolved organic matter (DOM) is a heterogeneous mixture of biogenically derived organic compounds that play an important role in aquatic ecosystems as a carbon source and other functions such as light screening. A significant DOM component is humic material that is refractory and chromophoric in nature. In this study we document the composition and transformation of DOM lacking humic components in the supraglacial stream of the Cotton Glacier, Antarctica. The prevalence of humic substances in all other aquatic environments prevents the study of humification. However, the Cotton Glacier is a unique environment devoid of humic materials. The DOM after the initial annual melt in summer is composed entirely of fresh microbial exudates. Supraglacial water samples were filtered (0.2μm) and aged in the dark for approximately one month. We observed increases in the molecular weight, polydispersity, and aromaticity of DOM in unfiltered water samples using High Pressure Size Exclusion Chromatography and Fourier Transform Ion Cyclotron Resonance Mass Spectrometry. The results of this study suggest that even in dilute solutions, microbial exudates may undergo condensation reactions to form complex molecules. (Abstract ID 10623)

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SURFACE CLIMATOLOGY OF THE SOUTHERN OCEAN IN THE CCSM4

The Southern Ocean is a key area in the climate system for many reasons, and a decent representation of its mean state, internal variability, and response to external forcing is essential for the fidelity of coupled climate simulations. Here we will present results of our evaluation of the surface climatology of the Southern Ocean in five 20th century ensemble members of the Community Climate System Model v4 (CCSM4). Specifically we will focus on the dominant modes of interannual variability (Southern Annual Mode and ENSO teleconnections), and late 20th century trends. We find that the natural variability, as simulated by CCSM4, compares very well with the ERA–40 reanalysis. However, late 20th century trends in sea surface temperature are significantly stronger than observed. Trends in the SAM index and the associated strengthening of the zonal winds are in agreement with observations, so the surface warming of the Southern Ocean appears to be a response to forced atmospheric warming. (Abstract ID 9469)

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HIGHER EDUCATION FACULTY/SCIENTIST INVOLVEMENT IN A G-62-12 SCIENCE EDUCATION PARTNERSHIP PROJECT

The NSF-MSP funded Rhode Island Technology-Enhanced Science Project (RITES) supports development of standards-based, technology-enhanced inquiry science activities for G6-12 classrooms statewide and associated teacher professional development (PD) courses. Activities and PD courses have been developed in all science disciplines, 40% of which include earth, ocean, and space science themes. This aspect of the RITES project is novel in that a team of a teacher and a higher education faculty member develops both the technology-based science activities and the PD course for a particular topic. During the first three years of the project, 25 higher education faculty and/or researchers representing four local institutions of higher education, and 22 teachers representing 12 RI school districts developed materials in 24 different content areas. We will present research on the efficacy of the RITES design model, including evaluation of the teacher-higher education faculty partnership, the use of technology
in the activities, and the design of support materials developed for the teams. Furthermore, we will highlight results on higher education faculty involvement in and attitudes toward the development of science-related classroom activities and teacher PD. (Abstract ID 10786)

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IMPLICIT CALIBRATION OF A MARINE ECOLOGICAL MODEL TO THE BERMUDA ATLANTIC TIME SERIES

We demonstrate the calibration of a nitrogen-based marine ecological model proposed by Spitz et al. (2001) to the Bermuda Atlantic Time Series (BATS) from the US Joint Global Ocean Flux Study. This model describes the evolution of plankton, nutrients, and dissolved organic matter in the mixed layer. Many of its parameters are unknown and impossible to measure in situ. We use an implicit Monte Carlo (IMC) method to estimate these parameters and then draw inferences about past, present, and future ecological states. In IMC, the goal is to determine the regions in state and parameter space with the greatest probability, then to sample an accurate approximation to the probability density function within those regions. The first step is equivalent to finding a variational estimate, while the second step refines this estimate using stochastic model simulations called particles. We show that IMC requires fewer particles to assimilate the BATS data than other particle-based methods including the ensemble Kalman filter and sequential importance resampling. In certain examples, this difference is an order of magnitude or more. Even if the initial estimates are very poor, the implicit estimate shows no evidence of bias, and its variance is comparable to the uniform minimum of any unbiased estimator. (Abstract ID 10728)

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FLUORESCENCE EXCITATION-EMISSION MATRICES OF CDOM IN THE CHUKCHI AND BEAUFORT SEAS

During the summer 2011 ICESCAPE cruise to the Chukchi and Beaufort seas we completed 173 bio-optical stations which included analyses of particle, detrital and soluble absorption as well as fluorescence excitation-emission matrix measurements on soluble material. Data was collected from coastal shelves as well as deep basin waters which were partially ice-covered. Absorption of soluble materials for ICESCAPE was much higher compared to our CalCOFI datasets from the California Current Ecosystem. Fluorescence (Ex 340 nm, Em 450 nm) of soluble materials was well correlated with soluble absorption at 340 nm with the exception of specific water masses showing poor correlation. The highest fluorescence values were observed in Kotzebue Sound and the neighboring waters of the Bering Strait, while the lowest were observed in the surface waters of the Beaufort Sea. Spectroscopy results showed a high ratio of UV-humic to visible humic-like fluorescence in both Chukchi and Beaufort basin surface waters, with a consistently lower ratio in deeper basin waters (~200m). The variability of excitation-emission matrices and CDOM for different water masses will be presented. (Abstract ID 8984)

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SEASONAL VARIABILITY IN B SPECIATION AND B/C Across PLANKTON FORAMINIFERA FROM THE CARLACO BASIN, VENEZUELA

B/Ca was measured on four planktonic foraminiferal species collected in biweekly sediment trap samples from Canaizo Basin, Venezuela from 2003 – 2006. These ratios show a repeatable seasonal pattern with the highest values occurring in summer and the lowest during winter upwelling. B/Ca MASS NMR spectra were acquired for samples of Orbitolina universa and Globorotalia menardii from winter and spring of 2007. During January the boron is almost entirely incorporated (~ 90%) in a previously unrecognized trigonal form. In April only ~75% of the boron is in this trigonal form, with the rest of the boron being divided evenly between borate and boronic acid. The observed trigonal form has a C of 0.30, which is similar to the theoretical value of 3.15 for the corner-sharing borate carbonate complex, BO(H2)CO3 . It is hypothesized that this model describes the boron conversion to a carbonate complex which is ultimately converted to either borate or boronic acid. Our results support this hypothesis except that most of the boron does not complete this reaction, but remains in the intermediate borate carbonate complex form. (Abstract ID 9364)

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VARIABILITY OF FRESHWATER TRANSPORTS THROUGH THE CANADIAN ARCTIC ARCHIPELAGO

The Canadian Arctic Archipelago (CAA) is one of the main pathways for freshwater exiting the Arctic Ocean. The amount of exported freshwater influences the deep water formation in the North Atlantic, which is crucial for the meridional overturning circulation (MOC). Modelling ocean and sea ice conditions in the CAA is difficult because of narrow straits and complex coastlines. A high resolution model study for the period 1958-2007 will be presented, which applies the Finite Element Sea-ice Ocean Model (FESOM) in a global configuration. The unstructured mesh approach allows for local refinement in areas of interest and accurate representation of coastlines. Volume and freshwater transports through the CAA show a strong interannual variability. Mechanisms driving the flow through the archipelago are investigated by exploring the sea surface height difference between Baifin Bay and the Arctic Ocean, far field wind fields and large scale pressure patterns like the North Atlantic Oscillation. Experiments with different mesh resolutions in the CAA are conducted and their effects on deep water formation in Labrador Sea and the Atlantic MOC are presented. (Abstract ID 11010)

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MAKING OCEAN MEASUREMENTS COST-EFFECTIVE & POLICY RELEVANT: DESIGN & OPERATION OF LARGE-SCALE MARINE TELEMETRY ARRAYS FOR IMPROVED FISHERIES SCIENCE

Society expects research to be rigorous. In fisheries, key issues are to rigorously quantify survival and duration of residence. From a statistical perspective, a “perfect” telemetry system is one where measurements are unbiased and of high precision. Recent results demonstrate that it is possible to measure whole life cycle survival rates from smolt emigration until adult return with little distortion, so high biological accuracy is achievable. In contrast, achieving high statistical precision is an engineering problem, and requires both solid array designs and high operational efficiencies to maintain data yields; both poor design or poor performance can seriously degrade precision, resulting in 6X as many tags (or more) being needed to achieve a given statistical precision. I will show how optimization methods provide the critical benefit of demonstrating that new designs are “provably best” and therefore provide the highest economic value and scientific performance. Achieving defined performance standards also allows the design of explicit experiments for the coastal ocean that should have high statistical power for testing key scientific theories, and should therefore lead to rapid scientific progress. (Abstract ID 10825)

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DENSE SHELF WATER CASCADE (DSWC) ON THE ROTTNEST CONTINENTAL SHELF IN SOUTH-WESTERN AUSTRALIA

Temperature and salinity (and associated density) data collected by autonomous shallow water ocean gliders along the Rottneest Continental Shelf, revealed the formation and propagation of dense water masses which is defined as dense shelf water cascading (DSWC). A common occurrence in shallow depths of the shelf (~50m) and continues throughout the year with varying degrees of intensity. Increase in salinity due to evaporation in summer and autumn and cooling in winter allows for relative increase in density in the inshore regions of the shelf. Higher density water is transported offshore near the sea bed as a dense water plume, which may be 20m in thickness where the water depths are 40m. The density currents are estimated to be ~1-2 cm/sec, which are similar to those measured in other similar regions globally. It is noted that occurrence of DSWC is minimal during summer, due to dilution of cross-shelf density gradients by strong wind mixing and upwelling at the edge of shallow shelf. The DSWC plays an important role in cross-shore exchange of water and material in Rottneest Continental Shelf. (Abstract ID 11271)

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UNDERSTANDING OXYGEN VARIABILITY IN RELATION TO BIOLOGICAL PROCESSES IN THE COLUMBIA RIVER ESTUARY THROUGH A BIOPHYSICAL MODEL

Coastal upwelling processes off the Oregon and Washington coast can lead to the development of low oxygen water masses in the Columbia River estuary. Using observations at endurance stations and mobile platforms from a river-to-ocean collaboratory (http://www.stcsmop.org/stomar), we are characterizing the spatial and temporal variability of hypoxia in the lower estuary. Observations are used in the development of an ecological model that is designed to address the question of how phytoplankton production and heterotrophic bacterial consumption impact incoming oxygen-depleted waters in the estuary. The ecological model is coupled to a three-dimensional circulation model extending from the continental shelf to the tidal freshwater regions. In this poster, we (a) summarize observations; (b) introduce the biological parameterization, sensitivity analysis, validation and preliminary results of the model; (c) offer insights into seasonal and interannual scales of variability of oxygen in the lower estuary in response to ocean and river forcings; and (d) examine in detail specific episodes of oxygen depletion in the summers of 2010 and 2011. (Abstract ID 11938)

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THE CALIFORNIA CURRENT LARGE MARINE ECOSYSTEMS INTEGRATED ECOSYSTEM ASSESSMENT (CCIEA): A CASE STUDY ON CALIFORNIA SALMON

The CCIEA focuses on key ecosystem components and a subset of the drivers, pressures and management strategies that influence these components. We refer to ecosystem components as the species, habitat, human dimension, or other ecosystem elements that are the target of management. In consultation with managers, we have identified key ecosystem endpoints in the CC LME of interest to NOAA, and adopted ecosystem endpoints as initial foci, including Ecosystem Health, Habitat, Protected Species, Resilient and Economically Viable Coastal Communities, and Wild Fisheries. The ultimate aim of the CCIEA is to understand the web of interactions that links drivers and pressures to Ecosystem Based Management (EBM) components and to forecast how changing environmental conditions and management actions affect EBM components. We describe approaches in one case study (California salmon) that are being used to evaluate how various combined management strategies across the life-history of salmon can affect the boom and bust cycle of the population. We examine the sensitivity of the CA salmon populations to factors such as hatchery practices, freshwater flows, emigration/release timing, and fishing effort. (Abstract ID 10770)

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ON STRATIFICATION, BAROTROPIC TIDES, AND SECULAR CHANGES IN SURFACE TIDAL ELEVATIONS: REALISTIC NUMERICAL SIMULATIONS AND IDEALIZED MODELS

The objective of this study is to examine the impact of stratification in the deep ocean, and climatic perturbations to this stratification, on surface tidal elevations, including the large horizontal scale (barotropic) component and small horizontal scale (baroclinic) component. Numerical experiments in realistic one- and two-layer models of the global atlas along with idealized one- and two-layer models in one spatial dimension are utilized to address this problem. Both realistic and idealized models reveal that perturbations in the depth of the interface between the layers, and perturbations to the value of reduced gravity, induce a change in the barotropic surface elevation. This suggests that changes in oceanic thermal structure can contribute to the secular trends noted in long-term tide gauge records. (Abstract ID 10518)
A GLOBAL VIEW OF SMALL-SCALE TURBULENT MIXING

Ship-based observations of mixing are currently unpractical to undertake over very large regions. We use strain information from nearly globally distributed Argo floats to generate over 400,000 estimates of dissipation throughout the ocean. Energy dissipation is inferred in the upper 2000 m from five of Argo profiles (2006–2011) using the Gregg-Heney-Folkins finescale parameterization. Temporally averaging estimates reveals clear spatial patterns of dissipation distributed across all the oceans. These results corroborate previous observations linking elevated dissipation levels to regions of rough topography, and produce heightened estimates in areas of high eddy kinetic energy. The continuous profiling of Argo floats produces time series exhibiting the temporal dependence of mixing, including seasonal variations correlating with fluctuations in near-inertial mixed layer energy. (Abstract ID 12312)

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A LOW-SEDIMENT-YIELD RIVER DISCHARGING INTO A HIGH-ENERGY OCEAN: THE UMPQUA RIVER DISPERSAL SYSTEM, OREGON

The Umpqua River has many characteristics of a small, mountainous river. It drains a tectonically active margin that has suffered extensive human alterations, discharge is driven by episodic, high-magnitude precipitation events, and it delivers sediment to a narrow continental shelf with an energetic wave environment. Many of these same attributes characterize northern California’s Eel River, with the important difference being that the Eel has an order of magnitude greater sediment yield that is thought to facilitate wave-supported gravity flows and creation of a well-defined shelf depo-center. Herein we provide textural, organic geochemical, and Pb-210-derived sediment accumulation rate data that is used to map a similar-sized depo-center off the Umpqua. Subtle differences in the along- and across-shelf position of the depo-center, as well as a sediment budget are discussed in light of fluvial and oceanic forcings. In addition, evidence for a recent acceleration of sediment accumulation, potentially caused by timber harvesting in the basin, is presented. (Abstract ID 11384)

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TURBULENCE-MEDIATED SETTLEMENT RESPONSES IN LARVAL OYSTER CRASSOSTREA VIRGINICA

The settlement of competent larvae to the seafloor is an important transition in the life history of the eastern oyster (Crassostrea virginica), representing a shift from the larval pelagic to adult benthic stage. Settlement is thus the final stage of larval dispersal, and understanding how oyster larvae disperse and settle in suitable habitats is important for design of marine protected areas and our expectations of how coastal anthropogenic influences will affect this commercially important species. Despite its obvious importance, the cues that induce oyster settlement are poorly understood. We hypothesize that increased turbulence levels induce a settlement (downward vertical velocity) response in competent larval oysters, as it induces the potential presence of nearby shallow benthic habitats. In this talk, we present experimental population-level swimming responses resulting from increasing turbulence levels in an oscillating-grid tank, isolated from the flow field using particle imaging velocimetry, and propose mechanisms by which larval oysters sense changing turbulence levels in a flow field. (Abstract ID 11825)

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TIME-SERIES ANALYSES OF PRIMARY PRODUCTIVITY AS A FUNCTION OF ABSORPTION, PIGMENT BASED PHYTOPLANKTON DIVERSITY AND PARTICLE SIZE DISTRIBUTIONS

Direct measurements of primary productivity at the Hawaii Ocean Time-series (HOT) Station ALOHA in the North Pacific Subtropical gyre reveal a strongly light-driven seasonal cycle of biomass normalized primary productivity (PP) punctuated by episodic surface blooms of large cell-sized organisms in summer months. These episodic and largely uncharacterized blooms lead to significant uncertainties in efforts to model PP. To improve upon the present state of satellite-based algorithms for marine productivity, many researchers have concluded that there is a need for field measurements that combine discrete measurements of phytoplankton physiology and taxonomic composition with classical bio-optics approaches as a means of testing, validating and expanding upon existing remote sensing algorithms. In collaboration with the HOT program, we have initiated time-series measurements of particle size distributions, hyperspectral absorbance and attenuation, optical measurements of particle and pigment concentrations, and CDOM profiles which are being merged with hyperspectral irradiance/radiance to generate PP models for the region. We will present results from these time-series analyses along with flow-thru bio-optical measurements and proxies for PP from a series of cruises of opportunity in the region. (Abstract ID 11484)

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GRAVITY CURRENT FRONTS IN STRATIFICATION: HYDRAULIC RESONANCE, NONLINEAR INTERNAL WAVES, AND ENERGETICS

When gravity currents propagate into ambient stratification, e.g. as river plumes into stratified shelf waters, the front exhibits a range of complex behaviors that can send energy propagating ahead in the form of bores and nonlinear internal waves (NLIWs). This energy exchange influences both frontal evolution and ambient water properties. NLIWs can transport fluid from behind the front in the form of trapped cores and contain regions of high shear that can be unstable to Kelvin-Helmholtz instabilities and lead to wave-breaking and mixing of plume and ambient water. We explore the range of dynamics using a framework from critical flow over topography. Transcritical resonance, leading to upstream undular bores and NLIWs, occurs when the frontal Froude number and thickness is such that the flow behind the front becomes critical with respect to long internal waves. Resonance is particularly strong where there is sharp near-surface stratification. We also show numerical and experimental results that demonstrate the process of NLIW generation and trapped core formation, and discuss the overall energy exchange between the waves and the front. (Abstract ID 12776)

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SHORT TERM HIGH CO2 EXPOSURE OF LARVAL BAY SCALLOPS (ARGOPECTEN IRRADIANUS) MAY SHOW LATENT EFFECTS

Marine invertebrates are particularly vulnerable to environmental stressors during larval development. Continuous exposure to decreased pH and CaCO3 saturation state, known as ocean acidification (OA), has been shown to have detrimental effects on bivalve larvae. However, bivalve larvae developing in coastal and estuarine systems likely encounter variable CO2 conditions, and their response to this variability is currently unknown. We hypothesize that exposure to elevated CO2 conditions during critical initial shell-formation (1–3 days post fertilization) of the bay scallop Argopecten irradians, followed by exposure to ambient CO2 conditions, will negatively affect the larva’s subsequent development and survival. Larvae were exposed to three treatments: 3-day exposure to elevated CO2 (2200 ppm) followed by 18 days in ambient conditions (390 ppm), 21-day exposure to elevated CO2, and 21-day exposure to ambient conditions. Initial measurements show no significant direct effects on survival during the larval stage, but experiments are continuing to determine whether negative effects on survival appear during or after metamorphosis and whether elevated CO2 exposure affects larval or juvenile growth rate. (Shell size). (Abstract ID 12189)

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BERING STRAIT THROUGHFLOW FROM A GLOBAL OCEAN MODEL

The Bering Strait (BS) is the gateway between the Pacific and Arctic oceans, exerting a critical influence on global climate and ecosystem processes. Long term mean transport is estimated to be 0.8 Sv, but often with the caveat that this number does not include occasionally or seasonally present coastal currents. Using a regional ocean configuration of the MITgcm, we extract vertical sections (6 horizontal cells, 2-5 vertical layers) that correspond to existing moorings in the BS. Direct comparison between the model and the moorings show similar seasonal. Calculations of the modelled long term mean velocity across a section including the ACC closely matches previously published data made at a single point (the A3 mooring) that
Abstract Book

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does not include the ACC. Although long term mean transport from the model is calculated as 0.85tve from A3 is not an ideal representation of BS velocity. Using modelled BS velocity, we refine estimates of mean BS transport to 1.1tve, suggesting that 33% of BS transport is excluded by omitting the ACC. Results and implications of revised heat and freshwater transport will also be discussed. (Abstract ID 10502)

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R/V SIKULIAQ: A NEW ICE-CAPABLE RESOURCE FOR THE UNOLS FLEET

The research vessel Sikuliaq is currently being constructed on behalf of the NSF to support future scientific studies in high latitude waters. The 261 foot global class vessel will be capable of breaking 2.5 foot thick ice at 2 knots with an endurance of 45 days at sea and cruising at 11 knots. The R/V Sikuliaq will have a beam of 52 feet and a draft of 18.9 feet that will carry 26 scientists and a crew of 20. The total laboratory space (main, analytical, electronics, wet, upper, and Baltic room will be 2100 square feet. The 4380 square foot working deck that is approximately 70 feet in length will accommodate 2-4 vans and multiple science operations. The science systems are prescribed to be state-of-the-art for bottom mapping, over-the-side "hands free" gear handling, broad band communications and scientific walk-in freezer and environmental chamber. The tentative shipyard schedule has a launch date of June 2012 and delivery to the University of Alaska Fairbanks in June 2013. Scientific operations following trials and testing is planned to start in early 2014. (Abstract ID 10643)

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COSEE-WEST ONLINE WORKSHOPS: HELPING SCIENTISTS BRING THEIR RESEARCH TO BROADER AUDIENCES.

Scientists can bring their research to a broader audience through online workshops. COSEE-West’s online workshops focus on bridging ocean science research and education and promoting collaborations among ocean scientists, K-12 teachers and informal educators. They provide a venue for scientists to share their research and expertise with educators, who reach an even broader audience of students and public. Educators question, give feedback, and share expertise in classroom application of science. COSEE-West has developed various online workshop models and been innovative in bringing new aspects to models while maintaining core characteristics of individual connection to scientists and their research content in real-time or near real-time. Using cutting edge science presentations, virtual field trips, undergraduate research, webcasting, and live broadcasts, we are building ways to reach out to wider and diverse audiences with a global geographic scope. Evaluation results indicate these workshop models provide tangible benefits to scientists in conducting science education outreach such as increasing understanding of science, presenting relevance of research, and assisting in policy making. Success of these online workshop models supports their use by other programs and institutions. (Abstract ID 10091)

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SILL EFFECTS ON PHYSICAL DYNAMICS IN LONG ISLAND SOUND

The Long Island Sound (LIS) is a large and wide glacially modified estuary on the U.S. east coast. The Mattituck Sill crosses the eastern LIS approximately 45 km from the mouth. The Connecticut River, the estuary’s major riverine freshwater source, enters the LIS between this sill and the mouth. This study is motivated by previous research by Valle-Levinson and Wilson. New process model runs with and without the sill bathymetry are analyzed to isolate the effects of Mattituck Sill. Results indicate internal hydraulic control exists only near slack tides for mean tidal conditions. The spatial distribution of subcritical areas is little influenced by the sill. The sill modulates the subtidal flow field both locally near the sill and in other parts of the estuary. Tidal variations and subtidal values of volume and salt fluxes are influenced by the sill. Results indicate that the sill reduces the amount of fresh water passing from the Connecticut River into the central and western LIS. (Abstract ID 11919)

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OTN: THE OVERVIEW

The Ocean Tracking Network (OTN) is a Canada Foundation for Innovation (CFI) - International Joint Ventures Fund global research and technology development project headquartered at Dalhousie University, Halifax, Nova Scotia. Starting in 2008, the OTN began deploying Canadian state-of-the-art acoustic receivers and oceanographic monitoring equipment in key ocean locations to document the movements and survival of marine animals show how both are influenced by oceanographic conditions. OTN deployments will occur in all of the world’s five oceans, and span seven continents. The Natural Sciences and Engineering Research Council of Canada (NSERC) supports OTN-Canada, a national network of researchers that works with the OTN infrastructure and the Social Sciences and Humanities Research Council of Canada (SSHRC) funds the participation of social scientists in OTN work. OTN hosts a Data Warehouse that serves as a repository for data collected by OTN researchers, and is working to develop interpretation and visualization tools for tracking data. OTN also operates a fleet of three autonomous vehicles (Slocum gliders) in support of oceanographic and tracking research. (Abstract ID 11940)

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MODELING SEDIMENT EXCHANGE BETWEEN TIDAL CHANNELS AND ADJACENT FLATS OR MARSHES UNDER VARYING TIDAL RANGES

Recent observations by coastal scientists have documented sediment fluxes and deposition rates in micro-, meso- and macro-tidal systems as water and sediment are exchanged between tidal channels and adjacent flats or marshes. Here, we use a three-dimensional, unstructured-grid, finite-volume coastal-ocean hydrodynamic model, FVCOM, to explore whether these observations can be placed into a general framework with appropriately specified conditions of sediment availability and flow resistance in the channels and flats/marshes. We begin with a simplified model of the meso-tidal flat-channel system in southern Willapa Bay and compare the resulting flow and suspended sediment concentration fields to observations obtained as part of the ONR Tidal-Flats DRI effort in Willapa Bay. Modeling of systems with smaller tidal ranges, typically characterized by tidal channel-marsh complexes, is compared with observations from marsh systems on the mid-Atlantic coast. Modeling of systems with larger tidal ranges, often characterized by high-concentration fluid mud, are compared to available data from the Bay of Fundy system. Transitions among these systems depend on thresholds for maintenance of marsh vegetation and for the development of fluid mud. We explore ways of representing the factors controlling these transitions as part of this study. (Abstract ID 12128)

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INTERCOMPARISON OF THE UNCERTAINTY IN DIURNAL WARMING ESTIMATES FROM PHYSICAL MIXED LAYER MODELS

Diurnal warming at the ocean surface is a source of significant potential uncertainty in current multi-sensor sea surface temperature (SST) products that blend observations from different effective measurement depths at different times throughout the day. The Diurnal Variability Working Group of the Group for High-Resolution Sea Surface Temperature (GHRSTT) has undertaken an evaluation of the uncertainty in several leading detailed physical models of diurnal warming. Estimates of diurnal warming through the upper 25 m of the ocean were generated from models including the General Ocean Turbulence Model (GOTM), TOGA-COARE warm layer model, Profiles of Ocean Surface Heating (POSH) model, and modified versions of the Kantha-Clayson and Schiller-Godfrey models. The models were forced with direct observations from several different sets of cruise data taken from diverse geographical regions. The corresponding predictions of diurnal warming are compared with observations both at the ocean skin and several different subsurface depths to illustrate the expected uncertainties under different environmental conditions. The associated uncertainties provide a bound on the expected contribution of diurnal warming effects to errors in present SST analyses. (Abstract ID 12017)

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CYANATE CONCENTRATIONS IN THE CHESAPEAKE BAY

Many microorganisms, including strains of the abundant marine cyanobacteria Synechococcus and Prochlorococcus have the genetic capability for cyanate uptake and metabolism. As the simplest organic nitrogen compound, cyanate may be an easily accessible source of reduced nitrogen to marine microbes. However, we currently know little about cyanate distributions in seawater and the ability of marine microbes to take up and metabolize cyanate. As a product of urea decomposition and decomposition of several cellular pathway intermediates, cyanate may be abundant in coastal areas. We hypothesized that cyanate is present at “nutrient-like” concentrations in natural waters. By modifying a method originally developed for medical analyses. (Abstract ID 11666)

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BIOGEOGRAPHIC VARIATIONS IN DELT VERTICAL MIGRATION DETERMINED FROM HIGH-FREQUENCY MULTI-FREQUENCY ACOUSTIC BACKSCATTERING IN THE NORTHWEST ATLANTIC OCEAN.
Multi-frequency active acoustic scattering techniques, which capitalize on the fact that different kinds of organisms scatter sound differently as the frequency changes, are uniquely suited to the study of zooplankton and fish distributions. Acoustic systems are particularly useful for documenting did vertical migrations (DVM). Multi-frequency measurements made with a hull mounted Hydroacoustic Technology Inc. (HTI) echosounder operating at frequencies of 43, 120, 200, and 420 kHz were made near-continuously on a 26 day cruise in the Northwest Atlantic Ocean in August 2011 as part of an inter-disciplinary project examining pteropods and ocean acidification. The distribution of scattering in relation to changing environmental quantities along the latitudinal gradient of the cruise track enabled characterization of the rates and amplitudes of diel vertical migrations and indices of pelagic animal abundance in relation to hydrographic regimes. The most pervasive acoustic phenomenon observed was a regular DVM evident along all transects. Significant variations in timing, speed, and intensity of the vertical migrations were related to the biogeography of the region and these have implications for ecosystem dynamics and carbon flux in the upper ocean. (Abstract ID 11967)

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ASSESSING THE INFLUENCE OF HEAT AND FRESHWATER ANOMALIES ON DEEP AND BOTTOM WATERS OF THE ROSS SEA
The Southern Ocean interacts with the polar atmosphere and cryosphere year-round. This active exchange of heat and freshwater over the continental margins facilitates the rapid propagation of ongoing changes in these Antarctic environments. Deep boundary currents carry these signals to the abyssal layers farther north. Documented warming and freshening of bottom waters in the Southern Ocean’s Pacific sector can be traced back to their Ross Sea origins. This study investigates the influence of potential sources of heat and freshwater anomalies on the characteristics of source water masses that are able to escape the Ross Sea as new deep and bottom waters. Contributions to the freshwater budget of the Ross Sea by sea ice formation, meltwater inputs from glaciers in the Amundsen Sea and from the Ross Ice Shelf are quantified using multiple data sources. Among them are a newly compiled time series of sea-ice thickness, a volumetric 0-50 cm of Ross Sea waters, and all available hydrographic stations. The effects of inferred changes in the mixing recipes of Ross Sea source waters on the bottom waters offshore are also investigated. (Abstract ID 9731)

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EVALUATION OF THE AMSEAS GULF OF MEXICO/CARIBBEAN REGIONAL FORECAST SYSTEM: A SURA SUPER-REGIONAL MODELING TESTBED ACTIVITY
The U.S. IOOS Program Office sponsored a one-year science and engineering activity, led by the Southeast Universities Research Association (SURA), entitled: A Super-Regional Testbed to Improve Models of Environmental Processes on the U.S. Atlantic and Gulf of Mexico Coasts. The long-term goal of this activity is to create a multi-disciplinary, community-modeling testbed that will foster and facilitate improved operational coastal ocean prediction. This presentation will focus on the operational forecast evaluation of the Naval Oceanographic Office Americas (AMSEAS) regional forecast system that encompasses the Gulf of Mexico and Caribbean region. AMSEAS, placed into operation on 25 May 2010, provided one-of-the-remote ocean forecast products utilized by NOAA’s Office of Response and Restoration during the Deep Water Horizon (DWH) oil spill. Here, we will present quantitative evaluation of AMSEAS forcing fields (COAMPS winds), during two seasonal periods, and its 3-hourly hydrodynamic forecasts from June 2010 onward. The validation data represent a comprehensive acquisition of time series from moorings, instrumented oil platforms and extensive glider and profile measurements obtained during the DWH response time frame. (Abstract ID 12727)

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MIXING AND CIRCULATION OVER A ROUGH TOPOGRAPHIC BANK
A measurement program has been conducted over the East Flower Garden Bank (EFGB) at the edge of the continental shelf off Texas, to improve our understanding of structure and dynamics of small-scale to sub-mesoscale mixing processes and their impacts on the circulation. The study focuses on processes with timescales ranging from seasonal to minutes. Year-long moored measurements of currents, temperature, salinity, and high-resolution bottom pressure in conjunction with several short-term, ship-based measurements were made in 2011 to examine both low-frequency and high-frequency variability; and mixing. Vertical profiles of dissipation rates were also collected using a microstructure profiler. To capture both lateral and vertical mixing, Fluorocin dye was released twice as a tracer at a water depth of about 30 m, and was sampled using a towed ScanFish and an autonomous vehicle. REMUS. The data have been examined to identify low-frequency variability, internal waves, bottom stress variability, mixing, and lateral spreading of water masses over the bank. Spreading of dye over the bank is presented under during two different background current flow conditions. (Abstract ID 10357)

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A COMPARISON BETWEEN TWO CO2 CONTROLLER SYSTEMS FOR DEPLOYMENT IN OCEAN ACIDIFICATION RESEARCH
Much research has recently been published concerning the impact of ocean acidification on marine calcifiers. However, detailed methods for pursuing such research are virtually unreported. Given the importance of interlaboratory experimentation and validation, two CO2 dosing systems were compared directly for performance and stability. An industrial process control system (Omega Engineering) and a hobbyist aquarium controller system (Digital Aquarium, ReefKeeper Elite) were tested extensively using a variety of time frames, pH values, probes, and aquarium tank sizes. We found specific strengths and weaknesses in both systems with significant differences between systems in cost-effectiveness, long-term stability, upgradability, and user-friendliness. We found that selection of a system would be based on scale of application, future experimental plans, and technical expertise. Nevertheless, we find both systems are suitable technology for use in ocean acidification research. (Abstract ID 11489)

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ALTERED SAN FRANCISCO ESTUARY: HOW WASTE WATER TREATMENT PRACTICES NEGATIVELY INFLUENCE THE PELAGIC FOOD WEB
San Francisco Estuary has been heavily impacted and altered by human activities including nutrient loading from waste water treatment and agriculture. Phytoplankton blooms occurred regularly in the northern Estuary but now are rare, resulting in deleterious bottom-up impacts on the food web, the “pelagic organism decline.” The northern estuary receives anthropogenic ammonium, from waste water treatment plants, that prevents access by phytoplankton to the larger pool of dissolved inorganic nitrogen, nitrate. In spring 2010, two rare diatom blooms were observed after ammonium was reduced below a threshold level; a combination of reduced waste water ammonium discharge and increased river flow (more seaward). Water flow conditions are important. Too little estuarine flow will keep ammonium high but too much will cause phytoplankton washout. Understanding the importance of different N species and the interaction of anthropogenic nutrient loading with freshwater flow or diversion will offer approaches for environmental management of this altered estuary. (Abstract ID 12812)

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PROPAGATING OCEANOGRAPHIC UNCERTAINTIES USING THE METHOD OF POLYNOMIAL CHAOS EXPANSION
The method of polynomial chaos expansions is illustrated by showing how uncertainties in boundary conditions specifying the flow from the Caribbean Sea into the Gulf of Mexico manifest as uncertainties in a model’s simulation of the Gulf’s surface elevation field. The method, which has been used for a variety of engineering applications, is explained within an oceanographic context and its advantages and disadvantages are discussed. The characterization of the spatially and temporally varying boundary uncertainties is new. (Abstract ID 11942)
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COMPARING THE SIZE, AGE AND HEALTH OF AMERICAN EELS (ANGUILLA ROSTRATA) COLLECTED FROM SOUTH CAROLINA TRIBUTARIES.

Age, growth and nematode infection were determined for American eels (Anguilla rostrata) from four South Carolina tributaries covering a wide range of salinities: Lower Pee Dee River (0 ppt); Winyah Bay (~5 ppt); Cooper River (~5 ppt); Baruch (~20 ppt). Age (otoliths) and health determinations focused on parasitization by the nematode Anguilluloides crassus using histological techniques. Age did not differ significantly between sites, whereas length did, with smaller eels at the highest salinity site (mean total length = 320.4 mm) and larger eels at the Cooper River site (mean total length = 432.1 mm). Eels from the Pee Dee River, Winyah Bay, Baruch and Cooper River had a 48.9% prevalence of adult stage of A. crassus and 53.4% prevalence of any stage of the parasite. There was no significant relationship between either eel age and total length and the likelihood of being infected by A. crassus. Adult A. crassus infection showed no significant difference between sites, however infection by any stage of A. crassus was highest at Baruch (highest salinity site) and lowest at Pee Dee River (freshwater site). (Abstract ID 10687)

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VARIABLE CONTROLS ON SUBARCTIC CORALLINE ALGAL GROWTH

The skeletons of marine crustose coralline algae yield significant records of mid-to-high latitude change. In particular, multi-century long records of variability in seawater temperature and climatic patterns can be extracted from the alga Clathromorphum. Abundant along the Aleutian archipelago and the Northwest Atlantic, Clathromorphum forms annual growth increments in its high-Mg calcite skeleton. By measuring the relative widths of each increment, the environmental factors driving Clathromorphum growth can be reconstructed over time to provide climatic information in regions that are severely deficient in instrumental data. Here, we present two regional growth-increment width records compiled from multiple specimens from the northwest Atlantic and the Aleutian archipelago. In the northwest Atlantic, growth rates track multi-decadal sea surface temperature. In contrast, light availability drives growth rates in specimens from the Aleutian archipelago where the annual range in temperatures is much smaller (6°C versus 17°C). Taken together, these records indicate that light dynamics is the primary influence on growth rates in environments with restricted temperature ranges. (Abstract ID 11419)

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WIND-DRIVEN NUTRIENT FLUXES IN SHELF SEAS

Shelf seas are highly productive regions of the ocean. During summer stratification, new production at the thermocline is maintained by diapycnal nutrient fluxes that sustain subsurface chlorophyll maxima. Diapycnal fluxes across the thermocline are driven by internal tides at the continental slope and by wind-driven inertial oscillations across the whole shelf. A sudden increase in the wind magnitude or change in wind direction may result in oscillations of the surface layer over the thermocline. Here we quantify the contribution to diapycnal nutrient fluxes caused by a storm passing over a stratified shelf sea. Observations of turbulent dissipation, ocean currents, phytoplankton, and inorganic and organic nutrients were taken on shelf before, during and after a strong wind event. Preliminary results suggest that although a wind-generated spike in turbulence may only last ~1 hour it can in fact double the daily nutrient flux into the surface. Strong storms are shown to contribute ~1.5 mmol N m⁻² d⁻¹ to a daily background flux of 1-2 mmol N m⁻² d⁻¹. The contribution of wind mixing to an annual nutrient flux will be discussed. (Abstract ID 10215)

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PELAGIC MICROBIAL HETEROTROPHY IN A HIGHLY PRODUCTIVE ANTARCTIC POLYNYA

The Amundsen Sea is thought to host the most productive (per m²) polynyas in the southern hemisphere. Its formation is also climate-sensitive. As part of the ASPIRE project (Dec-Jan 2010), our goal was to determine the influence of pelagic heterotrophic microorganisms on net community production (NCP) and atmospheric CO₂ uptake by the polynya. Despite high levels of NCPr indicated by low surface pCO₂ values, our measurements of bacterial production, respiration, and amino-acid uptake kinetics indicate that the bacteria are actively growing and respiring at sub-zero temperatures, further indicating that this net autotrophic system was clearly overwhelmed by the algal bloom. Bacterial production rates in the surface waters ranged up to 4 µg C l⁻¹ d⁻¹, with occasional subsurface peaks associated with deep chlorophyll maxima. Warming the water from in situ (~15°C) to 5°C approximately doubled the bacterial production rate, but additional warming to 10°C did not stimulate further, and rates dropped significantly at 20°C. These temperature sensitivities indicate an active psychrophilic community sensitive to future warming scenarios. (Abstract ID 12236)

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SEDIMENT DISPERSAL AND DYNAMICS OF A SMALL MOUNTAINOUS RIVER DELTA IN A MIXED CARBONATE SILICLASTIC BACK-REEF LAGOON, NORTH STANN CREEK DELTA, BELIZE

The North Stann Creek is a small mountainous river that debouches into the Mesoamerican back-reef lagoon of central Belize. During the wet season, a high sediment yield results in pulsed inputs of terrigenous siliciclastics into the primarily carbonateous mud lagoon environment. To investigate the sediment dynamics and intermixing of these systems, 22 gravity cores and 112 grab samples were obtained. The dispersal and accumulation of fine-grained sediment was evaluated using radiocarbon dating of ¹⁴C, core x-radiographs, laser diffraction particle size analyses, and determination of carbonate percentage. A dominant dispersion pattern of sediments indicating the asymmetry of the delta is evident in the distribution of fine sediments and relative increase in accumulation rates towards the south. Additionally, x-radiographs reveal an increase in bioturbation away from areas of high sediment deposition. Accumulation rates of the delta range from 0.59 cm yr⁻¹ near the mouth of the river to 0.20 cm yr⁻¹ at the distal portions, and are found to be as high as 0.52 cm yr⁻¹ in the central lagoon. These data provide insight into the depositional characteristics of the delta, and the mixing dynamics within the lagoon. (Abstract ID 9421)
ATLANTIC OCEAN

The ocean storage and transport of heat within the North Atlantic is diagnosed from 1950 to 2010 using a dynamical assimilation of historical temperature and salinity data. There is an overall warming trend, as well as reversing changes in heat storage, often with opposing responses in the subtropical and subpolar latitudes. To understand why there are these different responses, changes in ocean heat transport are diagnosed in terms of horizontal and vertical overturning cells, with the latter further separated into cells including and excluding the wind-driven Ekman flow. Each of these cells has a different temporal and spatial character: the Ekman and horizontal cells provide contributions of opposing sign between the subtropical and subpolar gyres, whereas the overturning cell without Ekman usually has the same response over the entire basin. The dominant modes of atmospheric variability in the North Atlantic correlate with each of these heat transport cells in a different manner: an increase in the North Atlantic Oscillation index is associated with enhanced heat transport by the Ekman cell over the central part of the gyres and by the horizontal cell over the subpolar gyre, while an increase in the East Atlantic index is associated with a decrease in the overturning cell at low latitudes. Hence, different modes of atmospheric variability excite different mechanisms by which heat is transported in the ocean. (Abstract ID 9474)

UPWELLING CIRCULATION ON THE CANADIAN BEAUFORT SHELF

The Canadian Beaufort Shelf (CBS) in the southeastern Beaufort Sea has a 115 km-wide, 300 km-long shelf that runs from Mackenzie Trough in the southwest to Amundsen Gulf and Cape Bathurst in the northeast. It is a shallow shelf, with a shelfbreak depth of only ~70 m, and so lies above the nutrient maximum of Pacific-origin water that lies at ~150 m depth along the continental slope in the Canada Basin. Upwelling circulation over the shelf, forced by alongshelf wind and ice-motion from Amundsen Gulf to Mackenzie Trough, will draw the denser nutrient-rich Pacific water onto the shelf both locally at Cape Bathurst and in a distributed fashion along the shelfbreak. It will transport the fresher surface water across the shelfbreak and enhance production of dense winter shelf water via ice growth and brine rejection from the flaw leads of the southeastern Beaufort Sea. We use data from a moorings deployed at Cape Bathurst and across the shelf to assess the magnitude of these effects and consider the possibility that upwelling-favourable conditions over the CBS may become more frequent with a changing arctic ice-pack. (Abstract ID 12878)

THE LEATHERBACK TURTLE IN THE SOUTH PACIFIC

Eastern Pacific populations of the critically endangered leatherback turtle (Dermochelys coriacea) have declined by over 90 percent during the past two decades. The decline is primarily attributed to unsustainable egg harvest, development on nesting beaches, and bycatch mortality. The effects of climate change may confer additional stress to leatherback populations. This study analyzes how the pelagic habitat of Eastern Pacific leatherbacks will be affected by climate change over the next century. Forty-six nesting females were fitted with satellite tags that transmit position and tag diagnostic information. Based on turtle positions, ten environmental variables were sampled along the tracks. Presence/absence habitat models were created to determine the oceanographic characteristics of preferred turtle habitat. Core habitat was characterized by relatively low SST and chlorophyll-a. We predicted habitat change based on output from the Geophysical Fluid Dynamics Laboratory climate model, under IPCC A2 scenario. We estimate that the population's core pelagic habitat will decline by up to 20 percent within the next century. This habitat loss could increase pressure on a critically endangered population, possibly forcing distributional shifts, behavioral changes, or even extinction. (Abstract ID 11778)

CHLOROPHYLL ANOMALIES ALONG THE 30°N CRITICAL LATITUDE IN THE NE PACIFIC

The dissipation of surface tidal energy into internal tides plays a critical role in ocean mixing. However, quantifying the spatial distribution of this energy flux, which is required for ocean and climate modeling, has been largely based on modeling efforts and there is a need for validating observations. The summer development of large blooms of chlorophyll along 30°N in the Pacific is presented as evidence of enhanced tidal mixing. The region near 30°N is a “double” critical latitude, with a transformation of internal waves occurring at both diurnal and semidiurnal frequencies. The breakdown at the critical latitude of internal waves generated at Hawaii could provide the physical mechanism to explain these blooms. The blooms develop in a region characterized by a weak summer surface stratification, which is therefore more susceptible to mixing. (Abstract ID 10020)

SURF ZONE DATA ASSIMILATION AND BATHYMETRIC INVERSION FROM VIDEO REMOTE SENSING

We present a remote sensing, modeling, and data assimilative study of rip current circulation at Duck, N.C. The observational data consists of estimates of the alongshore drift velocity of foam on the sea surface (a proxy for alongshore current) obtained in September 2010 from the Argus video remote sensing platform, and analyzed using the method of Chickadel et al. (2003). We also utilize Argus-based estimates of wave phase speed. These data are assimilated in a numerical model for nearshore circulation, using an ensemble-based least-squares data assimilation method. When assimilating data, we assume the dominant source of model error is due to incorrect model bathymetry: detailed bathymetric survey data is available in this case, but is held back for cross-validation of the method. In this way, we assess the utility of the remote sensing data for surf zone bathymetric estimation. Practical aspects of this problem are addressed, regarding the data assimilation methodology itself, the potential for bias due to neglected errors in model physics, and the influence of nonlinearity. (Abstract ID 11493)
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TIME-SERIES METHANE MONITORING IN GASSY SEDIMENTS AND THE BENTHIC BOUNDARY LAYER
Quantifying temporal variability in methane release from gassy sediments is critical to determination of its sources and sinks. In the deep sea, where the largest reservoir of methane is gas hydrates, the dynamic nature of factors controlling methane release (solubility, tides, storms, tectonics) and the high costs of ship, submersible, ROV and cruise technologies have forced development of innovative dissolved gas sampling technologies. We used two novel experimental approaches to collect continuous pore-water gas samples plus in situ measurements of relevant physical and chemical parameters. Pore-water samples were collected with a Pore-Fluid Array (PFA) outfitted with OsmaSampler pumps that utilized osmotic pressure differential to pull fluids slowly through filter ports into 300 meter-long copper tubing coils. Two 9-month records of methane concentrations and stable carbon isotopes were obtained from bottom- and pore-water samples. Continuous bottom-water measurements were made for 21 days with a Churney Sampler Array (CSA) which is designed for both long-term (months) bottom water monitoring and for in situ flux measurements. The CSA measured dissolved methane and oxygen, plus pressure, turbidity, conductivity, temperature, current velocity and direction. (Abstract ID 11978)

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MOORED OPTICAL ATTENUATION MEASUREMENTS IN THE CALIFORNIA CURRENT SYSTEM
Understanding primary production is essential in a physically and biologically dynamic system such as the California Current System (CCS). While satellites give high spatial coverage in the horizontal, they are limited by their penetration depth and provide only intermittent sampling due to cloud cover and orbit period. Multidisciplinary mooring deployments in the CCS off Pt. Conception started in November, 2008; at present, two highly collaborative moorings CCE1 and CCE2 are being operated there in the open-ocean and upwelling regime, respectively. With seven-wavelength radiometers at the surface and depth (30 meters before and 40 meters after CCE2), optical attenuation is measured in situ, along with rad–depth Chi-A fluorosence. Linear methods provide a technique for taking out the attenuation due to chlorophyll, yellow matter, and sea water, arriving at a time series of chlorophyll concentrations. (Abstract ID 12540)

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A NEW THEORY FOR SLOW DYNAMICS IN THE PRESENCE OF STRONG ROTATION AND WEAK STRATIFICATION
Motivated by gaining fundamental understanding of ocean dynamics at high latitudes my collaborators and I have derived a new theory, based on the method of multiple scales presented in Embid and Majda (1996,1998) that address the scale separation between slow- and fast-time dynamics in the limit of fast rotation and weak stratification. The slow dynamics describes a regime we call Taylor-Proudman flows. These flows are characterized by a new type of dynamics that couples vertical kinetic energy with potential energy (buoyancy) and allow for the creation of deep columnar vortices. We show numerical simulations that support the theory as well as observations that show deep columnar vortices measured during the Beaufort Gyre Exploration Program. These new dynamics are nonhydrostatic and suggest the vertical velocity can play a role in the large scale dynamics of the ocean when the stratification is weak. (Abstract ID 10904)

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PHYLOGEOGRAPHY AND POPULATION MITOGENOMICS OF THE GIANT SQUID ARCHITECTIS DUX
Few phylogeographic studies have addressed dispersal of deep-sea species due to the logistical difficulties in obtaining samples or conducting tagging or mark-recapture studies. The giant squid, Architeuthis dux, is an excellent example of an organism that is difficult to study using conventional methods, due to their natural habitat deep in the oceans. The genus has a global distribution, yet little is known about dispersal patterns and it is not clear how many populations exist, or even how many species/subspecies there are. We have generated mitogenome data from 38 individuals providing first insights into questions including how many species there are, and their phylogeographic structure. The data suggest that there is only one species of giant squid, and that individuals are highly vagile, possibly dispersing through a drifting larval stage. Demographic history analyses indicate a recent population expansion higher level consumers. In recent years, extensive retreat of seasonal sea ice of the Chukchi shelf have led to massive walrus haul-outs on Chukchi beaches in Russia and Alaska. The need to fully assess the impacts of foraging from shore instead of from offshore sea ice led to the current study, which will help constrain walrus food supply with energetic requirements. The goals of this study were to conduct a spatially-relevant caloric analysis of the walrus prey field in the Chukchi Sea, compare new values to historical energy values, and generalize conversion factors between dry weight and caloric content for dominant formalin preserved taxa. Current caloric values suggest a visible but non-significant trend of increasing energy density in macroinvertebrates from nearshore to offshore. Current energy densities are also significantly higher than historical values, which may be due to the influence of sampling season, algal blooms associated with sea ice decline, or advances in instrumentation. (Abstract ID 12238)

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PRODUCTION OF DISSOLVED ORGANIC MATTER BY THE DIATOM CHAETOCEROS SOCIALIS UNDER SILICATE AND NITRATE STRESS
We investigated the effect of nutrient stress (silicic acid, nitrate or both silicic acid and nitrate) on dissolved organic matter (DOM) release by diatoms in a batch culture experiment of a non-axenic strain of the cosmopolitan species, Chaetoceros socialis. Dissolved organic carbon (DOC) accumulated following nutrient depletion in all treatments, but on different timescales. Upon both Si depletion and simultaneous Si & N depletion, cell division ceased and DOC accumulation began immediately; however, upon N depletion, cell division continued for 2-3 more days, delaying net DOC accumulation. Similarly, the peak in extracellular DOC release (ER) by N stressed cells was also delayed two and three days, respectively, from ER peaks in Si & Si & N stressed cells. When normalized to diatom cell number, transparent exopolymer (TEP) accumulation and DOC accumulation was approximately two and three fold greater, respectively, under Si & N stress relative to the N stress treatment. Bacterial production, however, reached its maximum on the day that each limiting nutrient(s) became depleted, suggesting the release of highly labile DOM upon nutrient depletion in all treatments. (Abstract ID 11880)
or selective sweep, potentially explaining the low genetic diversity. This study demonstrates that such studies can be conducted on deep-sea species despite the logistical challenges imposed by this habitat. (Abstract ID 10219)

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NEW PLIOCENE ISOPODE SCLEROCHRONOLOGY DATA FROM THE US MID ATLANTIC COASTAL PLAIN

Though previous studies have provided constraints on regional sea-surface temperatures (SST), Pliocene temperature data from the US Atlantic coastal plain is insufficient for a detailed understanding of how the epoch's global-scale climatic shifts manifested themselves regionally. Specifically lacking are data with sub-annual resolution spanning multiple years. To resolve this, we present stable isotope sclerochronology analyses of 12 fossil Mercenaria (bivalve) shells. These analyses test the hypotheses that: (1) shells from the Mid Pliocene Warm Period (Yorktown Formation, VA) recorded higher SST and decreased seasonality relative to today; and (2) shells from the subsequent Late Pliocene cooling interval (Chowan River Formation, NC) recorded lower SST and increased seasonality relative to present conditions. Calculated temperatures from Yorktown shells are on average warmer with lower amplitudes than those produced from Chowan River shells. These findings are also consistent with other proxy data, including growth rate estimations of fossil Mercenaria populations. On a broader scale, our results give insights into how global-scale climate change specifically affected the US Mid Atlantic Coastal Plain. (Abstract ID 9443)

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AUV GLIDER AND HF RADAR OBSERVATIONS OF CIRCULATION AND STRATIFICATION FEATURES IN THE CHUKCHI SEA

We present unique high-resolution time-dependent observations of circulation and stratification features in the Chukchi Sea from AUV gliders and HF radars. The observations highlight a complex flow field and concurrent stratification changes that influences both the physical, biological and chemical structure of the ocean on different time and space scales. Wind and buoyancy forcing drives strong nearshore flow, which together with topographic steering creates confluence, divergence and eddies in the flow field. Stratifcation changes are large and are associated with both flow field anomalies and storm events. These observations show a more complex, dynamic and high-energy ocean environment than previously reported in this area. (Abstract ID 10861)

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BOUNDARY EFFECTS OF OXYGEN MINIMUM ZONE EXPANSION ON ZOOPLANKTON IN THE EASTERN TROPICAL NORTH PACIFIC

Oxygen minimum zones (OMZs) may be expanding as global climate changes. A spatial comparison between two stations (Tehuantepec, BCS; Costa Rica Dore) with different OMZ thicknesses in the Eastern Tropical North Pacific served as a proxy for temporal change to show how variability in oxygen depth may have broad consequences for distributions and ecosystems. Day and night vertically-stratified zooplankton to 1000m was collected with a MOCNESS during two cruises. Similar biomass features were present at both locations but responded differently to changes in OMZ thickness. Peak biomass occurred at the thermocline. At the Lower Oxycline, a secondary biomass peak occurred. This layer, locked into position by oxygen concentration, changed depth by over 200m between locations. In contrast, another secondary biomass peak at the daytime depth of diel vertical migration occurred at a constant depth at both locations, despite different oxygen levels. The vertical re-orientation of biomass layers, and the increased depth of low oxygen water that diel vertical migrators and sinking particles must transit in an expanded OMZ, could have widespread effects. (Abstract ID 9882)

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DEFINING MARINE FUNGI: CULTIVATION TESTS OF FUNGI ALONG A SALINITY GRADIENT OF THE DELAWARE BAY

Fungi can be found in any marine or aquatic habitat and have a range of functions from decomposer to pathogen. The separation of marine fungal species from terrestrial species assists in the ability to assess the potential roles of fungi in the marine environment. In order to further investigate the properties that set marine and aquatic fungi apart from terrestrial species, water and sediment samples were taken from differing salinity zones in the Delaware Bay. We characterized the fungal species present in the Delaware Bay and marsh areas using cultivation, microscopic, and genetic analyses. The results of this study were threefold: 1) both marine and terrestrial fungal exhibit a varied response to differing salinity levels in their growth media, indicating that marine species cannot be ‘picked out’ based on growth in salinity alone, 2) fungi are present in sediments, but their role in the sediments remains to be seen, and 3) there are more fungal species to discover in the waters of the Delaware Bay. (Abstract ID 10106)

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THE ADIABATIC POLE-TO-POLE OVERTURNING CIRCULATION

The adiabatic pole-to-pole cell of the residual overturning circulation (ROC) in the Atlantic is studied in a two-hemisphere, semi-enclosed basin, with a zonally-reentrant channel occupying the southernmost eighth of the domain. Three different models of increasing complexity are used: a simple, analytically-ttractable zonally-averaged model, a coarse-resolution numerical model with parameterized eddies, and an eddy-resolving general circulation model. Two elements are found to be necessary for the existence of an adiabatic pole-to-pole cell: 1) a thermally-indirect, wind-driven overturning circulation in the zonally-reentrant channel, analogous to the Deacon cell in the Antarctic circumpolar Current (ACC) region, and 2) a set of outcropping isopycnals shared between the channel and the semi-enclosed region of the Northern Hemisphere. These points are supported by several computations varying the domain geometry, the surface buoyancy distribution and the wind-forcing. All three models give results which are qualitatively very similar, indicating that the two requirements above are general and robust. All three models illustrate how the geometry of the isopycnals is shaped by the interhemispheric ROC, leading to three major thermostads, which we identify with the major water masses of the Atlantic. The models also illustrate how changes in buoyancy fluxes and winds in the high latitudes of both hemispheres can accelerate or decelerate the ROC. (Abstract ID 10261)

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MULTIDECADAL OSCILLATIONS AND MULTIPLE EQUILIBRIA IN THE ADIABATIC REGIME

In the limit of small diapycnal diffusivity, the deep meridional overturning circulation (MOC) is dominated by an adiabatic pole-to-pole cell with downwelling in the North Atlantic (NA) and wind-driven upwelling in the Southern Ocean (SO). Wolfe and Cessi (2011) have shown that two elements are necessary for the existence of an adiabatic pole-to-pole cell: a thermally-indirect overturning circulation driven by westerlies in the SO, and a set of buoyancy values which are shared between the SO and the NA. Under these conditions, the the size of buoyancy window shared between the SO and the NA—and thus the strength of the MOC—is maintained by a salt-advection feedback that tends to return the system to its original state after a freshwater perturbation. However, if the freshwater is sufficiently large and persistent to destroy the window completely, the MOC will shut down and the salt-advection feedback will no longer operate. The MOC may remain in its ‘off’ state even the forcing perturbation is removed. The possibility of such multiple equilibria is investigated using a GCM in an idealized domain supporting a pole-to-pole overturning cell. At low diffusivity, self-sustained multidiscadal oscillations are observed with amplitudes which increase as the critical freshwater forcing for MOC shutdown is approached. These oscillations mediate the transition between MOC ‘on’ and ‘off’ states and destroy the multiple equilibria observed at higher diffusivities. (Abstract ID 12371)

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A BIOMARKER PERSPECTIVE ON COCCOLITHOPHORID PRODUCTION AND EXPORT IN A STRATIFIED SEA

Understanding the behavior of cocolithophorids, the ocean’s dominant calcifiers, in stratified settings is crucial for predicting what role they play in the marine carbon cycle as the surface ocean warms. Research into their preferred growth conditions has traditionally focused on bloom succession at open ocean sites (such as the North Atlantic), leading to the paradigm that they ‘prefer’ low nutrient conditions. Recent studies, however, have yielded conflicting predictions on how shauling mixed layers in the mid- to high-latitude ocean will alter cocolithophorid production. Cruises to the Gulf of California and adjacent Eastern Tropical North Pacific from 2004-2008 have provided a data set on non-bloom cocolithophorid abundance and production in nutrient depleted waters across a range of surface temperatures.
and degrees of stratification. Using lipid biomarkers, it was found that these organisms routinely exhibit peak standing stocks and production rates in subsurface chlorophyll features near the nitraline, as opposed to the N-depleted surface. There is evidence, however, to suggest that they still enjoy a competitive advantage in settings where nutrients are furthest removed from the surface. Though coccolithophorid export scales with production in these settings, the export efficiency of bulk organic carbon varies enough to erasure potential trends in the relative importance of coccolithophorid export, e.g. alkaline/POC ratios or, presumably, PIC/POC ratios. (Abstract ID 9792)

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PROVOR 505

The traditional method for deploying microstructure sensors for oceanic turbulence measurements is from ship-borne vertical profilers. Since ship operations are costly and provide only limited spatial coverage, we have developed a turbulence measurement system based on an autonomous profiling float that will enable us to conduct autonomous, continuous profiling measurements for several weeks. Our prototype system consists of a PROVOR profiling float and a MicroRider turbulence instrument, carrying two velocity shear probes and two fast-response thermistors. The MicroRiders is a self-contained instrument that is routinely deployed on ocean gliders. We tested the prototype profiling system in a 10-m deep tank and conducted a series of dives to assess the performance of the turbulence sensors under controlled conditions. Of particular interest is the amount of signal contamination of the shear probe data due to vibrations of the profiling float. We present spectral analysis of the shear probe and thermistor data and evaluate them against data sets obtained from glider deployments. We draw conclusions about the usefulness of this measurement system for global turbulence observation. (Abstract ID 11840)

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PARTICLE FALL VELOCITY IN IN-STREAM EMERGENT VEGETATION

In sediment transport analysis for engineering design, particle fall velocity is typically estimated by Stokes’ Law or guidelines derived from empirical observations. Stokes’ Law is not necessarily valid in creeks and wetlands, due to turbulence in the flow and also in-stream vegetation. Vegetation is a specific focus of this work. This study is to quantify how in-stream emergent vegetation affects sediment fall velocity. We do so by tracking individual particles. We set up a re-circulating flume, filled with irregularly shaped polystyrene particles serving as a model of sediment, and use Particle Image Velocimetry (PIV) to simultaneously measure flow field and particle velocities. In this experiment we measured three flow scenarios: (1) Particles free falling in still water; (2) Particles in open-channel flow (in a flume); (3) Particles in open-channel flow through an array of Fluorinated Ethylene Propylene (FEP) tubes which serve as a surrogate of in-stream emergent vegetation. This study provided laboratory scale observations on how vegetation affects fall velocity. We will use the result to evaluate how vegetation management in creeks and wetlands can alter sediment trap efficiency. (Abstract ID 12725)

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THE SALT INTRUSION AND ITS RESPONSE TO RIVER DISCHARGE IN FUNNEL-SHAPED HAN RIVER ESTUARY, SOUTH KOREA

Salt intrusion in estuaries and tidal river is important for oceanography, water-quality, ecological, and engineering reasons. Variance in the limit of salt to upstream depends on a number of factors, including freshwater discharge, tidal and wind mixing, estuarine circulation, and geomorphological effect. In this paper, an analytical solution is presented for the salt intrusion in a well mixed, funnel-shaped estuary in which longitudinal mixing coefficient is calculated from long-term salinity at 2 surface stations. The solution is verified against observations at 9 stations over 13 year period obtained from NFRDI. The correlation between freshwater inflow and length of salt water intrusion is good fitting line with R2=0.92. The length of salt intrusion is changed 74–101 km from estuary mouth by discharge rate of freshwater. The solution offers a useful tool for predicting the relationships between salinity and river discharge. (Abstract ID 10966)

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OPTICAL CHARACTERISTICS OF CHROMOPHORIC DISSOLVED ORGANIC MATTER ASSOCIATED WITH SEA ICE IN THE CHURCHI AND BEAUFORT SEAS

The optical properties of chromophoric dissolved organic matter (CDOM) have been shown to correspond with the quality and quantity of dissolved organic matter. Here we analyze the optical characteristics of CDOM from the under-ice water column, ice cores and surface melt ponds in the Chukchi and Beaufort Seas during the melt season in 2010 and 2011 as part of NASA’s ICESCAPE mission. Based on absorbance values between 200 and 800 nm, the under-ice water column had the highest concentrations of CDOM, suggesting that sea ice may not be a source of CDOM but rather dilutes the under-ice water column CDOM upon sea ice melt. In addition, under-ice water column samples from three sites in 2011 had optical characteristics that indicated higher concentrations of CDOM and higher molecular weight material which may be associated with the significant under-ice phytoplankton bloom that was observed at these stations. Multiple samples from ice cores and the upper under-ice water column also showed evidence of aromatic and mycosporine-like amino acids suggesting that these signals may be associated with sea ice and sea ice melt. (Abstract ID 12536)

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A GIS ANALYSIS OF THE CHINCOTEGUE INLET EDDY AND ITS IMPACT ON THE SHORELINE MORPHOLOGY OF NORTHERN WALLOPS ISLAND, EASTERN SHORE VIRGINIA

Longshore currents along the Delmarva Peninsula run predominantly south-westward toward the mouth of the Chesapeake Bay. Due to local barrier island architecture and vigorous tidal flows at barrier island inlets, i.e. between Assateague and Wallops Islands, longshore currents can be disrupted or displaced offshore by eddy currents, resulting in locally-reversed longshore currents. In the case of Wallops Island, the eddy’s clockwise rotation and associated ebb tidal delta have significantly impacted sediment distribution and wave refraction patterns since the 1930’s. This has produced a progradational pattern of successive beach faces that stack seaward some 1.14 kilometers, to the detriment of beaches to the south. This study focuses on an evaluation of shoreline change both seasonally and annually on the north end of Wallops Island. Using field surveys and a GIS, the goal is to assess sediment transport rates both onshore and alongshore since the 1930s. These data will be used to predict future sediment transport and erosional patterns in the vicinity of north Wallops to support the development of a shoreline management plan for the NASA Wallops Flight Facility. (Abstract ID 11211)

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TIDAL CONTROLS ON THE TRAPPING OF HURRICANE IRENE SEDIMENTS IN THE LOWER CONNECTICUT RIVER

It has been 24 years since the Connecticut River has reached flood levels similar to heights observed recently following Hurricane Irene, and not since 1955 has the river experienced greater flooding in the fall by a tropical cyclone. Given their rarity, it remains unclear how important these extreme events are in trapping sediment within low gradient river/estuarine systems. Here we present results from a rapid response study that documents resultant sedimentation from Hurricane Irene along the tidal reach of the Connecticut River. The study is focused to coves and other off-river waterbodies adjacent to the main channel, where trapping is typically enhanced towards the mouth due to the flood-dominated asymmetry in fine-grained sediment flux via tidal channels connected to the main river. Fresh water flooding by Irene was preceded by a prolonged period of low precipitation, with conditions optimal for high sediment loads in the main channel. Tides were still persistent towards the mouth of the river during the event, presenting near-ideal conditions for fine-grained sediment trapping at backwater sites along the lowest portion of the river’s tidal reach. (Abstract ID 9597)

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PROJECT THE CONSEQUENCES OF CLIMATE CHANGE ON FISH ABUNDANCE AND FISHERIES IN THE NORTH PACIFIC

Output from an earth system model is paired with a size-based production model to investigate the effects of climate change on the abundance of large fish over the 21st century. The earth system model, forced by IPCC Special Report on Emission Scenario A2, combines a coupled climate model with a biogeochemical model including major nutrients, three phytoplankton classes, and zooplankton grazing. The size-based production model includes linkages between two overlapping size-structured pelagic communities: primary producers and consumers. We investigate how changes in sea surface temperature and phytoplankton abundance and size composition propagate up the marine food web to influence abundance at high trophic levels. Our investigation focuses on eight sites in the Pacific, each highlighting a specific aspect of forecast climate change, and includes ecosystem exploitation through fishing. In the earth system model changes in the proportion of large phytoplankton are generally much greater than changes in total phytoplankton biomass or sea surface temperature. We see this effect magnified through the food web as changes in biomass of large fish are greater than changes in the proportion of large phytoplankton. (Abstract ID 10679)

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EXPLORING AN UNDER-ICE OCEAN CAVITY WITH SOUND

Sensible predictions of the future rise in sea level require an understanding of the melting processes underneath the floating ice sheets of Antarctica and Greenland. Acoustic transmissions into the ocean caverns underlying the ice sheets could provide time series of average temperatures and currents to augment intermittent point measurements by instruments lowered through the ice and carried on autonomous underwater vehicles. The wedge of diminishing height formed between the underside of the ice and the seaward sloping seafloor horizontally refraacts sound toward deep water, allowing sources and receivers located seaward of the ice edge to probe the ocean cavern beneath the ice. Incoming rays come to a coastal turning point near the grounding line of the ice sheet before returning seaward. Alternatively, sources and receivers lowered through holes in the ice could form a long-term tomographic array to image the temperature and current fields in the ocean cavern. Little is known about the acoustic characteristics of the underices of the ice sheets, however. A pilot study is essential to assess the feasibility of the approach. (Abstract ID 12398)

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OCEANOGRAPHY IN 2030: THE ROLE OF ACOUSTICS IN OBSERVING THE OCEAN

Since the end of the Cold War, society has not had an easy metric to decide how much funding to provide basic research in oceanography. Institutional arrangements that were developed during the Cold War are therefore unlikely to continue unchanged. Further, new observational tools — including satellite altimetry, profiling floats and gliders, and acoustic remote sensing — combined with the development of ever more realistic ocean modeling and data assimilation capabilities, have revolutionized our ability to observe the ocean. These developments have resulted in a shift toward the paradigm of meteorology, with development of operational observing systems that are distinct from research systems. These operational systems will evolve over time as the effectiveness and costs of various ocean measurement technologies become clearer. Acoustic systems have not yet been widely applied in ocean observing systems, even though they have capabilities that are difficult to obtain using other technologies. In our view, the wider application of acoustic methods will ultimately be inevitable, as it is inconceivable to us that oceanographers should not take advantage of the fact that the ocean is transparent to sound. (Abstract ID 12632)

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IMPACT OF TOPOGRAPHY ON THE PROPAGATION AND VERTICAL STRUCTURE OF LONG ROSSBY WAVES

Observed waves/eddies appear to follow a roughly nondispersive dispersion curve with phase speeds up to twice the standard prediction for long Rossby waves. While some of the features once described as anomalously fast Rossby waves may be coherent vortices, larger scale (>1000 km) features are yet to be fully explained. Since existing observations are insufficient to explore...
the vertical structure of Rossby waves, we examine output from the ECCO2 numerical model, which has a sea surface height spectrum largely consistent with the altimetric observations. When the vertical structure of horizontal velocity is decomposed into barotropic and first baroclinic modes, these modes are coupled such that surface currents are enhanced and deep currents diminished. This coupling is increased over rough topography, suggesting a role for topography in controlling Rossby wave propagation and vertical structure. We present predicted phase speeds and vertical structures for long Rossby waves based upon a modified theory by Bobrovich and Reznik (1999) for waves over rough topography. Global results with realistic topography and stratification agree with observed phase speeds and the vertical structure seen in models. Small scale topography appears to play a crucial role in long Rossby wave dynamics. (Abstract ID 11470)

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MEASUREMENTS OF SAND TRANSPORT OFFSHORE OF A RENOURISHED BEACH, MYRTLE BEACH, SOUTH CAROLINA
The purpose of this study was to determine the synoptic variability of sediment transport and the relative contribution of frequent meterological events in relation to more intense storm systems that impact the coast of Myrtle Beach, SC. Long-term hydrodynamic, sediment concentration, and seabed altimetry data were collected on the inner-shelf using two instrumented frames deployed from July 2008–December 2009. Using our classification system, 13 non-tropical and four tropical events were identified. Six were classified as dominant high systems, five were classified as cold fronts, two events resulted from a stationary front, and one event was classified as a coastal low pressure system. Wind speeds ranged 7–15 m/s, near-bottom wave velocities ranged from 20–40 m/s and currents from 5–15 cm/s. Transportation was predominantly directed in the along-shelf direction, as cold fronts transformed and sediment northeastward and DH events transported sediment southwestward. The frequency of the meteorological events resulting in sediment transport was 2–14 days during the autumn, winter, and spring. Transport during the summer months was typically due to tropical cyclone events. The results indicate that the sediment dynamics at the site is dominated by frontal passages, dominant high pressure systems, and tropical storms, and during a given year with no direct impacts from tropical cyclones the net direction of transport will depend on the relative frequency of these events. (Abstract ID 9879)

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THERMAL FRONTS OFF NORTHERN TAIWAN
A high-resolution SST data derived from several satellites is used to investigate the variability of the thermal front off northern Taiwan. Hidden by a dominant annual cycle, the SST data cannot reveal the thermal front fluctuation in the form of Hovmöller diagram. An innovative methodology has been applied to derive the SST Standardized Index (SSTSI), capable of revealing the frontal variability with multiple time scales. Principal component analysis shows the SSTSI variation consists mainly of two modes. Mode 1 represents a strong annual cycle related to the seasonal reversal of the monsoonal winds. The temperature gradient is enhanced in winter and a cold dome is observed off northern Taiwan in summer. Mode 2 is highly correlated with the upstream Kuroshio variability. The shoreward (seaward) migration of the thermal front takes place when the Kuroshio transport weakens (strengthens). Mode 2 is coherent with the Kuroshio transport through the East Taiwan Channel at periods of 120 and 45 days with a time lag of 40 and 11 days, respectively. This 120-day fluctuation is due to the interaction between westward-propagating eddies and the Kuroshio east of Taiwan, while the 45-day signal arises from the Kuroshio’s self-instability. The interannual variations of the SST pattern in winter and summer are also discussed. (Abstract ID 9851)

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ROLE OF HIGH FREQUENCY WAVES ON BED EROSION IN THE SHEBOYGAN ESTUARY, WISCONSIN
Water level fluctuations up to 40 cm with periods of 15 – 30 minutes after storm events were observed in the Sheboygan River Estuary, Wisconsin. Fluctuations are amplified inside the harbor and bottom oscillatory velocities near the bed are therefore increased. Temperature stratification caused by intrusion of cold water in Lake Michigan is found to affect near bed velocities created by the high frequency water level fluctuations. We calculate bottom shear stresses from the velocity records during river base flow and flood conditions. It is found that the magnitude of shear stresses induced by high frequency fluctuations is equivalent to those caused by 5-year flood events. Amplitudes of high frequency fluctuations increase for larger flood events, suggesting that bed shear stresses can be further amplified to cause severe erosion of contaminated sediments on the site. Results of this study will serve to aid the assessment of ecosystems related to sediment transport in the estuaries of the Great Lakes. (Abstract ID 12314)

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THE VARIATION OF SEDIMENT RATE IN THE LAN-YANG PLAIN AND ADJACENT CONTINENTAL SHELF
The Lan-Yang Plain, along the northeastern Taiwan orogen, provides an excellent example of the tectonic and climatic controls on erosion and subsequent riverine sediment supply to the coastal ocean and deep sea. 12 deep borings on the Lan-Yang Plain and 3 long cores in the adjacent offshore I-Lan Sea Valley (MD12480, MD12483, ODP1202), together with preliminary chirp seismic data, provide a 30-ka record of the depositional history, both on land and in the deep sea. Total post-LGM sediment thickness throughout the study area reaches 150-200 m on land and in the coastal areas and 30-100 m in the I-Lan Sea Valley. On-land bore-hole data indicate that the post-LGM depositional environment fluctuated between marine and terrestrial in response to sea-level rise. Based on more than 130 radiocarbon dates, we find particularly high accumulation rates between 9 and 11 ka BP, perhaps in response to intensification of the southwest monsoon monsoon southern China. Another apparent period of high sediment accumulation, 5 to 7 ka BP may reflect the intensification of ENSO. And high terrestrial sedimentation rates after 2 ka BP presumably have resulted from human-related activities (forestation, agriculture, urbanization) that have intensified landscape erosion. (Abstract ID 12236)

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TIDAL MODULATION ON THE CHANGJIANG RIVER PLUME IN SUMMER
Tidal effects on the structure of the near-field Changjiang River Plume and on the extension of the far-field plume have often been neglected in analysis and numerical simulations, which is the focus of this study. Numerical experiments highlighted the crucial role of the tidal forcing in modulating the Changjiang River plume. Without the tidal forcing, the plume results in an unrealistic upstream extension along the coast. With the tidal forcing, the vertical mixing increases, resulting in a strong horizontal salinity gradient at the northern side of the Changjiang River mouth, which acts as a dynamic barrier and restricts the upstreamward plume migration. Furthermore, the tidal forcing produces a bi-directional plume structure in the near field, with one to the northeast and the other to the south. Such a bifurcated structure is related to the sub-tidal sea surface local high and the tidal rectification. Moreover, the plume varies significantly during a spring-neap cycle, with the diluted water extending more offshore during the neap tide while less offshore and being detached during the spring tide. (Abstract ID 9494)

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COUPLED OCEAN-ATMOSPHERE RESPONSES TO RECENT FRESHWATER FLUX CHANGES OVER THE KUROSHIO-OYASHIO EXTENSION REGION
Observations have indicated a trend of freshwater loss in the global western boundary current extension regions over recent several decades. In this paper, coupled ocean-atmosphere response to the observed freshwater flux trend (defined as Evaporation minus Precipitation, EmP) over the Kuroshio-Oyashio Extension (KOE) region is studied in a series of coupled model experiments. The model explicitly demonstrates that the positive EmP forcing in the KOE region can set up a cyclonic gyre straddling the subtropical and the subpolar gyre, which induces anomalous southward cold advection in the west and northward warm advection in the interior. This leads to a formation of temperature dipole in the midlatitudes with a cooling in the west and a warming in the east. With the positive EmP forcing in the KOE, the response of the extratropical atmospheric circulation in the North Pacific sector is characterized by an equivalent barotropic low originating primarily from the western tropical Pacific changes and countered by the extratropical SST forcing. The positive EmP forcing also strengthens the tropical zonal SST gradient and thus ENSO through several competing processes including surface coupled wind-evaporative-SST (WES) mechanism, subduction of extratropical warm anomalies, and a spin-up of the density-driven meridional overturning circulation. Applications to recent Pacific climate changes are discussed. (Abstract ID 12769)

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TOS/AGU/ASLO Abstract Book
ARSENIC BIOGEOCHEMISTRY IN THE NORTH ATLANTIC OCEAN: RELATIONSHIP TO PHOSPHATE STRESS

Arsenic and phosphorus are biochemically very similar, and hence arsenate (AsV) is toxic during P limitation. However, many pyrophosphatase detoxify As by reducing arsenate to arsenite (AsIII), and/or methylating it to mono (MMAs) and dimethyl As (DMAs). Such detoxification becomes operative in oligotrophic waters when nanomolar phosphate concentrations are below those for As. During the US GEOTRACES North Atlantic transect, we evaluated the potential use of these detoxification products as indicators of P stress by measuring As speciation in meso- to oligotrophic surface waters. We found a significant correlation between As(III) concentration and alkaline phosphatase activity, the conventional approach for assessing P stress. Such correlations were less evident with methylated As species, but they still may be good proxies for P stress over longer periods. We measured the degradation rates of As species through photochemical oxidation and demethylamidation experiments. A lifetime for As(III) of days is promising for its use as a proxy for P stress; an advantage over alkaline phosphatase activity. Overall, the proposed indicators for time-integrated P stress/limitation have the potential to be an important tool for future biogeochemical studies. (Abstract ID 10425)

LEVEL ECOSYSTEM ON THE NORTHEAST U.S. CONTINENTAL SHELF

This study is an effort to address the question: how many pytoplankton (P) and zooplankton (Z) compartments should be included in lower trophic ecosystem models in order to fully characterize coastal carbon cycles? Five ecosystem model variants are implemented in a 1D assimilative (variational adjoint) model tested at six sites along the northeastern U.S. continental shelf. The five models resemble one another except for variations in the level of complexity, which range from a simple 1P1Z food web to a considerably more complex 3P2Z food web. The experiments of assimilating satellite-derived chlorophyll and particulate organic carbon (POC) data indicated that one sole variable (chlorophyll or POC) could not constrain the model well enough, and therefore both data should be assimilated. When assimilating these data, simple models showed similar model-data mismatch as the more complex models at individual sites, but the more complex models had greater model skill when fitting multiple sites simultaneously. These preliminary results suggest that incorporating multiple phytoplankton groups will be required to accurately simulate the ecosystem in a large-scale region such as the U.S. eastern continental shelf. (Abstract ID 11905)

GENERATION AND PROPAGATION OF INTERNAL TIDES AND SOLITARY WAVES IN THE SHELF EDGE OF THE BAY OF BISCAY

The shelf edge of the Bay of Biscay is a region where one of the world’s strongest semi-diurnal internal tides is generated, with a large impact on mixing in the area. These internal tides experience a nonlinear evolution and break into a train of internal solitary waves (ISWs) when propagating away from the shelf. This was notably shown in previous study based on SAR images and cruise observations. However in situ observations of these ISWs remain relatively scarce. During the oceanographic campaign MOUTON 2008 high frequency mooring data were collected in the shelf edge with the aim to investigate the generation and propagation of internal tides and ISWs. During spring tide, strong nonlinear internal tides and large amplitude ISWs are clearly observed every semi-diurnal tidal period. Surprisingly, although the mooring site is located shoreward of the internal tidal generation location, the seaward traveling internal tides and ISWs are also observed apart from the shoreward propagating internal tides and ISWs. A realistic hydrostatic HYCOM model is applied to identify the role of the interaction between the barotropic and baroclinic tides on the change in the propagation direction of internal tides and nonlinear waves. (Abstract ID 11407)
The sub-surface temperature field is also improved with this new MDT in the SCS. (Abstract ID 9614)

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A DATA-ASSIMILATED CIRCULATION MODEL OF THE NORTHWESTERN ATLANTIC OCEAN USING THE NEW MPI-VERSION OF THE PRINCETON OCEAN MODEL

Eighteen-year (1993-2010) data-assimilated model analysis of the Northwestern Atlantic Ocean west of 55°W and between 50°N to 50°N is presented using the new MPI-version of the Princeton Ocean Model recently developed by Dr. Toni Jordi. The new model keeps the original POM's versatility, yet it has excellent scalability running on computers with 4-1000s of processors. In addition to the POM's original physics, new numerics and physics and forcing modules have been implemented to enhance accuracy and ease of usage in realistic simulations. These include (i) a 4th-order pressure gradient scheme; (ii) a wind-wave enhanced bottom drag; (iii) a data-assimilation comprising of both satellite-data (SSH, SST) and drifter-data assimilation modules; (iv) a wind module that incorporates high-resolution hurricane analyses; (v) a river module; (vi) a tidal module; (vii) an option to release tracers; and (viii) a suite of open-boundary conditions for regional or nested-grid calculations. The model has been thoroughly checked in various idealized cases. It has also been extensively tested and compared against in situ and historical data in two regions of the northwestern Atlantic Ocean: the Gulf of Mexico and the Middle Atlantic Bight. These results will be presented including a discussion on the origin of the alongshelf pressure gradient in the Middle Atlantic Bight (Xu and Oey, 2011, [PO], as well as hindcast and forecast experiments during the 2010 oil spill in the Gulf of Mexico. (Abstract ID 12342)

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A SLOW-MOVING TURBIDITY CURRENT IN MONTERY SUBMARINE CANYON

Field observations in Monterey Submarine Canyon during the past decade have demonstrated the frequent (sub-annual) occurrence of turbidity currents. Instrument-measured velocities, as high as 250 cm/s, indirect inferences from the movement of objects (some weighing more than 1300 kg), and changes in the bedforms on the canyon floor suggest that these turbidity currents are tremendously energetic. Here we present evidence of a weak, slow-moving turbidity current, a phenomenon that has rarely been discussed in literatures, that traveled through Monterey Canyon at least 10.5 km, from 1200 to 1800 m water depth. The bulk speed of the current was ~70 cm/s, much less than the historically observed speed of turbidity currents in the canyon, but still significantly greater than local tidal currents. The sediment concentration within the body of this turbidity current was merely ~450 mg/L. High-resolution velocity measurements suggest that the turbidity current resulted from a local slumping of the northeastern canyon wall in the vicinity of 1200 m water depth. The ebbing tidal currents that happened to flow down-canyon during the 4-6 hour existence of the turbidity current presumably provided a "tail wind" that assisted its survival for this duration. (Abstract ID 9685)

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HYPOXIA MODELING IN THE NORTHERN GULF OF MEXICO

The depletion of dissolved oxygen in coastal and estuarine waters has been increasing in frequency and intensity in recent decades. Hypoxia results from complex interactions between physical and biogeochemical processes and causes stress in the marine environment. Well-tested numerical models are invaluable tools for studying, predicting and informing site-specific management decisions. As part of the US IOOS Testbed project managed by SURA, this effort focuses on new applications to address the seasonal hypoxic conditions in the northern Gulf of Mexico. Fennel's NPZD-type ecosystem model is implemented in NOAAs FVCOM-based Northern Gulf of Mexico Operational Forecast System (NGOFS). NGOFS model domain covers the coastal waters from Chocotawhatche Bay, AL to Texas. The coupled system is driven by basin-scale model at the open ocean boundary as well as river and surface forcing. Hindcast simulation results from the coupled system are compared against available observations. The evolution of oxygen in the water column and the relative importance of different processes in contributing to the seasonal oxygen depletion are analyzed. We will also discuss the tentatively set-up for applying the model in a forecast mode. The results can be compared to various existing modeling efforts in this region, which will provide guidance in building up the ecological forecasting capabilities at NOAA. (Abstract ID 11402)

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DECADAL VARIABILITY OF CLIMATE AND WINTER PHYTOPLANKTON BLOOM IN THE MID-ATLANTIC BIGHT

The inter-annual variability of winter phytoplankton bloom in the Mid-Atlantic Bight (MAB) is examined using a combination of satellite data and biogeochemical ROMS model for the time period of 1983-1986 and 2004-2008 during which two ocean color sensors provide data for the MAB. The MAB has been experiencing significant changes over the last 30 years, with warmer atmospheric and water temperatures, increased river discharge, and increased wind forcing in the late winter. Based on satellite and glider observations, the winter bloom magnitude is enhanced by increased water column stability. Given the counteracting effects of wind, temperature, and river discharge we conducted a stability analysis for the two time periods, where the balance between mixing (tide and wind) and buoyancy (heat and freshwater) processes, are used to define winter mixing. Model simulations suggest that phytoplankton blooms have increased slightly in the winter despite the increased wind forcing. This suggests that enhanced river flow is playing a significant role in enhancing MAB winter phytoplankton despite increased wind forcing. (Abstract ID 10460)

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THE BEHAVIOR OF SUBGLACIAL FRESHWATER PLUMES: NUMERICAL MODEL AND TANK EXPERIMENTS

Most of the surface melt water on Greenland tidewater glaciers drains to the ice base and enters the ocean from the bottom of glaciers. The buoyant subglacial plume is considered to be a major contributor to fast subaerial melting as it rises along the tidewater glaciers. But sedimentation studies suggest that plumes would travel near-horizontally at the ocean bottom before rising some distance away from the ice. Here we use the Massachusetts Institute of Technology general circulation model (MITgcm) to study the plume behavior with different (i) subglacial channel sizes, (ii) initial plume speeds and (iii) densities, and (iv) glacier thicknesses. Previous studies indicate that the plume behavior is sensitive to the densimetric Froude number: subglacial plumes rise along the ice face for small Froude numbers (low plume speeds) and travel horizontally for high Froude numbers (high plume speeds). Tank experiments with horizontally injected plumes are conducted to test the sensitivity of the plume trajectory to the Froude number. Our results help us evaluate the efficiency of the subglacial freshwater flux on triggering the subaerial melting of tidewater glaciers. (Abstract ID 12302)

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INTERNAL SOLITARY WAVE AMPLITUDE ESTIMATION FROM SAR AND NAUTICAL X-BAND RADAR IMAGES IN THE MID-ATLANTIC BIGHT

Wind conditions and radar parameters such as look direction are as crucial as internal solitary wave (ISW) parameters and interior ocean dynamics to the ISW intensity modulation in the SAR and X-Band radar images, while the distance between the positive and negative peak (p-p distance) in the ISW intensity signature is much less affected by them. In the Mid-Atlantic Bight, the ISW amplitude can reach 15 m in the water depth of 80 m. Under the consideration of the highly nonlinearity caused by the large ISW amplitude, a second order Korteweg-de Vries equation is used to describe ISWS here. Combined with action balance equation and Bragg scattering model, the relation between the p-p distance and ISW amplitude can be established. In the shallow water 2006 experiment, we have five cases that clear ISWs signatures show both on SAR and X-Band radar images, and in the temperature record in the nearby moorings. The amplitude estimations based on the p-p distance of ISW intensity profiles of the cases agree reasonable well with in-situ measurements. (Abstract ID 11600)

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THE EFFECT OF RIVER DISCHARGE ON THE CARBON CYCLING OF THE US EASTERN CONTINENTAL SHELF: RESULTS FROM A THREE-DIMENSIONAL...
MODEL STUDY

Recent studies have shown that discharges of most of the world’s largest rivers have undergone significant changes in the past half century. In this study, we used a coupled biogeochemical-circulation model of the U.S. eastern coastal shelf to examine the effect of changes in riverine discharge of freshwater, nitrogen and carbon on the coastal carbon fluxes in this region. Our results show that changes in river discharge most significantly affect carbon burial and air-sea CO2 exchange, with a doubling of river discharge resulting in increases of up to 20-30% in the magnitude of these fluxes. These anomalies occur mostly in the summer months, and are greatest in the surface waters within the mid-Atlantic Bight coastal area. These changes result from two mechanisms: increased nutrient input to the coastal zone increases productivity, carbon burial and air-sea CO2 flux, whereas increased freshwater input enhances stratification and air-sea CO2 flux, but lowers productivity. As a result, the overall effect of increased river discharge is minor in terms of changes in productivity, but significant in terms of its effect on air-sea CO2 exchange. (Abstract ID 10599)

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MEASURING SEASONAL AND INTERANNUAL VARIABILITY OF CIRCULATION AND BIOGEOCHEMICAL PROCESSES IN THE GULF OF MEXICO

A 3-dimensional coupled physical-biogeochemical model is adapted for the Gulf of Mexico to examine seasonal and interannual variability in circulation and biogeochemical cycling in this regional ocean. Driven by realistic atmospheric reanalysis forcing, open boundary conditions from a data assimilative global ocean circulation model, and observed freshwater and terrestrial nutrient input from major rivers, this coupled model is used to perform a 7-year hindcast from 2004 to 2010. Extensive model validations are performed against satellite observed surface chlorophyll and in-situ measurements including temperature, salinity, nutrient, alkalinity and dissolved inorganic carbon. Significant seasonal and interannual variations in coastal circulation, nutrient and carbon contents, and plankton concentrations are reasonably well simulated by this model. Major physical processes related to such variations are identified and discussed. This research provides a useful modeling framework to examine important hydrologic-physical-biogeochemical coupling processes in the Gulf coastal ocean, allowing for an integrated understanding of regional marine ecosystem responses to climate and land use changes. (Abstract ID 10568)

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ANACONDASS: AMAZON INFLUENCE ON THE ATLANTIC CARBON EXPORT FROM NITROGEN FIXATION BY DIATOM SYMBIOSES

The Amazon River plume, extending thousands of km from the river mouth, represents a significant, climate-sensitive carbon sequestration pathway that seems to violate the expectation of an inefficient open-ocean biological pump. Phytoplankton blooms triggered by the riverine plume are thought to be responsible for significant carbon dioxide drawdown from the atmosphere. Our team came together to try to understand the factors affecting the phytoplankton bloom and also the fate of its production, including the amount of carbon dioxide taken up by the plume. We propose that large tropical river plumes with low N:P ratios by the river plume are thought to be responsible for significant carbon dioxide drawdown by the river plume. Because DDAs have been found in other tropical river systems, they may represent a previously overlooked biological pump mechanism. Results from May-June 2010 and Sept-Oct 2011 cruises are presented highlighting the role of the plume in driving the ecology, biogeochemistry and carbon cycling of the western tropical Atlantic. (Abstract ID 12013)

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UNDERWATER RADIATION DETECTION USING A PRINCETON GAMMA TECH INSTRUMENTS SCINTILLATION DETECTOR ON AN IROBOT SEAGLIDER AUV

On March 11, 2011, an earthquake and resulting tsunami did extensive damage to the Fukushima Daiichi nuclear power plant in Japan. Within days of the disaster, officials began monitoring the oceans and seafloor extending out from the disaster site. Efforts have consisted of collecting samples from varying depths in the water column as well as sediment samples from the seafloor at predetermined test sites. These samplings have been limited in their point nature and by the 30m radius keep out zone that was established. In response to the need for persistent monitoring, iRobot has collaborated with Princeton Gamma Tech Instruments (P GT) to develop an underwater scintillation detector that can be installed on the Seaglider AUV. The detector is a 3x3 NaI crystal with integral PMT and HV supply and is capable of storing 1,000 spectra with all associated data. The sensor is packaged in a watertight housing and the Seaglider can be programmed to loiter in a specified area to provide a spectroscopic survey. Data from tank and ocean testing conducted by iRobot and PG T will be presented. (Abstract ID 10885)

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VERTICAL DISTRIBUTION OF PU ISOTOPES IN THE EQUATORIAL PACIFIC OCEAN

The objectives of this study are to measure the Pu-239+240 concentrations and Pu-240/Pu-239 atom ratios in seawater from the equatorial Pacific Ocean and to discuss the transport processes of plutonium. This study also deals with the relative contributions of the global stratospheric fallout Pu and the PG close-in fallout Pu in the water column. The Pu-239-240 concentrations and Pu-240/Pu-239 atom ratios were determined by alpha spectrometry and double聚焦SF-ICP-MS for seawater samples from the two stations (AQ-7 and AQ-13). The Pu-239-240 concentration at AQ-7 was 1.8 mBq m-3 in the surface water and increased with depth reaching 14.4 mBq m-3 at 600 m depth, then decreased with depth to 2.7 mBq m-3 at the bottom layer. The Pu-240/Pu-239 atom ratios in the water columns from the equatorial Pacific Ocean were higher than the mean global fallout ratio of 0.18, proving the existence of close-in fallout Pu originating from the Pacific Proving Grounds. The relative percent of the inventory of close-in fallout from the Pacific Proving Grounds were 25 % in the surface layer and remained 55% at the 3000 m depth. The decreasing rate of Pu-239+240 over the depth interval 0 - 1000 m was estimated to be 0.89 Bq m-3 yr-1 based on the difference in the Pu-239+240 inventories between AQ-7 and GEOSECS-246. (Abstract ID 9586)

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OBSERVATION OF ATMOSPHERIC OXYGEN/NITROGEN RATIO ON BOARD A CARGO SHIP BY USING GAS CHROMATOGRAPHY/ THERMAL CONDUCTIVITY DETECTOR

Measurements of atmospheric O2/N2 ratio and CO2 concentration have been used to analyze the -ΔO2/ΔCO2 ratio to obtain information on CO2 sources, e.g. anthropogenic or terrestrial biogenic sources (respiration or wildfire). In this study we report on the development of a shipboard system for measuring atmospheric O2/N2 ratio by using the gas chromatography/thermal conductivity detector (GC/TCD) technique. The standard error for a one hour average (N = 6) is found to be ~5 per meg (~1 ppm). The shipboard measurements have been conducted since the end of September 2007 on TRANS FUTURE S, a cargo ship sailing between Japan, Australia, and New Zealand every six weeks. Spatially, the observation covers latitudes between 41°S and 31°N over the western Pacific. Air masses with high CO2 concentration are observed along the coastline of Australia and New Zealand. In more than two thirds of the cases (17 of 23 events) detected between September 2007 and July 2009, values of the -ΔO2/ΔCO2 ratio are less than 1.15, indicating dominance of biogenic sources (e.g. respiration or wildfire) of CO2. (Abstract ID 10794)

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NITROGEN ISOTOPIC SIGNATURE OF AMINO ACIDS DURING MICROBIAL PROCESSES

For the application of nitrogen isotopic composition (δ15N) of amino acids as a biogeochemical tool, it is essential to constrain the nitrogen isotopic fractionation in amino acid during...
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IMPACT OF RAPID SEA-ICE REDUCTION IN THE ARCTIC OCEAN ON THE RATE OF OCEAN ACIDIFICATION

The reductions in pH and aragonite saturation state (Ωarag) in the Arctic Ocean have been caused by the sea-ice reduction as well as by increases in atmospheric CO₂ concentrations. Therefore, future projections of pH and Ωarag in the Arctic Ocean will be affected by how rapidly the reduction in sea ice occurs. In this study, we compared the reduction rates of pH and Ωarag calculated from outputs of two versions of an earth system model in which summer ice-free condition by 2080 (new version) and 2090 (old version), respectively, is projected under similar CO₂ emission scenarios. The Arctic surface water was projected to be undersaturated with respect to aragonite in the annual mean when atmospheric CO₂ concentration reached 480 (560) ppm in year 2048 (2080) in new (old) version. At an atmospheric CO₂ concentration of 520 ppm, the maximum differences in pH and Ωarag between the two versions were 0.08 and 0.15, respectively. Thus, the reductions in pH and Ωarag in the Arctic surface waters are significantly affected by the difference in future projections for sea-ice reduction rate. (Abstract ID 9585)

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PACIFIC SUBTROPICAL CELL RESPONSE TO EFFECTIVE OCEAN OPTICAL PROPERTIES

A series of ocean model simulations is conducted to assess Pacific climate sensitivity to effective ocean optical properties. The control experiment has a conventional radiative scheme (Paulson & Simpson, 1977), and is integrated for more than 1,300 years with the CORE forcing. Sensitivity experiments have two radiative schemes: the varying solar angle (Ishizaki & Yamanaka, 2010) and the local heating by chlorophyll-a concentration (Morel & Antoine, 1994) in addition to the varying solar angle. Introduction of the effective ocean optical properties makes the attenuation depth shallower, and causes the loss of radiation absorption to shift upward. This significantly enhances the Pacific subtropical cell as a result of a dynamical response to the decrease in the mixed layer depth (MLD), and cools the upper ocean of the eastern tropical Pacific. The MLD decrease also amplifies the ENSO and Pacific subtropical cell response to the decrease in the mixed layer depth (MLD), and cools the upper ocean of the eastern tropical Pacific. (Abstract ID 10980)

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BORON AND OXYGEN ISOTOPE SYSTEMATICS FOR A COMPLETE SECTION OF OCEANIC CRUSTAL ROCKS IN THE OMAN OPHIOLITE

Boron content and the isotopic composition of boron and oxygen were determined for a complete section of oceanic crust in the Oman ophiolite, a fragment of Cretaceous oceanic lithosphere. The upper pillow basalts underwent low temperature alteration (∼60°C) or seafloor weathering; the lower pillow basalts and upper sheeted dikes were altered at 250 to 350°C at the spreading axis and subsequently experienced retrograde alteration (∼200°C) in the early Pliocene, and the lowermost sheeted dikes complex and upper gabbros underwent high-temperature alteration at 300 to 450°C; the lower gabbros were altered at very high temperatures of ∼450°C. The boron content of the rocks in the oceanic crust decreases in both abundance and range with increasing stratigraphic depth. Boron from seawater was incorporated into the rocks through hydrothermal alteration, even at temperatures higher than 300°C. The B/³⁸ values systematically increase with stratigraphic depth. The whole-rock B/³⁸ values negatively correlate with the ³⁸O values, suggesting that the B/³⁸ values of altered rocks are essentially controlled by alteration temperature. The B/³⁸ values estimated for hydrothermal fluids range from 28 ± 33%, values indistinguishable from those of vent fluids observed at modern mid-ocean ridges. (Abstract ID 12819)

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OCEAN REANALYSIS IN THE INDIAN AND WEST PACIFIC OCEANS

The relatively high-resolution ocean reanalysis product is constructed by a multi-year model integration with the assimilation system. The ocean model is a Hybrid Coordinate Ocean Model (HYCOM) with the horizontal resolution of about 0.25°×0.25°. A various types of observations including in-situ temperature and salinity profiles (MBT, XBT, ARGO, TAO, and other stations), remotely-sensed sea surface temperature and altimetry sea level anomalies are assimilated into the HYCOM via the ensemble optimal interpolation method. A new method is developed to assimilate temperature and salinity observations. The pseudo-observations of layer thickness calculated from temperature and salinity observations are firstly assimilated to adjust model layer thickness and current fields. Then, the temperature or salinity observations are assimilated. The ocean reanalysis is evaluated through the comparisons to the climatological observations, independent ARGO observations, and tide gauge observations. The ocean reanalysis shows a good agreement with observations. At the same time, the comparisons with other reanalysis products such as SOEDA, ECCO are carried out. The comparisons indicate the importance of high-resolution reanalysis products. (Abstract ID 9824)

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(INVITED) REMOTE SENSING OF COASTAL PLUMES AND ALGAL BLOOMS: RECENT EVENTS OF PHYSICAL- BIOLOGICAL COUPLING IN THE MID ATLANTIC BIGHT COASTAL REGIONS*

Real time satellite receiving stations at the Center for Remote Sensing, University of Delaware have recently captured a number of coastal plumes and large algal blooms in Delaware and New Jersey coastal regions. Using multi-satellite sensors, in situ measurements and numerical models, we have identified the likely physical processes that drive these coastal plumes and algal blooms. We find that the contributions of buoyancy driven outflows resulting from super normal precipitation, episodic wind events, coastal upwelling, and strong stratification on the continental shelf in the Mid Atlantic Bight are likely related to the large coastal blooms. In addition, we will also discuss the impact of Hurricane Irene on the large algae blooms. State-of-art satellite scatterometer wind, SST, ocean color, and SAR data provided a unique data source in addition to in situ observations and numerical simulations. This presentation will emphasize on comparisons of both historic and new coastal plume and algal bloom events in the US East Coast, and focus on analyses of physical and biological coupling of these recent episodic events in the Mid-Atlantic Bight. (Abstract ID 10480)

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MODULATION OF SST RESPONSE TO TROPICAL CYCLONES BY THE SUMMER UPWELLING IN THE NORTHERN SOUTH CHINA SEA

Strong wind affects mixing and thermal structure in the upper ocean. In turn, upper-ocean thermal structure affects the evolution of TCs. Here based on satellite data, in situ temperature and salinity data, best-track data of the US Joint Typhoon Warning Center, together with an ocean mixed layer model, the coastal upwelling in the northern South China Sea (NSCS) is investigated during June to September TCs season to identify its impact on SST and surface thermal structure and TCs intensification. The results show that the amplitude of TC-induced surface cooling is larger by more than 50% in the presence of the upwelling.
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Dissipation rate of turbulent kinetic energy showed a significant diurnal variation in the mixed layer both over the shelf and slope. The thickness of the mixed layer changed synchronously with the magnitude variation of ε due to the distinct wind energy and buoyancy flux during daytime and nighttime. Beneath the mixed layer, the ε variation showed a six-hour variability over shelf, with maximum values reaching 10^9 W/m^2 at 1000 m depth when the maximum of tidal current is at peak. The shear variance level of semidiurnal and diurnal tide is one order larger that of sub-tidal flow on average. These reveal the important contribution of internal tide to the turbulent dissipation over shelf. While over slope, the ε values always prevailed in the pycnocline during the whole observation period, and reached 10^7 W/m^2. In contrast to the shelf, the shear variance of sub-tidal flow is at least one order larger than those of semidiurnal and diurnal tidal flow. Study reveals the high shear variance caused by Kuroshio intrusion played a key role in furnishing the elevated dissipation rate in the pycnocline over shelf. The spatial distribution shows an energetic turbulent dissipation and mixing over shelf region. (Abstract ID 11063)
cycle is significantly suppressed. This suppression appears to be associated with the acceleration of oceanic planetary wave due to an increase of buoyancy frequency in global warming. This shortens the time from a decadal to an interannual timescale for the first-mode baroclinic Rossby waves to cross the subtropical North Atlantic basin, the primary memory for the NAT decadal variability in the model. The modeling study also found that the global warming does not modulate the North Atlantic sea-air coupling significantly but it may be model-dependent. (Abstract ID 9305)

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DECLINE OF THE HUANGHE (YELLOW RIVER) DELTA TO DESTRUCTION PHASE

The consequential decline of the modern Huanghe delta to destruction phase due to rapid decrease of sediment discharge to the sea since 1976 is studied based on the Huanghe water and sediment discharge to the sea in 1950-2009, bathymetric records of 36 transects on the subaqueous delta in 1976-2004 and the LANDSAT satellite images. The distinct feature of the delta evolution is its phased decline in three periods: a construction phase in 1976-1987, a transition-balanced phase in 1988-1996 and a destruction phase since 1997. The three phases of the delta evolution were caused by three periods of sharp stepwise decrease of the water and sediment discharge due to dam constructions, decrease of precipitation in the river basin and other human activities. The sediment accumulation rate of the delta was 0.48t/yr in 1976-1997 and 0.42t/yr in 1998-2004. The threshold of sediment discharge to the sea for keeping the delta alive in erosion-accumulation balance is estimated as 0.256t/yr and 0.180t/yr respectively. The sediment load in recent 10 years is 0.137t/yr, resulting in keeping delta in a balanced phase since 1997. (Abstract ID 10897)

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EVOLUTION OF STORM SURGE INDUCED BY A TRANSLATED ATMOSPHERIC CYCLONE IN THE PRESENCE OF A BENDING COASTLINE

When the atmospheric cyclone approaches the coastline it induces a storm surge, which can propagate along the continental shelf as a long wave trapped by bathymetry and/or coastline. If the Eulerian time scale of the translating atmospheric cyclone is comparable to or longer than the inertial period, subinertial continental shelf waves (CSW) dominate the response and propagate cyclonically relative to the deep ocean. For atmospheric systems with a superinertial period, subinertial continental shelf waves (CSW) dominate the response and propagate cyclonically relative to the deep ocean. Atmospheric systems with a superinertial Eulerian time scale, edge waves propagating in both alongshore directions become important, especially on wider shelves. The lowest trapped modes are typically excited along a straight coastline. However, in reality coastlines are seldom straight. The adjustment of CSWs to the curvilinear coastline and continental shelf modifies the storm surge, especially when the coastal changes orientation rather abruptly, in a corner-like manner. In such a case, a multiple-mode response occurs with the development of smaller-scale but more energetic transient jets aligned with the "blocking" (deviating) coastline and followed by the formation of mesoscale eddies. Edge waves are less affected and are mostly reflected by the bending coastline. (Abstract ID 11777)

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INTER-ANNUAL VARIABILITY OF THE SUMMER INTRUSION OF GULF OF ADEN INTERMEDIATE WATER IN THE RED SEA

The Red Sea is a concentration basin where one of the most saline water masses, the Red Sea water, is produced and exported to the Indian Ocean through the Strait of Bab el Mandeb as a deep outflow during most of the time year except in summer. During summer months from June to September, as a unique and striking feature, most of the deep export of the high-salinity water from the Red Sea in the strait is replaced by a subsurface intrusion of the Gulf of Aden Intermediate water (GAW), driven by the southwest Indian monsoon. The GAW brings into the Red Sea at intermediate depths with cold, fresher and nutrient-rich water, and has the potential to significantly impact the biological productivity in the southern Red Sea. The inter-annual variability of the intrusion of the GAW is studied with the MITgcm (MIT general circulation model) and ocean reanalysis data from ECCO (Estimation of the Circulation and Climate of the Ocean project). The model results suggest that the inter-annual variability of the intrusion of the GAW and the water properties in the southern Red Sea are linked to the inter-annual variability of the larger scale circulation in the north Indian Ocean through the upwelling in the Gulf of Aden and along the northern coast of the Arabian Sea. (Abstract ID 10974)

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COMMUNITY BUILDING IN MARINE BIOLOGICAL RESEARCH: LESSONS LEARNED FROM THE CENSUS OF MARINE LIFE

The Census of Marine Life was a 10-year scientific initiative to assess and explain the diversity, distribution and abundance of life in the oceans. The largest scientific collaboration conducted in the field of marine biology, the program brought together more than 2,700 researchers from 80 nations and, to date, produced over 3,100 scientific papers and other information products, and the results are being used in marine resource policy. The Census built new collaborations that transcended disciplines, institutions and countries and pioneered global-scale marine biodiversity research, including the demonstration of technologies and approaches for long-term biodiversity observation in the oceans. Several key elements or “lessons learned” that identified that might be applied to future programs including: the importance of a simple message; the need for community building and a culture of sharing data; engaging user communities early in the process; building collaborations through the arts to capture public interest; and the importance of fostering an environment where collaboration is better than competition. (Abstract ID 12167)

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RECENT HYDROGRAPHIC DEVELOPMENTS IN THE LABRADOR SEA AND VARIABILITY IN THE PROPERTIES OF THE DEEP WESTERN BOUNDARY CURRENT DOWNSTREAM

In addition to record-high temperatures in the upper 1000 m, hydrographic surveys of the Labrador Sea conducted in May and July of 2011 (by Bedford Institute of Oceanography and University of Bremen, respectively) reveal remarkable changes in the spatial structure and properties of newly-formed Labrador Sea Water and warm saline Intermediate Current Water (ICW). A strong inflow of relatively high temperature and salinity ICW enters the Labrador Sea on the Greenland side as in other years, but there isn't a distinct T and S maximum near the Labrador Slope where one might expect the ICW to exit the region. Instead, our observations show broad lenses with high temperature and salinity in the central part of the sea. It appears that these features, and the accumulation of ICW in the northern Labrador Sea (seen in both CTD and Argo data), are associated with limited deep convection in the Labrador Sea in the past three years and have important implications for the regional heat and freshwater budgets. Downstream hydrographic variability is described from surveys and recent moored measurements with the Halifax line across the Scotian Slope and Rise (in conjunction with the UK Rapid Climate Change program) where anomalous properties of the transiting intermediate and deep waters can be tracked back to the Labrador Sea. (Abstract ID 11577)

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RESPONSES OF LOWER TROPHIC ORGANISMS TO TYPHOON PASSAGE IN THE EAST CHINA SEA

Tropical cyclones such as typhoons can induce upwelling and vertical mixing in the water column. As a result, phytoplankton blooms sometimes occur after their passages. However, little is known about typhoon-induced changes in the composition of lower trophic organisms in the sea. Therefore, we tried to estimate the community successions in the East China Sea through on-deck bottle incubation experiments simulating the hydrographic conditions after the passage of typhoon. In all experimental conditions we designed, chlorophyll a concentrations increased in the bottles, and the enhanced algal cells were mainly composed of large diatoms, while they were minor components in the phytoplankton community before the experiments. Although nano-sized ciliates also increased, the abundance of possible diatom grazers such as dinoflagellates little changed throughout our incubations. These results suggest that the increased diatom bloom may exist and enhance biogenic carbon flux in the water column. Typhoons can affect not only phytoplankton productivity, but also the composition of lower trophic organisms and biogeochemical processes in the East China Sea. (Abstract ID 9564)

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RARE EARTH ELEMENTS DISTRIBUTION AND WATER MASS CHARACTERIZATION IN THE PACIFIC

We present contour simulations for Pacific REEs using a new dataset of six water columns along a S–N transect (54°N–40°N) crossing the date line (150°E–150°W). Remarkable local benthic maxima (e.g., Nd >70 ppm/kg; Lu >4 ppm/kg) were observed at 20°N – 40°N. Supply from ocean floor, rather than the vertical regeneration in a water column, contributed to the local maxima, because dramatic enrichment of REEs was poorly correlated with dissolved silicate increase in the North Pacific. The Pacific cerium concentrations varied slightly and non-systematically (5 ± 3 ppm/kg) at depth of 1000 to 3000 m. Gradual enrichment of neighboring LREE toward the North Pacific can account for the systematic decrease of shale-normalized Ce anomaly without considering progressive Ce scavenging during horizontal advection. The REEs in the Southern Ocean enabled our characterization of the AAIW, AABW and LCDW. With Y–Ho/Dy diagrams, the theoretical mixing curves of water mass endmembers revealed Pacific water structures, suggesting that the lateral advection, rather than vertical processes within a basin, broadly controls the Pacific REE distribution. (Abstract ID 9805)

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THE EFFECTS OF HYPOXIA ON VERTICAL DISTRIBUTION OF CHESAPEAKE BAY ACARTIA TONSA

Summer hypoxia within the Chesapeake Bay has played a major role in reshaping the vertical migratory behavior within the zooplankton community. Higher trophic levels have been affected as a direct result of lower oxygen availability and zooplankton abundance. This study focused on the zooplankton species of Acartia tonsa, prevalent within estuarine waters, including the Chesapeake Bay. Through various sampling techniques aboard the RV Hugh R. Sharp we were able to quantify the abundance of A. tonsa at different depths to examine how the diurnal vertical migration was affected by hypoxia. We also examined A. tonsa predator concentrations at specific depths to determine whether hypoxia or predation played the more dominant role in A. tonsa vertical distribution. Results show that A. tonsa population abundance and vertical migration behavior decrease throughout the summer months in conjunction with hypoxic conditions. It is imperative that we understand A. tonsa vertical distribution because of its role as a primary consumer of phytoplankton that links to secondary consumers such as larger fish within the marine ecosystem. (Abstract ID 9820)

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A CCSM4 DEcadAL PREDICTION CASE STUDY: LATE 20TH CENTURY NORTH ATLANTIC OCEAN HEAT CONTENT

Ensembles of initialized decadal prediction (DP) experiments using the CCSM4 model show considerable skill at forecasting changes in North Atlantic upper ocean heat content up to a decade in advance, after correcting for a drift bias. In particular, the observed large, rapid rise in subsurface gree (SPG) heat content in the mid 1990s is successfully predicted in the ensemble initialized in January of 1991. A budget of SPG heat content from the forced hindcast (HD) simulation used to derive historical ocean initial conditions sheds light on the origins of the 1990s regime shift, and it demonstrates the extent to which low-frequency changes in the Atlantic meridional overturning circulation (AMOC) dominate temperature tendencies in this region. The DP ensembles show varying degrees of predictive skill in the individual heat budget terms, with large advective heat flux anomalies from the south exhibiting the highest correlation. The DP success is thus strongly tied to correct initialization of AMOC, while external forcing is found to contribute negligibly (and for incorrect reasons) to predictive skill in this region and over this time period. (Abstract ID 10420)

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DEVELOPMENT OF A WAVE MODEL FOR THE NORTH SHORE OF MOOREA: UNDERSTANDING WAVE ENERGY DISSIPATION IN A CORAL REEF LAGOON

A wave model was used to simulate the transformation and distribution of wave energy across a coral reef system in Paapao and Opunohu Bays, on the North shore Moorea, French Polynesia. Modeled wave fields were compared to data collected on a cross-reef transect during the austral summer of Dec 2006 to Feb 2007. A systematic series of model runs were made to determine the optimal values of empirical parameters for bottom roughness length scale ($k_w$) and wave breaker coefficient ($\gamma$) that would give the best model skill for observed values of significant wave height. The best predicted wave transformation, using $k_w = 0.011$ and $\gamma = 0.74$, was in good agreement with observations in the back reef and lagoon, however under predicted the wave conditions near the reef crest. The dissipation by wave breaking found by the model was in agreement with similar studies, however dissipation by bottom friction was found to be lower than expected. (Abstract ID 10127)

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BIODEGEOGRAPHY OF BACTERIAL COMMUNITY ALONG AN ENVIRONMENTAL GRADIENT IN THE SOUTHERN EAST CHINA SEA

We investigated bacterioplankton community structure in the southern East China Sea (ECS) based on pyrosequencing. In particular, we examined the relative contribution of local environmental conditions versus dispersal processes in determining the spatial-temporal variation in community structure (relative abundance or presence/absence of species) of bacterioplankton. We analyzed the community as a whole as well as separating the data into either two functional types (autotrophic and heterotrophic) or three dominant taxonomic groups (Alphaproteobacteria, Gammaproteobacteria and Actinobacteria). When considering presence/absence of species, we found local environmental effects in heterotrophic bacteria but not other groups. When considering relative abundance, no significant difference between environmental and dispersal effects was found for the community as a whole or heterotrophic bacteria. However, we found that Cyanobacteria community was better predicted by environmental factors while Alphaproteobacteria community was related to spatial predictors, i.e. dispersal constraint of Alphaproteobacteria was higher than that of Cyanobacteria. Contrary to the previous assertions that all bacteria have high dispersal capability and should be influenced by local environmental factors, these results suggested that different bacteria groups might have differential dispersal ability. (Abstract ID 9845)

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IMPACT OF DIATOM-DIAZOTROPH ASSOCIATIONS ON CARBON EXPORT IN THE AMAZON RIVER PLUME

The outflow of the Amazon river influences biogeochemistry up to thousands of kilometers from the river mouth in the oligotrophic tropical North Atlantic (TNA). The resulting surface plume is characterized by an undersaturation in CO$_2$ and dissolved inorganic carbon (DIC) linked to biological new production. Previous estimates of net production in the seasonal Amazon plume suggest that up to 1.7 Tmol C yr$^{-1}$ is sequestered from the atmosphere, reversing the TNA’s “normal” condition as a carbon source to the atmosphere. We report measurements of primary productivity associated with blooms of the diatom *Hemiselmis lacusii* and its diazotrophic cyanobacterial symbiont *Richelia intracellularis* using the oxygen triple-isotope (i.e., $^{13}$Δ, biological oxygen supersaturation ($O_{/Ar}$ ratios), and DIC-based methods in offshore plume waters. We find peaks in net community productivity, but relatively small changes in gross primary productivity, in blooms of these diatom-diazotroph assemblages (DDAs), suggesting that the ecosystem carbon export efficiency increased more than twofold therein. This enhanced export efficiency has a long-term impact on the surface DIC budget of the Amazon plume, although the spatial distribution of DDA blooms is still uncertain. (Abstract ID 10864)

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A NUMERICAL STUDY OF THE EFFECT OF OCEANIC BOTTOM BOUNDARY LAYER DYNAMICS ON FORERUNNER DURING HURRICANE IRENE IN THE NORTHERN GULF OF MEXICO

It has long been recognized that forerunner plays an important role in generating large hurricane-induced storm surge in the Gulf of Mexico. The forerunner is a phenomenon whereby water elevation in the vast coast was elevated days before Hurricanes make the landfall. The 2008 Hurricane Ike, which devastating the Galveston Bay in the Texas coast, was a good example, in which 1.8 m out of 4.5 maximum surge is contributed by the forerunner. A
collective effort for improving storm surge and inundation modeling skill in the Gulf of Mexico including forerunner was recently been funded by NOAA IOOS program and carried out by a team of modelers on a tested paradigm using open source codes. It was found that the forerunner occurred as a result of Ekman set up along the Louisiana-Texas shelf and it is highly sensitive to the bottom drag coefficient. Given the fact that Gulf of Mexico is known to be rich in mud, our hypothesis is that during the stormy condition, the suspended sediment-induced density stratification is likely to be ubiquitously present at the bottom boundary layer. A sediment-transport model and bottom boundary layer sub-model including the sediment-induced stratification effect were coupled to the unstructured grid circulation and wind wave density stratification is likely to be ubiquitously present at the bottom boundary layer. A model results demonstrate that the bottom boundary layer dynamics have a significant effect on the cross-shore Ekman setup. (Abstract ID 1898)

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STRENGTH OF COHESIVE SEDIMENT-BIOPOLYMER FLOCS UNDER COMPRESSIONAL LOADING

Sediment flocculation controls several sediment transport processes and the geotechnical properties of settled sediment beds. A variety of primary factors, including clay species, organic matter type and concentration, water chemistry, and degree of packing, affect flocc strength. A pilot nanomechanical investigation was conducted to directly characterize the strength and deformation behavior of submerged clay-biopolymer micro flocs under compressional loading. Totally four types of kaolinitic, illitic, Ca-smectite, and Na-smectite and two exopolymers (xanthan and guar) of different polarities were used to generate flocs at six different clay-to-exopolymer ratios under a recirculating tube flow condition, and selected flocs were then subjected to compressional loading in a nano universal testing machine (Nano UMT). Results from nanomechanical testing are in good agreement with the strength data estimated indirectly from the shear stresses in recirculating flow. In general, the neutral guar promotes the formation of stronger flocs for clays with higher surface charges, while the anionic xanthan can only form flocs with kaolinite (little or no charges). Results suggest that biopolymer bridging is the primary bonding responsible for flocc formation and strength. (Abstract ID 11519)

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THE DYNAMICS OF YELLOW SEA WARM CURRENT

The winter water mass along the Yellow Sea Warm Current (YSW) – especially on the western side is considerably warmer and saltier than the ambient shelf water mass. This observed tongue-shape hydrographic feature implies a possible existence of a winter, along trough and onshore current, often referred to the Yellow Sea Warm Current (YSWC). Based on the Chinese observations in 2006-2007 winter on the western YST, the existence of the warm current had been proved. And using a linear, barotropic model, the experimental results showed that the westward shift of YSWC was mainly due to the potential vorticity input by the wind stress over YST. But there are some other important roles, such as Kuroshio, stratification, tide, Ekman transport, which also have obvious impacts on the YSWC formation and westward shift. Here we will configure a realistic model which includes all these factors by using the Regional Ocean Model System (ROMS). The role of each factor has been analyzed respectively, which makes the dynamics of the YSWC more clear. (Abstract ID 12798)

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PHYTOPLANKTON ASSEMBLAGES IN NORTHEAST LUZON AS INFLUENCED BY THE PACIFIC WESTERN BOUNDARY CURRENT SYSTEM

The northeastern waters of Luzon, Philippines is a dynamic area experiencing a confluence of large-scale circulation features. The North Equatorial Current bifurcates offshore feeding into the Mindanao Current flowing south and the Kuroshio Current that begins to consolidate in the waters off of Luzon. This region serves as an important fishing grounds for both municipal and commercial fisheries, thus this study attempts to look at the variability at the base of the food chain to help understand the dynamics in secondary production. Previous studies have highlighted the spatial variability of primary production in this area, which appears to be driven by upwelling processes at the shelf break, and the formation of cyclonic eddies. The phytoplankton assemblages in zones that were identified a priori based on chlorophyll a and temperature features were characterized in order to investigate the influence of the North Equatorial and Kuroshio Currents on the productivity of coastal waters of the Philippines. Abundances of phytoplankton were obtained using microscopy and image analyses, and through an in situ fluorometer. The results from these two methods are compared. (Abstract ID 12858)

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HIGH RESOLUTION IMAGING, MAPPING, AND CHEMICAL SENSING FROM AN AUTONOMOUS UNDERWATER VEHICLE

Autonomous vehicles such as the Sentry AUV image the seafloor using cameras and sonars while also making near-bottom chemical measurements. Often used in conjunction with complementary surveys from human-occupied and remotely operated submersibles, these capabilities enable us to build three-dimensional visualizations of benthic environments. Fine-scale bathymetric and sidescan mapping, often combined with seafloor magnetics, produce accurate three-dimensional spatial and textural models of a variety of volcanic and tectonic structures, vent sites and seeps. Monocular and stereo digital cameras have enabled Sentry to make color images photos supporting detailed geological interpretation and species identification. Recently, Sentry carried an experimental stereo camera from the Australian Centre for Field Robotics (ACFR). When processed using ACFR software, these stereo images produced full three-dimensional reconstructions of seep sites and pinnings showing a variety of habitats in their geological context. We illustrate these capabilities with examples of biological and geological interest from the Haakon-Mosby Mud Volcano, sites near the Deepwater Horizon oil spill, volcanoes in the Kermadec Arc, and natural oil and gas seeps. (Abstract ID 12149)

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DETECTION OF THE EFFECTS ON SUBTIDAL BENTHIC ECOSYSTEM BY TIME-SCALE MONITORING SINCE DEVELOPMENT OF ESTUARIES AROUND NAKDONG RIVER, KOREA

Nakdong river is a typical estuary with wide scale marshes, developed sand bar having diverse habitats in the marine ecosystem. But, because of geographical prospects, it have potential development demands because of city, industrial, port facilities. Since 1987, by complete to the barrage on the mouth of river, the natural functions of estuaries have been affected. So the change of coastal environment and ecosystem are continuing. Estuarine ecosystem also changed along to the spatial and temporal scales. Closer to the mouth of river, benthic communities differentiated to coasts in that estuary after 10 yr more. Three spatial community structure confined by species composition on subtidal area resulted by 2010. Opportunistic species of organic pollutants are dominant in close to barrage, in near coast area. Typical benthic animals found around the Korea coast, and L. kongilol, F affinis are dominant in offshore area. The changes of the distribution of dominant species considering the spatial scale were different before and after the construction of barrage. Now the huge dredging works improving the water front along to river are carrying over the barrage. It also seems to be affected around estuary because of suspended sediment transport and irregular water discharge, and the habitats also would be changed. In this benthic monitoring, some of species were characterized, for example, S. sinensis as inhabit heavily organic polluted area prevailed in abundant on inner estuary. (Abstract ID 12833)

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ANALYSIS OF TIDAL ASYMMETRY AND FLOOD/EBB DOMINANCE AROUND THE HAN RIVER ESTUARY, SOUTH KOREA

Several field measurements were conducted to study the characteristics of tidal asymmetry and flood/ebb dominance in the Han River estuary (HRE) on the western coast of Korea. The HRE is macro-tidal coastal zone with a mean depth less than 12 m and a tidal range varying 3.5 (neap) to 8.0 m (spring). The tidal amplitude to depth ratio is large enough to generate non-linearity in the tidal wave. The harmonic analysis results of tide at HRE indicate that
relative phases of 2M2-M4 are less than 180° for most of measured points. Hence, the analysis of relative phases is shown that HRE type is flow dominant. But field measurement of tidal current from 3 periods (December, 2005, September, 2007 and May, 2010) is showed ebb current that is stronger and longer than flood current. The reconstructed of averaged current and harmonic constant of tidal current is presented ebb dominant at all surveys. The averaged current to downward estuary is generated by river discharge, long-term variation of sea surface slope due to estuary non-linearity. (Abstract ID 11008)

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INTERANNUAL TO DECADAL GULF STREAM VARIABILITY IN AN EDDY-RESOLVING OCEAN MODEL

Meridional shifts of the Gulf Stream (GS) jet on interannual to decadal timescales and the corresponding sea surface temperature changes are examined using a global eddy-resolving ocean model hindcast from 1960 to 2003. Simulated variability in the shifts of the GS jet axis shows good agreement with available observations, and large atmospheric fluctuations characterized by the North Atlantic Oscillation by 2 years. This lagged response of the jet to the atmospheric variations is attributed to the westward propagation of the jet undulation with a phase speed of about 2.8 cm/s. The direction and phase speed of the propagation of the undulation can be explained by a thin-jet theory. The shifts of the downstream jet are likely induced by wind fluctuations through Ekman convergence. Associated with the northward (southward) shift of the jet is sea surface temperature warming (cooling) around and north of the jet. Our numerical results suggest that the GS jet brings the atmospheric signals from the central to the western North Atlantic, and the resultant meridional shift of the jet induces notable oceanic changes around the GS. (Abstract ID 19590)

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VELOCITY AND HYDROGRAPHIC FEATURES OF THE KUROSHIO-OYASHIO CONFLUENCE ZONE

Hydrographic and velocity data obtained from the R/V Kalmalii-O-Kanalos (KOK) cruise in June 2011 are examined to understand the ocean current system and water mass characteristics in the Kuroshio-Oyashio mixed region. Water samples were obtained from offshore stations toward the coastal region with several north–south transitions across the Kuroshio. A vessel mounted acoustic Doppler current profiler (SADCP) collected data during the entire cruise period with 15-minute temporal resolution. After tidal component is removed from the SADCP velocity using OSU TPO 7.2 tide model, the resultant surface currents capture the weak coastal flows (~0.1 m/s) as well as strong Kuroshio current (~2 m/s) from surface to 415 dbar, which are well correlated with the altimeter geostrophy currents. The correlation coefficients are 0.68 and 0.79 for zonal and meridional components, respectively. In order to more closely examine the detailed structure of the coastal ocean, we use the Navy Coastal Ocean Model (NCOM) outputs on 1km resolution. The presentation will include the analysis of water properties measured from CTDs in combination with the NCOM outputs. (Abstract ID 10657)

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THE WIND-DRIVEN TURBULENCE AND FLOW UNDER SURFACE HEATING

The wind-driven turbulence affects not only temperature and salinity profiles in the surface boundary layer but also the wind-driven flow structure. Our recent field study (Yoshikawa and Miura JGR 2009) revealed large seasonal variations in the speed factor and deflection angle of the wind-driven flow, suggesting a great impact of surface heating on the wind-driven turbulence and flow. However, the wind-driven flow under surface heating has been well quantified so far. In this study, large-eddy simulations were performed to investigate the wind-driven turbulence and flow under surface heating. Experimental results and dimensional consideration suggest that the speed and thickness of the wind-driven flow can be scaled using \( U_1(\text{rake}) \) and \( U_1(\text{rake}) \), respectively, where \( U_1 \) is the friction velocity, \( f_0 \) is Coriolis parameter, a is constant coefficient and \( B_0 \) is Richardson number (B is buoyancy flux). Eddy viscosity and diffusivity are also scaled using these parameters. Possible causes of the observed seasonal variations of the wind-driven flow will be discussed in terms of the present experimental results. (Abstract ID 10991)

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IMPROVEMENTS OF THE THREE-DIMENSIONAL ATMOSPHERE-OCEAN COUPLED EXPERIMENTS

Intensity suppression of typhoons in three-dimensional atmospheric-ocean coupled experiments on 10983)

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APPLICATON OF THE THIRD-ORDER RAW-FILTERED LEAPFROG SCHEME FOR OCEAN MODELING

The Taiwan multi-scale community ocean model (TIMCOM) that solves the 3D primitive equations using the third-order Robert-Asselin-Williams-filtered leapfrog scheme (RAW-filtered leapfrog scheme) and the fourth-order finite volume approach is recently developed to efficiently and accurately simulate various oceanic motions from coastal regions to global basins. The characteristics of RAW-filtered leapfrog scheme are carefully examined through the oscillation equation, 1D linearized shallow water equation, and idealized coastal Kelvin waves. In contrast to the conventional filtering method(s), the RAW filter improves numerical accuracy for amplitude by two orders while avoiding the time splitting instability. TIMCOM is then used to simulate global ocean general circulation. Overall, model results are in better agreement with observations, demonstrating the successful application of the RAW-filtered leapfrog scheme for ocean modeling. Keywords: TIMCOM, RAW filter, leapfrog scheme, third order, ocean modeling. (Abstract ID 10983)

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THE SEASONAL VARIATION OF YELLOW SEA WARM CURRENT

The Yellow Sea Warm Current (YSWC) is one of the principal currents in Yellow Sea in winter. To understand the variability of YSWC, mooring arrays with bottom-mounted ADCP were deployed on the western side of the central trough of the Yellow Sea in the summer, winter, spring and autumn of 2006/2007. The existence and distributional features of YSWC were studied by analyzing current profile data in the path of YSWC in conjunction with CTD data and SSH data over the observed area in the southern Yellow Sea. The results show the following. For the YSWC in winter, (1) The upper layer of the YSWC is strongly influenced by winter cold surge; its direction and speed often vary along a south-north axis
when strong cold surges arrive from the north. (2) The YSWC near the bottom layer is a stable northwest flowing current with a speed of 4 to 10 cm/s. By combining the analyses of the CTD data, we speculate that the core of the YSWC may lie near the bottom. (3) On a monthly average timescale, the YSWC is stably oriented with northward flow from the sea surface to the sea floor in winter. For the seasonal variability, YSWC begin appeared in the bottom layer in October and move up to near-bottom later is around 2 cm/s. On the top layer of Yellow sea, there is still Yellow Sea Cold Water Mass Circulation (YSCWMC) with diverse direction. The YSWC became strong in winter and last to the middle spring. From the mooring current data in spring, the speed of YSWC near bottom layer is around 2 cm/s. (Abstract ID 10369)

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SETTLING OF POROUS PARTICLE CLOUDS IN STRATIFICATION: A PROXY FOR MARINE SNOW

The settling of particulate organic carbon, or ‘marine snow,’ is a major pathway for carbon transport from the surface to the deep ocean. However, because marine snow is a hotspot for microbial activity, most particulate carbon is remineralized while sinking through the upper water column, limiting the total deep ocean export. Thus an understanding of the competing timescales of physical sinking vs. remineralization can lead to a better understanding of vertical carbon flux. Recent results have shown that individual porous particles experience enhanced residence times at sharp density interfaces. Here we present experimental results for the settling of a cloud of porous particles through water columns with various stratification regimes, e.g., homogeneous, sharply two-layered, and uniform stratified. The overall settling rate and the residence time at the stratified interface were analyzed by high resolution video and image processing techniques. We find enhanced residence times at the density interface that depend on particle size, porosity, cloud density, and stratification regime. The results contribute to our understanding of particulate fluxes in stratification and also point the way toward future experiments with real marine snow aggregates that will incorporate enzymatic remineralization. (Abstract ID 11454)

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NUMERICAL SIMULATION ON FINE SEDIMENT TRANSPORT IN THE OSCILLATORY BOUNDARY LAYER – THE ROLE OF RHEOLOGY AND PARTICLE INERTIA

Our recent 3D simulations of fine sediment transport in the oscillatory boundary layer reveal the existence of four distinct regimes ranging from well-mixed transport, to the formation of a hitoline, shear instabilities, and a complete flow laminarization over a range of sediment availabilities and settling velocities. The existence of these flow regimes is also supported by field observations. However, due to the pseudo-spectral scheme, complicated rheological stress closure and hindered settling are neglected. When laminarization occurs, sediment concentration increases dramatically close to the bed and field observations indicate the dominance of enhanced viscosity or non-Newtonian effects. To accommodate these complex mechanisms in a more realistic setting, a sixth-order compact finite difference scheme on non-uniform grid is implemented in the vertical direction to replace the Chebyshev expansion. This scheme can give a spectral-like dispersion relationship and produce highly accurate result. The new model is used to investigate the interplay between rheological stress and turbulence modulation in determining the transition of flow regimes and hydrodynamic dissipation. It also provides a new tool to interpret field observation of wave-mud interaction. (Abstract ID 10313)

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ON THE EASTWARD SHIFT OF THE ARABIAN SEA OXYGEN MINIMUM ZONE

Observations indicate that the upper part of the Arabian Sea oxygen minimum zone (ASOMZ; above 400 m) appears to the east of most productive regions along the western boundary of the Arabian Sea. So far there is no consensus about what causes this “eastward shift.” We use a coupled biological/physical model to investigate the processes that determine the “eastward shift.” The physical component of the model is a variable-density, 6-layer model, with each layer corresponding to a distinct dynamic regime or water-mass type. Its biological component consists of a set of advective-diffusive equations in each layer that determine nitrogen concentration in five compartments, namely, nutrients, phytoplankton, zooplankton, and two size classes of detritus. In addition, the model contains an oxygen compartment that reacts to production and consumption of dissolved inorganic nitrogen in the biological system. We show the predominante role of horizontal advection in generating the “eastward shift” in the upper ASOMZ. (Abstract ID 9492)

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AN INTRODUCTION TO THE CHINESE CLIMATE CHANGE NATIONAL BASIC RESEARCH PROGRAM PROJECT: ROME

Tropical Indo-Pacific Ocean is a key area affecting the climate of the East Asia and the oceanic circulation and ecosystem of the marginal seas of China. The National Basic Research Program project “Response of the Ocean to Global Warming and their impact on East Asia Climate and China Marginal Sea Carbon Storage” (ROME in abbreviation), aims at disclosing the dynamic and thermodynamic responses of the tropical Indo-Pacific Ocean to global warming, their effects on the East Asian climate through the ocean-atmosphere coupling, and their impact on the variability of carbon storage in the marginal seas of China. Four subjects of research will be conducted for the purposes mentioned above: 1) Processes and mechanisms of the response of tropical Indo-Pacific to global warming; 2) Impact of tropical Indo-Pacific warming on east Asian monsoon; 3) Impact of tropical Indo-Pacific warming on the climatology of the western Pacific Typhoon; 4) Variability of carbon storage in the marginal seas of China forced by the monsoon, Typhoon, and the Kuroshio. (Abstract ID 9556)

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DECADAL VARIABILITY IN THE SOUTHERN HEMISPHERE

This study reveals that a quasi-decadal variability exists in the climate system of southern high latitudes, particularly in the Southern Annular Mode (SAM) and subpolar to mid latitudes sea surface temperature (SST), based on in-situ observations, reanalysis data, and the 20th Century runs of IPCC A1B coupled climate models. Spectral analysis reveals that a statistically significant variability with periods of 8-16 years appears in the SAM indices based on about 20 years of reanalysis data and observed SST. Observations of air temperature and sea level pressure from weather stations confirm that the decadal variability is more evident in the mid-latitudes than over Antarctica. Cross-spectral analysis indicates that the SAM index is related to the SST in the subpolar seas of Antarctica and SST gradient at mid-high latitudes at this decadal frequency band. The SAM indices from 20th century runs (longer than 100 years) of eighteen IPCC coupled climate models are also examined for the decadal variability. Sixteen out of the eighteen models exhibit decadal variability in SAM that is significant at least at the 90% of confidence level and eight are significant at the 95% confidence level. Seven models produce significant covariability between SAM and subpolar SST at this quasi-decadal frequency. (Abstract ID 12258)

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MIXING AND SPREADING IN A LABORATORY SCALE RIVER PLUME

When estuary water is discharged into the coastal ocean it undergoes a transition as it changes from a laterally confined channel to an unconfined water body. This transition affects the structure of the flow and it has been hypothesized that it also affects the mixing dynamics. We designed two sets of laboratory experiments to investigate how the unconfined gravity current spreads after it leaves the estuary channel and how this spreading modifies the mixing. We did two experiments with identical inflow conditions, one with a continuous buoyant gravity current in a channel with the same width as the inflow and the other one with a freely expanded current. We measure the turbulent buoyancy flux within the core of the plume using simultaneous density and velocity fields. We find that the spreading rate decreases with increased inflow Froude number, consistent with the assumption that the plume expands at the internal wave speed. Although lateral spreading significantly modifies the vertical plume structure, the buoyancy flux in both two cases is similar. We present a simple theoretical model shows that that it may be because the spreading occurs preferentially at the surface, whereas the most intense mixing occurs closer to the plume base. Our results suggest that the vertical variation of spreading, which is often ignored in simplified plume models, may be important to understanding the mixing and dynamics of these systems. (Abstract ID 12075)

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between fluxes under first-year and multi-year ice. In the former, the ML temperature reached unusually low. Ocean heat fluxes to the ice estimated using buoy motion and mixed-layer (ML)
MARINE N O PRODUCTION

Northern Ocean (NO) production is a powerful greenhouse gas, generated at high levels within marine oxygen minimum zones (OMZs). If OMZs expand as predicted in response to climate change-driven processes, NO production could rapidly increase in regions such as the Eastern Tropical Pacific (ETP). However, future regional NO emissions are highly uncertain because data indicate that NO2 levels drop low enough (~<12 μM), NO can also be consumed by denitrification. Here, we use tracer-distribution methods to assess three comprehensive database of NO observations currently available (the MEMENTO database). This method enables us to better describe the relationship between apparent oxygen utilization rate and NO2 production rate. Incorporating this relationship, we use an ocean circulation model to assess the sensitivity of regional NO emissions to changes in upwelling, expanding OMZs, and decreasing O2 content. Based on our findings, we are able to refine expectations of how changing O2 concentrations will affect NO emissions from the ETP. (Abstract ID 9832)

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KUROYOSHI EXTENSION MEANDERS: MODEL DATA INTERCOMPARISON

Recent analysis from the Kuroshio Extension System Study, KESS, quantifies the frequency, wavelength and growth of Kuroshio Extension meanders between 143E and 149E with periods 3-60 days. Comparable analysis is performed on output from the high-resolution global Hybrid Coordinate Ocean Model (HYCOM) circulation model. Two model simulations are considered, one with data assimilation (“assimilation”) and one without data assimilation (“free”). Propagation speeds estimated along the Kuroshio Extension path from both simulations produce similar results to the KESS study; however, the assimilative run shows slightly longer wavelengths than the observations or the free run. KESS observations indicate that the interaction between Kuroshio Extension meanders and external westward propagating barotropic eddies is important for the local intensification of Kuroshio Extension meanders. Both model runs have westward propagating barotropic anomalies that interact with meanders. Sea surface height variance along the mean Kuroshio Extension path between 143E to 155E is about 4 times larger for both the baroclinic and barotropic sea surface height in the assimilation run compared to the free run. (Abstract ID 11232)

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MODELING THE SEASONAL AND INTERANNUAL VARIABILITY OF THE NORTHERN GULF OF CALIFORNIA SALINITY

Seven years (2003–2009) of output from a regional version of the HYbrid Coordinate Ocean Model (HYCOM) nested in global HYCOM are used to study the seasonal and interannual variability of the salinity in the northern Gulf of California (NGOC). Previous studies illustrate that the NGOC is characterized by an annual evaporation of ~0.9 m/day. This evaporation generates high sea surface salinity (SSS) water, which reaches a maximum in the NGOC (>37) and decreases to ~35 toward the entrance of the GOC. The NGOC surface water is interannually modulated by fluctuations in evaporation and by fluctuations in the low-salinity water transported into the region by poleward eastern boundary currents. The crucial role of the transport of low salinity water for the interannual variability of SSS is illustrated by the 2006 and 2008 fall seasons, which include the lowest simulated salinity of the period 2003–2009. The lowest salinity in 2006 and 2008 cannot be explained solely by evaporation because 2006 was characterized by the largest evaporation of the period 2003–2009. (Abstract ID 10631)

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FORECAST SKILL AND PREDICTABILITY OF OBSERVED ATLANTIC SEA SURFACE TEMPERATURES

An empirical statistical model is constructed to assess the forecast skill and the linear predictability of Atlantic sea surface temperatures (SST) variability. Linear inverse modeling (LIM) is used to build a statistical model that represents observed Atlantic SSTs between latitudes 20S and 66N from 1870 to 2009. LIM allows to fit and test a multivariate red noise model to the observed annually averaged SST anomalies. Forecast skill is assessed and shown to be on the order of 3 to 5 years. After a few years, the skill is greatly reduced especially in the subpolar region. In the stable dynamical system determined by LIM, skill of annual average SST anomalies arises from three damped eigenmodes and optimal growth are shown to be relevant for predictability and variability of Atlantic SSTs on interannual timescales. LIM might be a useful benchmark for interannual and decadal forecasts of SST based on numerical models. (Abstract ID 11312)

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OBSERVATIONS OF UPPER-OCEAN TURBULENCE DURING THE VOCALS EXPERIMENT

As part of the VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) Regional Experiment, properties of upper-ocean turbulence were measured with a microstructure profiler during ship-based surveys, and a longer time series of turbulent kinetic energy dissipation at 9-m depth was collected from a surface mooring. The ship-based surveys allow examination of vertical mixing and its horizontal and vertical variation. The turbulence data from the mooring allows an assessment of the temporal variability of upper-ocean turbulence in the region and its relation to the surface forcing (wind, waves, and surface heat flux) and to oceanic variability, such as near-inertial waves. These data will be used to characterize upper-ocean turbulence beneath the Southeast Pacific stratus deck, its variability, and its role in setting upper-ocean mean properties. (Abstract ID 12429)

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GULF OF MEXICO PILOT PREDICTION PROJECT (GOMEX-PPP): FORECAST SKILL AND MODEL INTERCOMPARISONS

The Gulf of Mexico Pilot Prediction Project (GOMEX-PPP) is evaluating a suite of ocean forecasting systems for the Gulf of Mexico. The forecasting systems being compared utilize different data assimilation and initialization methods, numerical models, atmospheric forcing, and boundary conditions. Hindcasts and extended forecasts, up to three months, are being evaluated for 2010 and the last quarter of 2011 to determine system predictability and forecast skill. This presentation will report on skill assessment of forecasts including Loop Current and Loop Current Eddy front positions, along-track sea-surface height from satellite altimeters, and Florida Current Transport. Additional metrics of predictability based on model-model intercomparison will be reported. (Abstract ID 12447)

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THE EFFECT OF TEMPERATURE ON THE EMERGENCE OF THREE COMMON TREMATODE SPECIES INFECTING THE CALIFORNIA HORN SNAILCERITHIDAE CALIFORNICA

Increasing temperatures with global climate change are expected to influence the transmission rate of parasitic diseases caused by trematodes. To better understand the role temperature plays in the transmission of larval trematodes, we investigated the thermal limits of larval emergence of three species of digenetic trematodes (Euhaplorchis californiensis, Stictodraco bancocci, and Himasthla rhigedana) infecting C. californica. Previous research has demonstrated that cercarial output increases with temperature. However, larval emergence cannot increase indefinitely due to physiological limits in the parasites and host. To investigate the limits of larval emergence we collected 100 infected snails of the three most prevalent trematode species at Carpenteria Salt Marsh Reserve, California. Experiments were conducted over a four-hour period using a temperature gradient platform that allowed a temperature range from 10–45°C to be tested. We found that the probability of larval emergence increased with temperature for the three species of trematode studied. Larval emergence was unimodal for all species suggesting that there is a thermal limit. However, the thermal limit of larval emergence might be set by the snail host not the larval trematode. (Abstract ID 10505)

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AN EVALUATION OF DOPPLER SONAR FOR SAMPLING BEDLOAD TRANSPORT

A significant component of sediment transport takes place in the form of bedload but measuring that component in a field setting is extremely challenging. Any physical instrumentation inevitably interferes with the flow and at high sediment concentrations, optical systems have a short operating range again raising the complication of flow interference. Acoustic systems provide the prospect of a non-invasive profiling capability in this environment. In particular, ADCP-based river flow studies have reported evidence of a moving bottom suggesting that a bedload signal is present. But how a velocity extracted from that
moving bottom is related to the actual sediment transport is not clear. This paper presents the results of modelling the acoustic return from a bottom layer that is moving with a speed distinct from both that of the stationary bottom and the boundary layer in the fluid above. The ability of Doppler systems to work in this environment and the possible sampling configurations for measurements are explored. (Abstract ID 11950)

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LARGE-SCALE OCEAN ALKALIZATION FOR MITIGATING CLIMATE CHANGE AND OCEAN ACIDIFICATION?

If carbon emissions keep increasing unabated over the next century, atmospheric carbon dioxide concentrations will reach levels unprecedented during the past 30 million years. The world ocean is currently acidifying, i.e. seawater pH and carbonate mineral saturation state are dropping, with possible negative impacts on calcifying organisms. Laboratory, ship-board, and mesocosm studies indicate a reduction in the calcification rate of many marine organisms as a result of a decrease in saturation state. Projections predict an undersaturated Arctic Ocean with respect to aragonite minerals within a few decades. The lack of reductions in global carbon emissions has prompted exploration of various options to mitigate ocean acidification. One option that is being discussed as a potentially feasible mitigation strategy is the addition of alkaline minerals to the surface ocean, although its feasibility and economic viability is yet unclear. In this work, we present numerical simulations with an ocean carbon cycle model to assess the consequences for and evolution of ocean carbonate chemistry and atmospheric CO2 if a large-scale program of ocean alkalization was put into place within the next decade and was run over the next centuries. (Abstract ID 9633)

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PREFIPITATION, LAND-COVER, AND RIVER CONTAMINANT LOAD.

Precipitation can affect the quantity of contaminants moved from terrestrial areas and deposited in streams. In the Northeastern United States climate change is predicted to increase the amount of precipitation and also change its timing. We investigated the concentrations of a contaminant (fecal indicator bacteria, FIB) along the length of the Saco River in Maine on a monthly basis. Land use and land cover along the river was determined from Landsat satellite imagery and aerial photography and predicted twenty years into the future using IDRISI modeling techniques. We also investigated the ability to use TRMM precipitation measurements to predict unsafe water quality at coastal sites. Analysis shows that concentrations of FIB increase in summer, particularly in urbanized regions of the watershed. In more rural areas, sporadic increases may be due to manure spreading. The land-use modeling effort shows that urbanization will continue to increase in coastal areas, calling for new controls on effluents. Use of TRMM measurements improves prediction of reduced water quality in coastal areas. The techniques described may be applied to other contaminants and regions as well. (Abstract ID 12039)

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SEAGRASS BLADE DYNAMICS IN UNIDIRECTIONAL, OSCILLATORY, AND COMBINED FLOWS.

Many processes of interest in seagrass meadows, such as wave attenuation, sediment transport, and nutrient uptake, are governed by hydrodynamics. Prediction of these processes requires an understanding of the complex interaction between fluid motion and canopy dynamics. This problem is simplified to a single seagrass blade in a known flow field. Bent blade height and blade bending excursion are estimated as functions of nondimensional parameters comparing rigidity, buoyancy, and inertial forces to drag. The blade is modeled as a series of plates attached by torsion springs to compute a numerical estimate of blade bending. The numerical model is validated with acoustic Doppler velocimeter measurements and high definition video from laboratory experiments with blades modeled as strips of low density polyethylene. Blade bending is explored in unidirectional, oscillatory, and combined flow in order to represent the range of conditions in the coastal environment. (Abstract ID 9801)

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PRAIRIE POTHOLE POREWATER CHEMISTRY AND ITS EFFECT ON PESTICIDE FATE.

Prairie pothole lakes (PPLs) are a critical component of the hydrology and ecology of central North America and represent one of the largest inland wetlands systems on the Earth. The hydrogeochemistry of PPL sediment porewaters is influenced by both the local groundwater and surface water. PPL sediment porewaters can contain abundant levels of inorganic reduced sulfur species (i.e., bisulfide (H2S) and polysulfides (S2−n)n), and dissolved organic matter (DOM), which are important as both nucleophiles and chemical reductants. Limited attention has been given to understanding the influence of hydrology on PPL porewater chemistry. The porewater chemistry, in turn, is critical to understanding the fate and persistence of pesticides in this heavily agricultural region. In this study, reduced sulfur species and DOM levels were characterized seasonally in PPL porewaters, and the abiotic transformation of seven dinotriazinoil pesticides was investigated in the collected porewaters. Results highlight the importance of reductive transformation as an abiotic natural attenuation pathway for pesticides entering the PPL sediment environment, and quantifying such process is crucial for modeling pesticide fate in the PPL region. (Abstract ID 9661)

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DIPPOLE GENERATION IN THE RED SEA FORCED BY THE TOKAR WIND JET IN SUMMER.

Remote sensing and in situ observations are used to investigate the ocean response to the Tokar Wind Jet in the Red Sea. The wind jet blows down the pressure gradient through the Tokar Gap on the Sudanese coast, at about 19°N, during the summer monsoon season. By comparing scatterometer winds with along-track and gridded sea level anomaly observations, it is shown that an intense dipolar eddy spins up in less than seven days in response to the wind jet. The eddy pair has a horizontal scale of 140 km. Maximum ocean surface velocities can reach 1 m/s and eddy currents extend at least 200 m into the water column. The eddy currents appear to cover the width of the sea, providing a pathway for rapid transport of marine organisms and other drifting material from one coast to the other. The dipole is observed to quasi-stationary, although there is some evidence for slow eastward propagation—simulation of the dipole in an idealized high-resolution numerical model suggests that this is the result of self-advection. (Abstract ID 9379)

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NOAA'S COASTAL OCEAN OPERATIONAL FORECAST SYSTEMS.

NNOS has been developing and implementing a hydrodynamic model-based Operational Forecast System (hereafter OFS) for sea ports, estuaries, the Great Lakes, and coastal waters. The OFS performs optimized automated integration of real-time observations, hydrodynamic model nowcasts (near present conditions) and forecast guidance, product dissemination, and continuous quality control and monitoring. NOAA’s OFS is based on three dimensional coupled hydrodynamic ocean models, the Regional Ocean Modeling System (ROMS) or the Finite Volume Coastal Ocean Model (FVCOM). It is developed and operated under a standard coastal ocean modeling framework (COMF), which provides the common framework and tools for all NOAA operational forecast systems that run on NOAA High-Performance Computer (Central Computer Systems) operated by National Weather Service’s National Centers for Environmental Prediction (NCEP). NOAA’s OFS provides forecast assessment and model evaluation before and after transitioning to operation. Real-time observations from the National Water Level Observing Network (NWLOM), Physical Oceanographic Real-Time System (PORTS), and USGS river gauges are used for model forcing and model assessment. NOAA’s OFS provides forecast guidance on hydrodynamic properties such as water level, current, temperature, and salinity in coastal waters out to 48 hours in the future four times per day. (Abstract ID 11674)

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IMPACT OF FRESHWATER DIVERSION ON THE FLUSHING OF LAKE PONTCARRAIGN AND COASTAL OCEAN.

In the early summer of 2011, the Bonnet Carré Spillway was opened again, only 3 years after its previous opening, to relieve the flooding pressure downstream including the city of New Orleans as the Mississippi River flood made its 100-year record. Historically, the Bonnet Carré Spillway has been opened roughly every 10 years. The Mississippi River flood this year was compounded by a couple of major weather systems in April that contributed a large amount
of precipitation. In this NSF-funded study, we conducted hydrographic and hydrodynamic surveys at the Bonnet Carre Spillway inside Lake Pontchartrain and deployed several instruments inside and outside the tidal passages of the lake. Using the information from these surveys and long term moorings, we have examined the impact of the large freshwater discharge from the Bonnet Carre Spillway into the Lake Pontchartrain and the effect on the flushing patterns of the lake as well as the coastal ocean east of the Mississippi River Delta. The long time series of flow data illustrate the complex system and the response to a freshwater flux. The effect of weather is one of our foci in the interpretation of the data. Several weather events are discussed in this paper. (Abstract ID 12262)

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CONNECTION BETWEEN T/S DECadal VARIATIONS IN THE SUBPOLAR NORTH ATLANTIC AND THE TROPICAL ATLANTIC AMOC

The importance of Labrador Sea deep convection and water mass anomalies on decadal variations of the Atlantic Meridional Overturning Circulation (AMOC) has been demonstrated in various theoretical and modeling studies. The observational evidence for such a link has been lacking, however, due to the lack of long term AMOC transport time series. In Zhang et al. (2011), we reported that the North Brazil Current (NBC) in the western boundary of tropical South Atlantic can be used as an indicator of AMOC, since most of the AMOC return flow is contained in the western boundary region in that particular longitudinal band. That result shows a quick response of the tropical Atlantic AMOC to the Labrador Sea deep convection. Here we will show that the tropical Atlantic AMOC, indicated by 5 decades of hydrographic data in the NBC, is highly correlated with the observed decadal temperature/salinity (T/S) anomalies of the upper ocean in areas from the western subtropical Atlantic to subpolar regions with progressively longer lead times to higher latitudes. It seems to suggest that subsurface ocean responses to AMOC transport variations at 6ºS (inferred from NBC) are associated with the slow oceanic transport processes. More detailed analysis of the connection between T/S anomalies in the subpolar North Atlantic and the AMOC in different latitudes in data assimilation and model results will be shown in this presentation. (Abstract ID 12600)

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THE FORMATION OF A SURFACE ANTICYCLONE IN THE SPRING YELLOW AND EAST CHINA SEAS

A surface anticyclone develops in April over the Yellow-East China Seas. The Yellow-East China Sea anticyclone (YESA) is confined in the marine atmospheric boundary layer but highly influential on the onset of sea fog season on the Chinese coast. This paper investigates the mechanisms for YESA formation using atmospheric reanalysis, satellite observations, and model experiments. Our analysis indicates that YESA is composed of three parts: (a) the westerlies to the north are the surface extension of the westerly wind jet; (b) the southerlies on the Chinese coast are due to the thermal wind between the warm continent and cool Yellow-East China Seas; and (c) the northeastern to the south are due to the thermal wind between the cool East China Sea and warm Kuroshio Current. A regional atmospheric model successfully simulates the YESA under realistic boundary conditions. In an experiment where the Bohai-Yellow Seas are replaced with flat land, the surface anticyclone is pushed south and forms along the new land-sea boundary, consistent with the thermal high mechanism. (Abstract ID 10756)

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INTERNAL TIDES AND MIXING ON THE WASHINGTON COAST

Internal tides are a primary mechanism for mixing of buoyancy and nutrients in coastal areas. Disentangling the relative importance of remote and local sources is an active area of research. We report observations of their energy, flux and mixing as observed from from 1) a surface mooring and a subsurface profiling mooring atop the continental shelf in 100 m of water and 2) two short shipboard studies in Juan de Fuca Canyon, which incises the coastal slope. In summer 2010, the surface mooring measured onshore shelf integrated semi-diurnal baroclinic fluxes with an average magnitude of 0.11 kW/m. These are interpreted as internal tides generated in the deeper ocean and propagating towards the coast. Shipboard ADCP and CTD measurements indicate M2 baroclinic fluxes with an average magnitude of 0.19 kW/m, predominantly away from the mouth of Juan de Fuca canyon, suggesting generation of internal tides inside the canyon. Dissipation rate near the JDF canyon, with an average value of 3×10^-8, is small compared to Monterey and Ascension Canyons, other submarine canyons in the west coast. We will present the data and discuss their implications. (Abstract ID 19080)

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THE MECHANISM OF TYPHOONS ENHANCING NORTHWARD TRANSPORT THROUGH THE TAIWAN STRAIT, CHINA

The transport through the Taiwan Strait during the period from 1 January 2005 to 23 November 2009 is estimated using numerical model simulations. Usually the transport is northward and varies seasonally because of the adjustment of the East Asian monsoon, but it is not stable due to strong northerly winter winds and typhoons. The effect of every typhoon on the transport is examined. Statistical data shows that on the average, about 5 percent of typhoons have a positive net contribution to the northward transport, 31 percent have a negative net contribution, 2 percent have no obvious net contribution and the remaining 62 percent have no perceptible influence. Our study first demonstrates that a few typhoons, which had unique tracks or special life cycles, enhanced the instantaneous northward transport during those years. The observations, obtained from the buoy deployed in the Taiwan Strait, support these results. Case studies indicate that the mechanism of typhoons enhancing the northward transport is mainly the combination of the weak southward wind stress at earlier stage, strong northward wind stress at later stage and northerly water level gradient forcing enhanced by typhoons. The Coriolis effect, appearing with across-strait sea level gradient, tries to maintain the enhanced northward transport. (Abstract ID 9738)

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CLIMATOLOGICAL MEAN CIRCULATION AND BIOLOGICAL PRODUCTION AT THE NEW ENGLAND SHELFBREAK

Our goal is to understand the climatological mean circulation and biological production at the New England shelfbreak region, which is the crucial interface between the Middle Atlantic Bight continental shelf and the open ocean. A 2D model oriented in the cross-shelf direction is used to investigate these processes. Steady-state model solutions nudged to the observed density field show strong seasonal variation in along- and cross-shelf and vertical velocity and along-shelf sea level tilt in response to the seasonally varying winds. A persistent upwelling of slope water is generated at the shelf break. A coupled planktonic ecosystem model predicts relatively high biological productivity in spring and summer seasons at the shelfbreak as a result of the upwelled nutrient-rich water. However, zooplankton grazing prevents significant accumulation of phytoplankton biomass at the site of the upwelling. The cross-shelf distribution of phytoplankton biomass predicted by the model is consistent with climatologies of both satellite and in situ chlorophyll observations, neither of which reveal significant mean enhancement at the front. The predicted enhancement of primary productivity (not biomass) constitutes an hypothesis that could be tested in the future with suitable measurements from the OOI Pioneer Array, and the outcome could have important implications for management of resources in the region. (Abstract ID 9900)

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INTERFERENCE BETWEEN TOPOGRAPHY CONFINED SUB-MESOSCALE EDDIES AND LABRADOR SEA DEEP CONVECTION

Labrador Sea is one of the open ocean deep convection locations, and an important component as ‘push’ end to the global thermohaline circulation. Labrador Sea is characterized with strong boundary currents and sub-mesoscale eddies. The Irminger Rings (IRs) shed by the Irminger current are dominantly anticyclones about 50 kilometers in diameter. They are generated by the steep gradient of bathymetry west to Greenland, their seasonal variability is believed to be controlled by the interior-boundary temperature contrast. The stronger winter cooling induces stronger contrast and more warm-cored IRs, which on the other hand will favor restratification instead of deep convection. Our study has focused on the close interference between the IRs and the convection ‘chimneys’ in a more realistic sense than previous studies. The Labrador Sea current system is built with ROMS, and 6-hourly NCEP atmospheric flux and blended SeaWind are used to reconstruct the 2007-2008 deep convection event. Detailed heat and mass exchange has been investigated. This interference was found to be one of the physical mechanisms for the inconsistency between extreme heat loss and deep convection events. (Abstract ID 12557)

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THE SKEWNESS OF SEA-SURFACE SLOPE AND WIND STRESS
Sun glitter observations have shown an empirical correlation between the skewness of sea surface slopes, and wind speed and direction (Cox and Munk, 1954, Beven and Henriet, 2006). Skewness can arise from various causes, but recent studies show that, in laboratory wind-wave channels, slope skewness is associated with capillary waves and very short gravity waves accentuated while riding on the down-wind faces of longer gravity waves. Neither the capillaries nor the ultra short gravity waves depart appreciably from a symmetric wave form, but the wave form are tilted by the slope of the longer gravities (Longuet-Higgins, 1962). The same laboratory studies also show that variations of turbulent dissipation rate with height in the air flow over slick covered water (no capillaries or slope skewness observable) and clean water differ significantly. The energy flux transferred into surface water is equal to the total stress time the mean flow velocity subtracting the turbulent dissipation throughout the boundary layer. We suggest that wind stress is correlated with the variation of turbulent dissipation rate in the wind and that skewness is a valid measure of wind stress. (Abstract ID 12221)

Correlation of Aerosol Optical Thickness and Chlorophyll-A Concentration All Over the World

Chl-a has a close relationship with the nutrients and the atmospheric sedimentation is a good source for the nutrients of the sea. Moreover, the value of AOT can stand for atmospheric sediment concentration. So, there should be a coupling relationship between AOT and Chl-a. The correlation analysis between AOT and Chl-a had been early assessed by previous works in South China Sea and the Greenland Sea. The data analysis revealed that AOT had a big impact on the biogeochemistry of the South China Sea and there was a time-lag correlation between AOT and Chl-a in Greenland Sea. Using 12 years’ of AOT and Chl-a from the NASA/MODIS and SeaWIFS sensors, this paper studies the distributions and the coupling relationship between AOT and Chl-a all over the world. The correlation map shows some interesting areas on the earth. It is found that the highest positive correlation areas of the AOT and Chl-a time series are in the east coastal area of Africa, Baltic Sea, Caspian Sea and the band area in the Pacific between south Japan and San Francisco of USA; the highest negative correlation areas of the Chl-a and AOT time series are in The Mediterranean, west-south and east-south coastal areas of Australia. There should be some other parameters which can affect this kind of relationship except SST, irradiation, ocean current and nutrients. Correlation analysis of this paper provided some useful information for scientists in the field of biogeochemistry. (Abstract ID 9874)

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Linear Trend of Regional Sea Level Change in the Pacific Ocean and Its Relationship with Background Decadal Oscillation

The sea level linear trend (SLLT) is commonly used to quantify sea level change, often over short periods due to data limitation. However, the SLLT over short periods such as altimeter era is complicated by large-scale oscillatory climate phenomena which affect regional sea level on decadal to inter-decadal time scales, making the meaning of local SLLT over a short period (<20 years) questionable. In particular, it is not straightforward to distinguish the anthropogenic sea level change from fluctuations associated with natural climate variability. A simple mathematical model is developed here to understand the relationship between the SLLT and background climate oscillations, especially the sensitivity of SLLT derivation to the definition base period (starting and ending points, and its length). In the Pacific, the regional SLLT patterns over the altimeter era (1993-2009) can be explained quite well by the linear trend of background natural climate variability - the Pacific Decadal Oscillation (PDO). Possible physical mechanisms underlying PDO-related sea level changes are proposed. More analyses with reconstructed historical sea level dataset are also carried out to illustrate the sensitivity of regional SLLT to the background climate variability. (Abstract ID 18081)

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Investigation of Freshwater Transport on the Texas-Louisiana Shelf Using a High-Resolution Model

A high-resolution coastal model of circulation is used to investigate the freshwater transport associated with Mississippi and Atchafalaya Rivers on the Texas-Louisiana shelf. The coastal model (ROMS) is forced with realistic forcings, and nested to the Gulf of Mexico HYCOM, which provides realistic open boundary conditions. The simulation is carried out over an 8-year period from 2003 to 2010. The Mississippi and Atchafalaya freshwaters are each tagged with dye so that the freshwater transport associated with each river can be tracked separately. The seasonal patterns of the freshwater transport are consistent with prevailing winds, but with significant interannual variability. A mass balance is used to quantify freshwater flux across the 50- and 100- m isobaths of the shelf region. The flushing times for the Mississippi and Atchafalaya rivers discharges on the shelf are estimated based on the freshwater volume and the discharge rate. The flushing times for both rivers range from 3-6 months during spring to 12-15 months in the fall. (Abstract ID 10547)

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Particle Subpopulations from VSF Inversion

Particles of different composition and sizes contribute to the Volumetric Scattering Function (VSF) differently. An inversion method was developed to characterize particles and their subpopulations from VSF measurements. The inversion results using VSF data from coastal areas around US not only agree with LISST measurements but also reveal much detailed compositional and sizing information regarding submicron particles, individual phytoplankton species, detritus, and/or mineral particles. The results helped to understand local algal bloom and dynamics of dissolved and particulate particles. (Abstract ID 11329)

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Coupled Physical/Biological Modeling of Atlantic Surfclam Larval Transport and Responses to a Warming World in the Middle Atlantic Bight

The Atlantic Surfclam (Spisula solidissima) is a commercially significant species along the Northeast U.S. coast. In the past, systematic variations in the surfclam sub-populations in this region, thought to be associated with progressive environmental change, have been reported. The larval dispersal stage of the surfclam plays a key role in total recruitment rate and surfclam sub-population connectivity. As part of an NSF-funded Climate, Natural and Human Systems (CNHS) project, we have coupled a physical circulation model of the Northeast U.S. continental shelves and a surfclam individual-based larval model, with the intent to study surfclam population connectivity and response under past, present and future climate conditions. We first assess the simulated circulation and larval model results using available contemporary observations. In a further study, we focus upon the consequences of the observed warming event in the Delmarva region from 1999 to 2002, which has been associated with a significant observed displacement of the local surfclam population. We explore the mechanisms, both physical and biological, of the observed population variations, and comment upon analogous population changes currently ongoing elsewhere in the region. (Abstract ID 12801)

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The Monterey Bay Upwelling Shadow Frontal Complex: Results from an Ecosystem Process Study

Meteorological and oceanographic sheltering creates physically distinct and biologically enriched locales within “upwelling shadow” environments of coastal upwelling systems. Strong density fronts develop as cold upwelling filaments encounter warm, stratified waters in the upwelling shadow. During 10-22 June, 2011, we used autonomous underwater vehicles (AUVs), drifters, moorings, ships, and satellite remote sensing to study the upwelling shadow frontal complex of Monterey Bay, California (hereafter MBUS). During a transition from relaxation to upwelling, horizontal interleaving of regional water types developed in the frontal zone. As upwelling intensified, the warm MBUS expanded and developed a strong subsurface chlorophyll maximum. Multiple density fronts developed within the MBUS, and subsurface

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phytoplankton layers outcropped to the surface in these density fronts. Alternating eruption and retractions of the outer MBUS front occurred on time scales < 1 day. Using autonomous feature recognition, an AUV acquired water samples within the MBUS front and in waters on both sides. Laboratory molecular analyses revealed their distinct plankton populations. In subsequent relaxation of upwelling, the density front waned, but enhanced chlorophyll persisted near-surface at the MBUS outer boundary. (Abstract ID 9899)
They are important in predicting shoreline impact locations of oil spills and in harmful algae bloom initiation. Physical processes that control the convergent flows are investigated using a numerical hydrodynamic model (ROMS) for the Texas-Lousiana shelf. The model demonstrates positive skill at reproducing surface currents when evaluated against buoy observations. Potential mechanisms that create regions of convergent flows include wind direction, coastline curvature and buoyancy forcing. Convergence could occur where the alongshore winds change direction, or where wind-driven upcoast flows meet buoyancy-driven downcoast flows. Preliminary results suggest a high correlation between the alongshore winds and surface currents, indicating that alongshore-variation in wind is the primary factor determining surface convergence. (Abstract ID 10775)

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THE ARRESTED AGULHAS RETROFLECTION
Paleoceanographic data indicate that the Agulhas leakage into the South Atlantic was dramatically reduced during glacial. In previous studies, we hypothesized this was due to a northward shift of zero WSC that, in turn, forced the retroflection to occur farther north, where the coastline slant is steeper. Here we propose that strong westerlies (with stress of about 0.4 Pa), which were supposedly common during glaciations, could also have arrested the leakage. This arrest occurred because the wind stress opposed the momentum flux associated with the retroflection and, therefore, the retroflection did not shift in latitude. We use a simple nonlinear model to show that, under the above conditions, the eastward wind stress compensates for the westward flow-force associated with the retroflection, thus avoiding the development and shedding of rings. According to the formula that we developed for the arresting wind stress, wind typical for the Agulhas region during glacial times significantly affects rings of large PV. Our results are in agreement with numerical simulations showing that the wind tends to destroy the detached rings by squeezing them onto the wall. (Abstract ID 9719)

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EFFETS OF INTERANNUAL SALINITY VARIABILITY ON THE DEVELOPMENT OF ENSO EVENTS DIAGNOSED FROM ARGO
Oceanic salinity in the tropical Pacific has been of increased interest recently due to their roles in the El Niño-Southern Oscillation (ENSO), the global climate and water cycle. In this work, the role of salinity in ocean analyses is carried out based on the full three-dimensional temperature and salinity database of the 2001-2010 period in the tropical Pacific. The diagnostic analyses clearly demonstrate that the salinity fields play a significantly large role in modulating the wind stress, which is important for the westward flow-force associated with the retroflection, thus avoiding the development and shedding of rings. According to the formula that we developed for the arresting wind stress, wind typical for the Agulhas region during glacial times significantly affects rings of large PV. Our results are in agreement with numerical simulations showing that the wind tends to destroy the detached rings by squeezing them onto the wall. (Abstract ID 9719)

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UNMASKING THE NATURE OF OCEAN DOM THROUGH THE MICROBIAL CARBON PUMP ---- FROM GENES TO ECOSYSTEMS
The majority of marine dissolved organic matter (DOM) is resistant to biological degradation and thus can remain in the water column for thousands of years, constituting carbon sequestration in the ocean. To date the origin of such recalcitrant DOM (RDOM) is unclear. The microbial carbon pump (MCP) concept emphasizes the microbial transformation of organic carbon from labile to recalcitrant states, covering a wide study range from gene to ecosystem levels. ATP binding cassette (ABC) transporters are used as an example for the microbial processing of DOM at the genetic level. They can import labile DOM into and export refractory DOM out from the cells. The compositions of the ABC transporter genes of the two major marine bacterial clades Roseobacter and SAR11 are demonstrated to be distinct in DOM processing. Under global warming scenarios, partitioning of primary production into DOM could be enhanced, and thus the MCP could play a more important role in carbon sequestration by the ocean. Joint efforts to study the MCP from multiple disciplines are required to obtain a better understanding of ocean carbon cycle and its coupling with global change. (Abstract ID 10717)

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HOW TEMPERATURE AND ROUGHNESS CHANGES DUE TO A SLICK INFLUENCE THE MOTION OF SURFACE OIL SLICK: AN IDEALIZED STUDY
The University of Washington planetary boundary layer model is used to examine how temperature and roughness changes due to a slick influence the motion of slick. In idealized experiments, uniform geostrophic winds cause surface winds to blow across a square-stapled oil slick. Physically significant changes occur in surface wind speed, surface wind divergence, wind stress divergence and curl, and Ekman transport in the transition zones between water and oil. These changes appear linearly related to the magnitude of SST gradients in the transition zones. There are also changes in surface wind speed, wind stress in water and oil interior owing to different roughness of water and oil. Changes in wind and wind stress divergences are strongest where winds blow perpendicular to isotherms and the wind stress curl is strongest where the winds blow parallel to isotherms. The magnitude of the net Ekman transport in the transition zones becomes greater in response to an increasing SST gradient. The cycloidal rotation of net Ekman transport due to SST gradient causes the oil slick to spin cyclonically and spin faster when SST gradient increases. (Abstract ID 11255)

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NONLINEAR DYNAMICS OF TWO WESTERN BOUNDARY CURRENTS COLLIDING AT A GAP

The nonlinear collision of two western boundary currents (WBCs) of equal transport at a gap of the western boundary is studied using a 1.5 layer reduced gravity quasigeostrophic ocean model. It is found that, when the gap (of width 2a) is narrow, as 7.3LM (LM the Munk thickness), neither of the WBCs can penetrate into the western basin due to restriction of the viscous force. When 7.3LM <= a <= 9.0LM, both WBCs penetrate into the western basin for small transport and choke for intermediate transport, and shed eddy periodically for larger transport. When a > 9.6LM, no steady choking state is found. Instead, the WBCs have only two equilibrium states: the penetrating and the periodic eddy-shedding states. A Hopf bifurcation is found for a > 9.0LM. The Reynolds number (Re) of the Hopf bifurcation is sensitive to the magnitude baroclinic deformation radius, being small for larger deformation radius. In addition, a reverse Hopf bifurcations is identified in the decreased Re experiments, occurring at a smaller Re than that of the Hopf bifurcation. The Re of the reverse Hopf bifurcation is not sensitive to the magnitude of the baroclinic deformation radius. Hysteresis behavior of the WBCs are found for a > 9.0LM, due to the existence of the Hopf and reverse Hopf bifurcations. (Abstract ID 9645)

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SILICON ISOTOPE CONSTRAINTS ON SOURCES AND UTILIZATION OF SILICATE IN THE NORTHERN SOUTH CHINA SEA

We measured for the first time seawater δ30SiBSi and δ30SiSi(OH)4 in the northern South China Sea (NSCS). δ30SiBSi values were systematically lower than the corresponding δ30SiSi(OH)4 in the surface mixed layer (< 50 m) on the shelf and slope. In contrast, δ30SiBSi were equal to δ30SiSi(OH)4 in the surface mixed layer (> 50 m) of the deep basin and δ30SiBSi in waters below were significantly higher than the corresponding δ30SiSi(OH)4. By comparing the field data with calculation according to Rayleigh or steady state models, we demonstrated surface waters on the inner shelf were largely fed by nutrients from the Pearl River input. While the primary Si(OH)4 source for the euphotic zone on the outer shelf and slope was upwelling or mixing from underlying waters, the Si(OH)4 in the surface mixed layer of the NSCS basin might originate from horizontal mixing with highly fractionated waters. As a consequence, the Si isotope dynamics in the NSCS are largely modulated by variable biological fractionation of Si derived from different mixing-induced initial conditions rather than any single source water. (Abstract ID 10110)

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LOOP EDDIES, AGEOSTROPHIC VELOCITIES AND THEIR IMPACTS ON PRIMARY PRODUCTIVITY IN THE GULF OF MEXICO

Vertical velocities associated with ageostrophic motions at the ocean subsurface may provide an efficient way to bring deep, nutrient rich waters into the oceanic euphotic layer. Using a regional coupled physical and biological model, the authors construct an array of high resolution simulations forced by winds averaged at different temporal resolution (monthly- and six-hourly) in the western Gulf of Mexico. The response of a Nutrient-Phytoplankton-Zooplankton-Detritus (NPZD) model under these forcing conditions is examined. The six-hourly forcing contains a wider spectrum of energy including the near inertial frequency band, which can reinforce the vertical velocities by triggering near geostrophic velocity profile of this eddy suggests that the velocity of the outer edge can exceed 12cm/s, and its vertical extent can reach 200m. Observations suggest that these eddies can significantly change the bifurcation location of NEC. Model experiments further suggest that cyclonic eddies can put the bifurcation latitude northward, while anticyclonic eddies can put it southward. Intraseasonal variations of the NECBL are identified for the first time, the dynamics of which are induced by mesoscale eddies east of Philippine. The seasonal cycle of NECBL may be contaminated by mesoscale eddies east of Philippine. (Abstract ID 10147)

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STATISTICAL EVALUATION OF OCEAN REMOTE SENSING SALINITY MEASUREMENTS: A COMPARISON BETWEEN AQUARIUS AND IN SITIO OBSERVATIONS

In general, sea surface salinity (SSS) measurements are obtained from two data sources: (1) in situ observations provided by current instrumentation, e.g., Argo floats; (2) remote sensing measurements, e.g., Aquarius/SAC-D (launched June 2011). Because the surface observations are point measurements collected in a patchy and highly variable field, whereas the satellite measures a spatial average over a footprint with a scale of approximately 100 km, the different spatial scales make calibration and validation of the satellite data problematic. As a result, this paper is an attempt to reconcile the two measurements, taking the adjustment of spatial scales into account: we first estimate the SSS field over the globe by combining the Argo float data with the World Ocean Atlas 2005; and then evaluate the SSS from the Aquarius satellite-derived fields by comparing with the estimated salinity surface. More specifically, the kriging method is used to generate estimates of a full spatially-averaged SSS field, which are further compared with the satellite-derived estimates. Moreover, to predict a surface with smooth boundaries, overlapping regional studies are also considered. (Abstract ID 11219)

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DIFFERENT ENHANCEMENT OF PARTICLE EXPORT OBSERVED IN FIVE MESOSCALE EDDIES IN SOUTHERN CHINA SEA

Increasing studies has shown significant biogeochemical variability associated with mesoscale eddies in the ocean. We examined Particulate Organic Carbon (POC) fluxes in both anti-cyclonic (ACE) and cyclonic (CE) eddies east of Philippine. The seasonal cycle of NECBL and its vertical extent can reach 200m. Observations suggest that these eddies can significantly change the bifurcation location of NEC. Model experiments further suggest that cyclonic eddies can put the bifurcation latitude northward, while anticyclonic eddies can put it southward. Intraseasonal variations of the NECBL are identified for the first time, the dynamics of which are induced by mesoscale eddies east of Philippine. The seasonal cycle of NECBL may be contaminated by mesoscale eddies east of Philippine. (Abstract ID 9627)

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MESOSCALE CIRCULATION ON THE SHELF SLOPE REGION NORTH OF ELEPHANT ISLAND, SOUTHERN DRAKE PASSAGE, AND ITS IMPACTS ON IRON TRANSPORT

New Iron availability in Southern Ocean high nutrient low chlorophyll (HNLC) regions is critical in determining primary production and carbon export. A winter cruise in July-August 2006 was conducted to study circulation in the Southern Drake Passage and Bransfield Strait, and iron delivery processes. Results from current, hydrographic and trace metal measurements
revealed a clockwise circulation consistent with that of the summer season observed in previous studies: 1) a westward current on the shelf slope of the western Antarctic Peninsula driven by density gradients between the Bransfield Strait basin water and cold fresh shelf water; 2) the persistent Gerlache Strait Current that delivers the warm water to the northern shelf, and the resulting sediment transport due to wave-current interactions, we utilize a wave-resolving Reynolds Averaged Navier-Stokes (RANS) model with a k-ε turbulence closure and a standard suspended sediment transport model. This model is used to simulate field-scale wave-current interaction. Turbulence is significantly larger (smaller) when waves propagate against (follow) the current, suggesting an intra-wave interaction mechanism that contributes to the wave-averaged TKE. This feature also affects the suspended sediment transport through turbulent suspension and sediment-induced density stratification. Second, models result proposed the production of wave-averaged TKE due to intra-wave interaction contributes a significant amount of the total production. Hence, standard two-equation closure in typical wave-averaged coastal modeling scheme needs to be revised when wave-current interaction is significant. (Abstract ID 9647)

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UV AND FLUORESCENCE CHARACTERISTICS OF DOM FROM THE GULF OF MEXICO 5 MONTHS AFTER THE DEEPWATER HORIZON OIL SPILL
UV-vis and fluorescence excitation emission spectroscopy and PARAFAC modeling technique were used to characterize dissolved organic matter (DOM) and to track the fate and transport of oil in the northern Gulf of Mexico five months after the Deepwater Horizon oil spill. Two major types of DOM are found in the water column: one with a positive correlation between DOC concentration and SUVA254 values showing natural DOM characteristics for upper water column samples; the other with anomalously high optical yields and a negative correlation between SUVA and DOC found exclusively in deep waters with a characteristic salinity of 34. 96±0.03, showing the influence of oil. Based on PARAFAC analysis, five fluorescent DOM components could be identified at Ex/EEm maximum wavelengths of 264/460 nm (UV-humic-like), 240/409 nm (also humic-like), 226/330 and 270/330 nm (oil-related DOM), 230/265 nm and 324/390 nm (marine humic-like), respectively. The third component, with fluorescence characteristics similar to those found in samples from laboratory oil degradation experiments and other oil affected field samples, was hypothesized to be mostly derived from photochemical degradation of oil. (Abstract ID 11847)

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THE ANNUAL AND INTERANNUAL VARIATIONS OF THE SEA SURFACE CURRENT IN THE SOUTHERN TAIWAN STRAIT OBSERVED BY THE OSMAR HF RADARS
Annual and interannual variations of the sea surface currents in the west of Taiwan Bank on the southern Taiwan Strait were analyzed by using the OSMAR HF radar observations from the Jan 2006 to Apr 2009. The results show, the surface currents in the water channel on the west of Taiwan Bank are composed of the evident seasonal fluctuate component and the steady northward flow component. Affect by the seasonal monsoon, the annual variations of the surface current are notable, the longshore currents and winds have the obvious linear relation. Beside the seasonal variation is the steady northward flow with speed at about 10 m/s. The multi-year observations show the surface currents have the distinct interannual variations, southern flow strong in the 2007/08 winter is evident stronger than those in the other years. The bottom mounted adcp current profiles show that the longshore currents are much different from those in the 2006/07 winter, the northward flow is much weaker and the southward flow in most water depths. The La Nina in the year 2007/08 strengthens the northeast monsoon, maybe the main reason for the current anomalies in the research field. (Abstract ID 12806)

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TWO-DIMENSIONAL FERROUS ION DISTRIBUTIONS IN MARINE SEDIMENTS REVEALED BY A NOVEL PLANAR OPTICAL SENSOR
A planar optical sensor was developed for measuring two-dimensional ferrous distributions in marine sediments with high resolution. Ferroceine is used as indicator and the sensor absorbance shows good linear relationships with ferrous iron concentration in the range of 0 – 200 μM, with a detection limit of 4.5 μM. The sensor response time is 30 min at room temperature, and response is independent to temperature, dissolved oxygen, salinity and pH change under anoxic conditions. No interferences from other major components and trace metals in seawater were observed. The sensor is simple, stable and precise, and has been successfully used to measure two-dimensional ferrous distributions in intertidal flat and subtidal sediment samples. The sensor reveals the complex heterogenous distribution patterns of ferrous that are often associated with both inhabited and abandoned biogenic structures in surface sediment. When images are spatially averaged, 1-D vertical profiles typically measured by pore water separation techniques are readily obtained. Traditional sampling obscures the true range of ferrous iron actually present, whereas the sensor provides a basis for accurate resolution of kinetic, equilibrium, and transport relationships. (Abstract ID 12596)

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COASTAL DIURNAL WARMING
A diurnal warming (DW) cycle exists in the upper ocean, the study of which is important for satellite SST validation, heat budget calculations and understanding coral reef bleaching. Compared to the open ocean, the coastal DW has more spatial variability, is subject to bottom mixing, tides and sea breeze effects, and has been seldom addressed. It is the focus of our study, which concentrates on in-situ data analysis and modeling. The in-situ dataset from the Caribbean Sea allows us to study the vertical temperature profile evolution. Wind speed is shown to significantly affect warming amplitude and profile shape. During high winds (>9 ms⁻¹) the warming is simulated well using a simple well-mixed model. The dataset from the Australian Great Barrier Reef provides the coastal DW at more than 200 locations in a wide range of environments. Spring-neap tide cycles are clearly reflected in DW amplitude; also local topography and shoreline shape significantly affect DW. Future work will include modeling DW time series and profiles in weak and intermediate wind speed, as well as the analysis of satellite SST datasets. (Abstract ID 10604)

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EFFECT OF KRILL GRAZING ON PLANKTON SIZE SPECTRA DURING LATER AUSTRAL FALL IN THE WESTERN ANTARCTIC PENINSULA REGION
Grazing of krill on the size spectrum of plankton in late austral fall season was studied using a Laser In Situ Scattering Transmissometry (LISST, 1-250 mm), Laser Optical Plankton Counter (LOPC, 100 mm-3 cm), and Acoustic Doppler Current Profiler (ADCP) in the Galache strait and Wilhelmia Bay, western Antarctic Peninsula, during a field study on krill aggregation and while foraging behavior conducted in May-June 2009. The LISST and LOPC measurements were taken with CTD casts for plankton while ADCP volume backscattering data were acquired continuously for krill biomass. In a month, these measurements were repeated 3 times
for temporal evolution of the plankton-krill community structure and the spatial distribution in the study area. The measurements of LOPC, LOPC and ADCP were groundtruthed by results from net tow samples. The size and abundance measurements of LOPC and LOPC showed a continuous size spectrum of plankton. The large spatial variations in terms of size-abundance structures, and correlations with krill abundances and distributions were observed. The size dependent feeding behavior of Krill was interpreted from the differences in size structures of plankton and krill distributions, and the mechanisms supplying plankton to the krill aggregation in Wilhelmina Bay was interpreted with hydrographic and current data. Analysis indicates krill took the advantage of advection of plankton, and led omnivorously during the late fall season. (Abstract ID 10953)

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LOW-FREQUENCY SEA LEVEL VARIABILITY IN THE SOUTHERN INDIAN OCEAN

Sea levels in the southern Indian Ocean display significant interannual to decadal variability. North of the Australian coast, it has been demonstrated that sea level variability is mostly modulated by remote wind forcing in the tropical Pacific through the equatorial and coastal waveguide. In this study, a linear reduced gravity model, forced by the ECMWF interim wind stress curl, is used to investigate the relative importance of local wind forcing and remote forcing from Pacific to the sea level variability in the interior southern Indian Ocean. Model simulated sea levels are well correlated with altimeter observations at the dissipation timescale of 2-3 years, suggesting that the low-frequency sea level variability could be well explained by the nondispersive baroclinic Rossby wave adjustment. North of the Equatorial Current bifurcation latitude (17S), low-frequency sea level variability exhibit large amplitude on interannual time scale, primarily driven by local wind stress curl with only a minor influence from the remote Pacific forcing. In contrast, the variability around 20S displays lower amplitude due to weaker wind variations at this latitude band, whereas the Rossby waves generated at the eastern boundary have relative large amplitude and play more important roles in modulating the sea level variations in the western basin. (Abstract ID 12816)

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MAKING THE CONNECTION BETWEEN METATRANSCRIPTOMICS AND BIOGEOCHEMICAL CYCLES IN THE AMAZON RIVER PLUME

We collected eukaryotic metatranscriptomes to analyze gene expression in the Amazon River plume waters as part of the ANACONDA project. The six stations examined contained coastal diatom blooms, Trichodesmium-filled oligotrophic waters, and diatom-diazotroph association (DDA) blooms. Salinity ranged from 20.7 to 35.9. Each station included two true metatranscriptome replicates, yielding approximately 10 million U70bp cDNA sequences through Illumina sequencing. The sequences were compared to the entire RefSeq dataset using BLAST analysis within MG-RAST. Additionally, we compared all sequences to a select set of genes relevant to biogeochemical cycles. For example, carbonic anhydrase (a gene responsible for converting HCO₃⁻ to CO₂) was highly expressed at the lowest salinity station, and it had a strong correlation with pCO₂. These analyses against collaborative nutrient, physical, and optical measurements will allow investigation of the correlation between gene expression and biogeochemical processes, including the carbon, nitrogen, sulfur, and phosphorus cycles, potassium, iron, POM, DOM, silica, photosynthesis, pigment and vitamin biosynthesis. (Abstract ID 9618)

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THE LAST LAP: REGULATION OF NEAR-BED MEROPLANKTON TRANSPORT

Gravitational sinking could be a liability or an opportunity, depending on planktonic life style. Holoplankton (permanent) is adapted for remaining suspended in the water column. Sinking is neutralized by buoyancy, form drag or swimming. Conversely, meroplankton (temporary) is localized by bottom stress, form drag or swimming. The opposite tendencies occur during El Niño. In order to evaluate the MOC through the subtropical gyre of the Pacific Ocean, we apply the methodology developed for 7.5°S at a range of higher latitudes. (Abstract ID 9930)

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DISTRIBUTIONS OF NANOMOLAR REACTIVE PHOSPHATE AND ALKALINE PHOSPHATASE ACROSS NORTH ATLANTIC SURFACE WATERS

The hypothesis that much of the Atlantic Ocean is P limited is very data limited due to few measurements of reactive (ortho-) phosphate at nanomolar levels and sampling resolution sufficient to compare the cycling of phosphate with physical and biogeochemical processes. As part of the 2010 (Lisbon, Portugal to Charleston, South Carolina, USA) and 2011 US GEOTRACES cruises (Woods Hole, Massachusetts, USA to Cape Verde), we used liquid core waveguides and continuous flow colorimetry to measure surface water phosphate concentrations at nanomolar levels. Data were averaged every 30 seconds, and alkaline phosphatase assays were conducted on 6 hour intervals. Depth profiles for discrete samples were also taken at 24 stations along the transects. Along the two transects maximum surface concentrations at 100 nM PO4-3 were found in the upwelling region off North Africa and in the coastal region off N. America and minimum surface concentrations at 2-5 nM PO4-3 in the oligotrophic waters of the Central Gyre and Sargasso Sea. Data will be discussed in terms of input and transport processes, as well as internal cycling of the element. (Abstract ID 10432)

SENSORY EXPLOITATION AS A MECHANISM STRUCTURING MARINE COMMUNITIES

On rocky wave-swept shores, sea stars drive species abundances and distributions through selective predation on mussels, a dominant space competitor. This keystone interaction is established to a large degree by behaviorally mediated processes that rely on sensory inputs. Here, we isolated, purified, and identified the complete amino acid sequence (244 residues; mol mass = 27.8 kDa) for a protein, KEYSTONin, requisite to mussel biomineralization. In addition, the full nucleotide sequence for the gene encoding this protein was determined, and the gene product cloned and expressed in a heterologous system. The molecule is synthesized naturally by cells in mantle tissue and excreted into the extrapallial fluid before localization in the zone of new growth along the shell margin. We embedded purified KEYSTONin in a gel polymer at native tissue concentrations to create “faux prey”. Seastars did not distinguish between faux prey and live mussels. They fed equally, without preference, on both prey types in laboratory and field experiments. Whereas mussels use KEYSTONin to produce shell material that serves effectively as a morphological defense against predators, seastars have evolved offensive weaponry and sensory mechanisms for eavesdropping on this compound as a seminal feeding cue. Sensory exploitation thus mediates the behavior of a keystone predator and plays a crucial role in structuring rocky intertidal communities along wave-swept shores. (Abstract ID 11844)

COMPARING THE UTILITY OF BOTH HYPERSPECTRAL AND MULTISPECTRAL SENSORS FOR INVESTIGATION OF NEARSHORE COASTAL ENVIRONMENTS

Imagery from a suborbital hyperspectral imager (SAMSON) and an orbiting multispectral imager (WorldView2) were compared for their ability to map and quantify submerged habitats across Saint Josephs Bay, Florida. Benthic types ranged from bare sand to dense seagrass in optically shallow water. Satellite imagery was atmospherically calibrated using coincident ground based measurements of Rs. The hyper spectral imagery was able to identify submerged bare sand, submerged vegetation and shallow water floating seagrass canopy using narrow bands in the visible and NIR. Bare sand was distinguished from submerged vegetation by WorldView2, but could not distinguish floating and submerged vegetation canopies. Bottom reflectance (Rb) and abundances of submerged seagrasses were calculated using a physics-based approach involving water column optical properties and an empirical relationship between Rb and leaf area index, and both sensors retrieved similar densities. Seagrass productivity was estimated from both images to be about 29,000 tons C per year. Although seagrasses occupied only 24% of the area of the bay, they were responsible for more than 50% of the baywide NPP. (Abstract ID 10690)

MODELING STUDY OF TEMPERATURE STRUCTURE IN JINPU BAY

Jinpu Bay, open to the Bohai Sea in west, is approximately 40 km wide at bay mouth and 50 km long. In 2010, two times of continuous observations were conducted over 25 hours at 10 stations within the bay during the spring tide and neap tide, respectively. As shown by CTD data, there were strong thermoclines at 4 stations during the neap tide. These thermoclines did not exist during the spring tide. The CTD data also indicated that horizontal temperature gradient of the bay is relatively high. For example, the vertical-averaged temperature at station 1 is about 9 Celsius degrees lower than at the station 7 during the spring tide. To study the temperature structure in the bay, a three-dimensional hydrodynamic model - ROMS were applied. The ROMS was implemented for two nested domains: the Bohai Sea and part of Yellow Sea, and the Jinpu Bay. At the open boundaries of the regional model, currents and temperature from big domain were imposed. With the model, the contributions of tide and circulation to the temperature structure were discussed. (Abstract ID 11311)
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