# CONFERENCE ABSTRACTS

*Please note: Those abstracts appearing in blue correspond to oral presentations*

## Ahsan, Quamrul

**A Particle-Tracking Model for Predicting Entrainment of Ichthyoplankton at a Power Plant Intake on the East River, N.Y.**

Quamrul Ahsan[1], Alan F. Blumberg[2], Dennis Dunning[3], Honghai Li[4], Imali D. Kaluarachchi[5], Doug Heimbuch[6] and Dennis Logan[7]

A random-walk particle-tracking model was developed for the East River, the New York Harbor, the Long Island Sound and the New York Bight to predict the distribution of ichthyoplankton and their probability of entrainment through the cooling water system of the Charles Poletti Power Plant. The model was configured into a three-dimensional hydrodynamic model, ECOMSED, which uses neutrally buoyant passive particles as surrogates for ichthyoplankton. In ECOMSED, particles are transported by multidimensional advection and dispersion processes. The model was driven by time-dependent water levels, temperature and salinity along open boundaries, meteorological forcing and freshwater inflows from 28 rivers, 97 water pollution control plants and 306 combined sewer overflows. It was calibrated and validated using observed surface and bottom salinity and temperature, water surface elevations and surface, mid-depth and bottom currents at locations across the New York harbor and the East River during 1994 and 1995. Results indicate that estuarine circulation greatly determined the distribution of particles in the East River. The probability that particles would be entrained into the Poletti intake structure was highly dependent on the location and time of their release.

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## Ahsan, Quamrul

**An Operational Forecast Modelling System for the Mississippi Sound/Bight**

Quamrul Ahsan[1], Alan F. Blumberg[2], Honghai Li[3] and John Blaha[4]

A regional scale forecast modelling system of the Mississippi Sound/Bight and adjoining estuaries and bays has been developed. The system, based on the model, called ECOMSED, provides a reliable means of predicting the littoral circulation and the salinity and temperature structure of the region. The modelling framework adopts a high-resolution orthogonal curvilinear grid, which resolves the relevant bathymetric and coastline features, especially in the vicinity of the barrier islands and ship channels. In order to ensure that the model is capable of predicting the oceanography of the Mississippi Sound/Bight, a thorough calibration and validation effort has been conducted against field observations during September 2000. The calibration and validation efforts have been supplemented by rigorous analyses to understand the sensitivity of the model predictions to various forcing functions. Estimates of the variances in model prediction have been made using a First Order Variance Analysis (FOVA) method. Percent contribution of bathymetry, temperature and salinity boundary conditions, meteorological conditions and freshwater inflows to variances in model prediction has been determined. The ECOMSED model is currently in operational mode in the Major Shared Resource Center (MRSC) of NAVOCEANO at Stennis Space Center, MS. The operational MS Sound/Bight forecast model produces two 12-hour hindcast and two 48-hour forecasts every day, at 0000 and 1200 hours. The model results are made available on the NGLI website (www.navo.navy.mil/NGLI) for public use.

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## Alfonso, Edwin

**Response of the Nonlinear-Nonstationary Internal Tide to the Spring-Neap Cycle of the Barotropic Tide**

Edwin Alfonso[1] and Zachariah R. Hallock[2]

Data from bottom-moored ADCP's and thermistors chains deployed in data from the Mid-Atlantic Bight near 39.3° N, 72.7° W, offshore of the New Jersey Coast, are analyzedused to reveal the dependence of the semidiurnal baroclinic energy in shelf waters on changes in the barotropic forcing. The semidiurnal band iswas defined between 1.76 -2.48 CPD. Baroclinic semidiurnal current speeds are mostly below 5 cm $s^{-1}$, but they can reach 10-18 cm $s^{-1}$ during spring and neap tides. Coherence between the M2 barotropic and baroclinic tide at the shelf location (ADCP-3, at 80 m) was weak (~ 0.15) but above the 95 significance level. The total energy of the semidiurnal internal tide usually represents less than 20% of the total baroclinic energy present in the ADCP record at this locationour shelf station (ADCP3, 80 m). This percentage can increase from 40% up to 80% for periods of 1-2 days. Maximum in PE energy and KE arewere 0.5 and 3.5 J $m^{-2}$, respectively. Both values arewere observed at the pycnocline (~ 30 m) during neap barotropic tides. Empirical Mode Decomposition (EMD) and Hilbert Huang Transform (HHT) analysis arewas applied to the data. This approach is effectiveadequate for the analysis of nonstationary-nonlinear internal tides. The technique revealed KE values above 22 J $m^{-3}$ near the bottom (60-20 m) during spring tides in contrast with our previous estimates.

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## Allard, R.

**Development of a Wave Model Evaluation System Using Altimeter Data**

R. Allard[1], M. Brooking[2], T. Mettlach[3], R. Linzell[4] and T. Strahan[5]

A wave model evaluation system has been developed to provide a quality assurance tool for the Naval Oceanographic Office (NAVOCEANO), which runs regional wave models for many areas around the globe. Significant wave height from the WAM wave model is compared against available altimeter-derived significant wave height from the GFO, JASON-1 and ERS-2 altimeters. Monthly statistics, graphical products and the most recent 35 days of model/altimeter comparisons are available. The wave model evaluation system is a component of the Rapid Ocean Analysis Modelling Evaluation Relocation (ROAMER) system at NAVOCEANO.

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## Altalo, Mary G.

**Regional Market and Policy Imperatives as Drivers for the U.S. Coastal Global Ocean Observing System Design: Investigation Findings for the North East and Great Lakes Economic Regions**

Mary G. Altalo and Monica S. Hale

This paper describes an investigation based on the methodical assessment of the optimal configuration for coastal observing systems to meet the social, economic and policy needs of the U.S. at the regional level. Currently, the observation system design plan involves identifying the existing deployed coastal ocean observing systems, linking them together, supplementing them with sensors to make them uniform and adding sensors to "fill in the gaps". The "gaps" are usually defined as those places where more information is needed to improve the basic understanding of the coastal processes or coastal zone natural resource management. However, the work described by this paper is directed to the economic and policy applications of the information. This assessment will help to inform the design of observing systems to meet the needs of regional economies. It is an issues-driven design based on the established economic, policy, and governance geographical areas and designs an end to end system to provide improved environmental information for operations and action planning, such as emergency management, power buying, water allocation, etc. needed by society. The investigation focuses on assessing the needs and requirements of key sectors of the economy: energy, recreation and tourism, financial services sector, construction, and transport, for weather, climate and ocean products from observational systems such as GOOS.

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## Álvarez, F.

**Ecology of Eurythenes gryllus, Scavenger of the Deep-Sea Gulf of Mexico**

F. Álvarez [1], E. Escobar[2], E. Nájera[3] and G. Rowe[4]

A total of 128 amphipods of the species *Eurythenes gryllus* were collected at six sampling sites in the abyssal plain of the central gulf of Mexico using baited traps at three cruises. The catch per trap varied from three to 36 individuals. Specimens were measured and weighed, the total length of specimens ranged from 14 mm to 110 mm. The longitude – biomass allometric growth relationship obtained from 100 individuals was expressed by a power curve that fits the data with an equation $W = 0.0232L^{2.9674}$ ($r^2 = 0.98$). The elemental composition of the amphipod's soft tissue as analized with a FISONS elemental analyzer varied from 40.7 to 47.1 % C and 11.9 to 15.5 % N. A preliminary model for the potential food sources for the amphipod includes carcasses of pelagic fish, coastal debris and exported material of euphotic origin. The diet of the amphipods will be reconstructed based on the $\delta^{13}C$ and $\delta^{15}N$ composition of the amphipod and the materials collected using a Finnigan Mat 253 and Delta Plus XL mass spectrometer and will allow us to test the model. The genetic diversity of the amphipods and intraespecific variability among sites in the Gulf of Mexico will be analyzed by comparing 16S rRNA gene sequences from individuals fixed in ethanol and frozen in liquid nitrogen.

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## Ammons, A.W.

A.W. Ammons[1] and G.T. Rowe[2]

**Deepwater Anemones (Actinaria) of the Northern Gulf of Mexico: Regional and Bathymetric Distribution in Relation to Natural and Anthropogenic Habitats**

Trawl records from recent surveys are used to construct the most complete distribution maps to date of deepwater anemones for the northern Gulf of Mexico. Although a relatively minor component of deep-sea faunas, anemones' remarkable ability to colonize any and all hard substrata is well documented. The surprising quantity of "deep sea trash" encountered during the 2000-2002 DGoMB surveys was frequently colonized by anemones. This begs the question: is manmade trash contributing to increased recruitment and range dispersal in the deep sea?

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## Ammons, A.W.



**Deepwater Starfish (Asteroidea) of the Gulf of Mexico: Distribution of Dominant Species, with Ecological Considerations**

A.W. Ammons[1] and G.T. Rowe[2]

Starfishes make up a prominent component of deepwater fauna within the Gulf of Mexico. With a dizzying variety of forms, sizes, and behaviors, this echinoderm group accounts for much of the large-animal (megafauna) biodiversity found in the deep sea. The distributions of the more common species are presented, along with observations/hypotheses about their behaviors and ecological roles. The rigidly armored *Nymphaster* is the most common starfish of the continental slope, while the highly opportunistic *Dytaster* dominates the abyssal plain.

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## Anderson, Stephanie C.

**Sensitivity of Regional Coastal Models to Resolution of the Wind Forcing**

Stephanie C. Anderson[1], John C. Kindle[2] and Sergio deRada[3]

Ocean circulation models of the US west coast are used to examine the sensitivity to the resolution of the wind products that force them. In this study, we used the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) Reanalysis winds for the Eastern Pacific as well as the Navy's Global Atmospheric Prediction System (NOGAPS) winds on a one degree grid to force two different ocean models, one of which uses the Princeton Ocean Model formulation while the other utilizes the Navy Coastal Ocean Model (NCOM). Both ocean models have a grid resolution of 9 km with a domain that covers 30°N to 49°N and 115°W to 135°W with 30 sigma coordinate levels. The COAMPS Reanalysis wind product uses a triply nested 81, 27 and 9 km grid system, thus enabling a systematic examination of the effects of resolution on the oceanic simulations. Boundary conditions for the regional models are provided by real-time global simulations such as the operational Navy Layered Ocean Model (NLOM) and the global NCOM model, both running at the Navy Oceanographic Office. The ocean simulations are shown to be sensitive to the resolution of the forcing, as revealed by coastal sea level variations and seasonal variations of the coastal currents. Sea level observations from tide gauges along the entire coast are used to evaluate the simulations.

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## Arnone, R.

**Uncoupling the Optical Signatures in Coastal Waters with Ocean Color Sensors**

R. Arnone, R. Gould, Z. Lee, P. Martinolich, B. Casey, Chuan Min Hu and A. Weidermann

Ocean color signatures are used to determine the changing coastal water properties and improve our understanding of physical and biological processes. Optimization methods were applied to spectral signatures from satellite and aircraft sensors to uncouple the water and bottom components for several different coastal environments representing river plumes and shallow water areas in turbid and clear waters. We determine the dissolved organic matter, backscattering coefficient and chlorophyll properties of the water, in addition to bottom albedo and water depth for these different areas. Optimization methods provide unique solutions based on the non-linear spectral decomposition. These methods were applied to multi-and hyperspectral imagery (SeaWIFS, MODIS and Phills) sensors and validated with *in situ* measurements, to illustrate the changes in coastal optical properties and their inter-relationships.



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## Atkinson, L.

**The Proposed U.S. Integrated Ocean Observing System and its Relation to Ocean Research**

L. Atkinson[1], E. Lindstrom[2] and T. Malone[3]

The first steps to create an Integrated Ocean Observing System (IOOS) for the United States have been taken. Consensus on the overall scope of the system has been reached and implementation plans are being developed. This national effort is in conjunction with many other national efforts and is coordinated with the creation of a global ocean observing system. The creation of an IOOS will have many benefits ranging from more effective search and rescue to better management of fisheries. Research will also benefit. Research will be required to create and sustain the IOOS and research will benefit from the information coming from IOOS. Many of the societal needs that underpin the design of IOOS cannot be addressed until we have a better understanding of fundamental oceanic processes and have sensing systems that reliably measure biochemical parameters. Design of the optimum sampling systems will require combined efforts of researchers and operational groups. Coherence scales must be well understood before parts of IOOS can be installed. The NSF Ocean Observing Initiative (OOI) will provide some of that information. As IOOS becomes operational researchers will provide crucial review of IOOS and recommendations for modification and enhancements to it.

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## Baden, Daniel G.

**Overview of Harmful Algal Blooms**

Daniel G. Baden[1]

Harmful algal blooms (HABs) produce some of the most potent chemicals known to man. All HAB toxins interact with specific foci in living organisms. Some toxin types interfere with nerve conduction by blocking signaling ions that regulate nerve impulses. Other toxin types cause nerve to fire repetitively in an exactly opposite manner to the nerve blocking toxins. A third class of toxins causes a mis-regulation in the activation and inactivation of enzyme cascade systems, resulting in aberrant cell cycles. A fourth class of toxins interferes with central nervous system processing. HAB organisms may produce the toxins as regulators of their normal cellular function and imposition of their regulatory function in higher organisms like man leads to a classification of "toxin". Alternatively, toxins may be produced and extruded to lend a competitive advantage to the HAB species. A third and equally plausible hypothesis states that the interaction between toxin and living system receptor is pure serendipity. Environmental and toxicological consequences of HAB exposure will be discussed, with some speculation on methods by which human exposure to HAB toxins can be lessened.

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## Bai, X.

**Carbon Incorporation Patterns in Vertically Migrating Populations of the Red Tide Dinoflagellate, *Karenia brevis***

X. Bai[1], S.E. Lohrenz[2], D.G. Redalje[2] and G.J. Kirkpatrick[1]

Prior laboratory studies and modelling have provided evidence that the migratory behaviour of the red tide dinoflagellate, *Karenia brevis*(*K.brevis*), is strongly influenced by cellular biochemical fluxes. Here, we report results of measurements of the incorporation of photosynthetically fixed inorganic $^{14}C$ into major subcellular end products in migrating populations of *K. brevis* during bloom events in Florida coastal water in 2000 and 2001. Samples were incubated with bicarbonate in simulated *in situ* conditions on board ship, and determinations were made of $^{14}C$-incorporation into low molecular weight materials (LMW), lipid, carbohydrate+nucleic acids, and protein. Measurements were also made of incorporation of $^{14}C$ into the nitrogen transport amino acids, glutamine and glutamate. Carbon flux showed systematically higher proportion in carbohydrate+nucleic acids and lower proportion in protein in surface samples compared to that in deep samples. Responses to nutrient-enrichment exhibited enhanced protein incorporation in both surface and deep populations and decreased incorporation into carbohydrate +nucleic acids. Therefore the ratio of Protein/ carbohydrate+nucleic acids appeared to provide an index of population physiological state. Carbon flux into glutamate and glutamine exhibited higher relative incorporation in deep populations as compared to surface populations. Our results support arguments that vertical migration behaviour can be influenced by variations in cellular biochemical state.

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## Barron, Charlie N.

**Validation and Application of the Global Navy Coastal Ocean Model**

Charlie N. Barron[1], Clark Rowley[2], Lucy F. Smedstad[3], A. Birol Kara[4], Paul J. Martin[3] and Robert C. Rhodes[3]

A global implementation of the Navy Coastal Ocean Model (NCOM) has recently been developed for transition into operations at the Naval Oceanographic Office (NAVO). The operational roles of global NCOM include providing standalone data where the resolution of the global product is sufficient for guidance, a quick overview of local circulation where refined products are operationally unavailable, and boundary conditions for regional or relocatable models that may be more specialized for a particular task or domain. Some global NCOM results of particular interest include sea surface temperature, mixed layer depth, current profiles and shelf circulation. Global NCOM is designed to be suitable for inclusion in a coupled ocean-atmosphere modelling system, and it also serves as the host for an embedded ice model, PIPS3, which is in development for transition. Validation of global NCOM against unassimilated observations or climatologies provides a basis for estimating the accuracy of its nowcasts and forecast products and indicates directions for further model refinement and development. Representative results selected from evaluations performed during the model development and operational test phases include eddy kinetic energy, transports, vertical sections of temperature and velocity, sea surface temperature, mixed-layer depth, sea-surface height and event comparisons. These results are used to assess present operational capabilities and indicate directions for future research and development.

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## Barton, A.D.

**Evidence from a 130-year historical sea surface temperature record for coral bleaching**

Barton, A.D[1]. and Casey, K.[2]

Coral bleaching is a pan-tropical phenomenon that has serious ecological and economical impacts. Despite the extensive body of scientific research and increased public awareness about coral bleaching, it is not known where and when, if at all, coral bleaching occurred in the past. This study uses three 130 year historical SST data sets, ERSST, GISST, and HadISST, as well as the 1985-2001 AVHRR Pathfinder SST data, to identify persistent warm periods during the past 130 years. Here we present the preliminary results of this study, which suggest that while coral bleaching and anomalously warm SSTs have occurred over much of the world in recent decades, conditions favorable for thermally induced coral bleaching also existed in numerous regions and time periods over the last 130 years.

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## Beazley, Melanie

**Relationship Between Organic Carbon and Sediment Surface Area in the Gulf of Mexico**

Melanie Beazley[1] and John W. Morse[2]

Studies suggest that 90% of organic matter in marine sediments can be adsorbed onto mineral surfaces. In typical continental shelf sediments the amount of organic carbon to surface area (OC/SA) has been established as approximately 0.5-1 mg-OC $m^{-2}$. The purpose of this study was to examine the OC/SA relationships within the unique environments of the Gulf of Mexico. The study was conducted in association with the Deep Gulf of Mexico Benthic Ecology (DGoMB) program conducted by the Texas A&M Oceanography Department under Minerals Management Service contract. The surface area of the sediment samples was analyzed by multi-point BET (Brunauer-Emmett-Teller) method with the adsorption of $N_2$ determined on a Micromeritics ASAP 2010 Analyzer. High surface areas (8-50 $m^2$ $g^{-1}$) were found throughout the Gulf of Mexico in depths ranging from 200-3000m indicative of silt/clay sediments. Organic carbon contents ranged from 2-20 mg $g^{-1}$ with high values (>10 mg $g^{-1}$) found in the Mississippi Trough and Desoto Canyon areas. OC/SA values were low (0.2-0.3 mg $m^{-2}$) along the shelf near the Mississippi Trough and at deep water depths. High OC/SA values (1.6-2.2 mg $m^{-2}$) were found at shallow water depths (200-400m) near the Desoto Canyon. OC/SA values in the Gulf of Mexico can range both well above and below typical values and appear to be controlled not only by water depth, but also by location.

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## Beegle-Krause, C.J.

**Integrating Research Oceanographic Modelling into Emergency Response**

C.J. Beegle-Krause[1]

For U.S. disaster management, under the National Contingency Plan, NOAA Hazardous Materials Response (HAZMAT) is responsible for Scientific Support Coordination. HAZMAT provides the conduit for scientific information to support the decision makers (Unified Command) during a response. Increased interest in offshore oil development, harmful algal blooms and issues of national security will require NOAA/HAZMAT to leverage more and more remote sensing resources and external modelling capabilities. HAZMAT has been careful to construct the General NOAA Oil Modelling Environment (GNOME) trajectory model as an overlay tracer model that can use output from an increasing number of circulation models in different grids (finite element, finite difference with rectangular or curvilinear grid). This allows HAZMAT to use regional circulation models developed outside of HAZMAT. Trajectory modelling for response also has different requirements than research modelling. For example: HAZMAT modelers have the unique problem of needing data at odd hours, such as 3:00 AM on a weekend, and in a format that is readily accessible to trajectory analysis models and tools. HAZMAT's response time for providing modelling products is 2 hours from time of the initial call. Trajectory forecasts are provided with the Best Guess of where the spill will go, and Minimum Regret confidence bound. Minimum Regret forecasts provide information needed by decision makers to evaluate the best use of available resources. The Live Access Server /Distributed Ocean Data System is currently used to connect regional circulation models to HAZMAT.

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## Berger, J.

**High-Seas ROADNet: Providing Communications to the DEOS Fleet of Moored Ocean Observatories.**

J. Berger[1], J. Orcutt[2] and F. Vernon[3]

The National Science Foundation has initiated a Major Research Equipment and Facilities Construction initiative for a long-term globally deployed ocean observing system with expected FY04 funding at $198M for a five-year program. The establishment of a network of moored ocean buoy observatories will be an important element of this initiative that will lead to fundamental new understanding of the oceans and Earth. These buoys will provide a platform to connect ocean-bottom and ocean-column instruments to the shore via a telemetry system. The most important specifications driving mooring design are the telemetry rate that the buoy system must support for communication to shore, and the amount of power delivered to the seafloor and moored instruments. Two designs have been developed, a wave-following discus and a spar buoy each capable of delivering 500 W to the seafloor and telemetering at least 500 Mbytes of data per day to shore. The only cost-effective alternative for continuous moderate-bandwidth communication (>64 kbps) currently available is a C-Band or Ku-Band satellite system. The system must operate unattended for a year in the deep ocean environment.

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## Bernhard, Joan M.

**Abundance and Biomass of Benthic Foraminifers on the Gulf of Mexico Shelf, Slope and Abyss**

Joan M. Bernhard[1]

Benthic foraminiferal biomass and abundance were determined at nine sites in the Gulf of Mexico, as part of the Deep Gulf of Mexico Benthos Project. During June 2001 and June 2002, sediment samples were collected with a GoMex boxcorer, from which a 7.5-cm diameter sub-core was taken for foraminiferal analyses. After the sub-core was sliced into 1-cm depth intervals, the >63-mm fraction was examined shipboard. Individual foraminifers were measured for size and extracted for ATP. Luciferin-luciferase assay indicated the total ATP content per specimen, which was converted to organic carbon using established conversions. Foraminiferal biomass and abundance varied substantially (~2-53 mg C $m^{-2}$; ~3,600-44,500 individuals $m^{-2}$, respectively) and inconsistently with water depth. For example, at one 1000-m site, foraminiferal biomass was relatively low (~9 mg C $m^{-2}$) while another 1000-m site had the highest foraminiferal biomass (~53 mg C $m^{-2}$). These sites were geographically separated by only ~75 km but their environmental settings differed. In addition, although most samples from Sigsbee Plain (>3000 m) had low foraminiferal biomass, one Sigsbee sample had >20 mg foraminiferal C $m^{-2}$. Results indicate that foraminiferal biomass and abundance vary with a variety of environmental factors besides water depth and that foraminifera comprise a major component of deep-water meiofaunal biomass.

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## Bienhoff, Paul

**FAST Tactical Integration Console (FAST TACTIC)**

Paul Bienhoff[1] and Jeffrey Smart[2]

FAST TACTIC is designed to store, retrieve, and display own-ship, historical, and gridded environmental data using a Java GUI into a relational database. New data may be compared to historical data from the same geographic area and time. Fast Tactic can 1) *Plot* ownship, historical, and gridded-database vertical profile data (e.g. from CTDs, XBTs, submarine sound velocity sensors), 2) Plot along-track data (e.g., bathymetry, sediment thickness, ice thickness), 3) *Compare* own-ship and historical data, 4) Generate *statistics* to determine if data are within normal bounds and 5) *Automatically extract* profiles when a submarine or UUV conducts a depth change. By providing access to all data acquired within a cruise, the user is able to synthesize a broad picture of his survey area. When a ship loiters in a particular region, the FAST TACTIC displays enable the user to see how the environment changes over time and across the region. The *statistics* function summarizes environmental conditions in mission/cruise reports. FAST TACTIC's Key Capabilities include: ready access and display of data (some data collection is automated), simple comparison of various data, simplified data interpretation and easy export of data for turnover/handoff. FAST TACTIC systems have been successfully installed on US Navy submarines for evaluation. Manipulation of FAST TACTIC displays is simple. Selection of parameters for display on a chart/graph is made with the mouse, without ever typing on the keyboard.

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## Blain, Cheryl Ann

**Coupled Wave-Circulation-Sedimentation Dynamics**

Cheryl Ann Blain[1], Rick Allard[2], Tim Keen[3], Matt Bettencourt[4], Brett Estrade[5] and Jim Dykes[6]

In the realm of coastal modelling, state-of-the-art models have advanced such that the nonlinear feedback between different physical processes such as surface waves, marine currents, and sediments can no longer be ignored, but must be considered as a coupled system. Such a system is demonstrated by coupling numerical models representing coastal wave, circulation, and sedimentation dynamics via the Model Coupling Environmental Library, MCEL. Coupling involves sharing the following quantities: surface wave radiation stress gradients, wave orbital velocities, currents, and sea surface heights. Such coupling captures important nonlinear processes such as the impact of sea level variations on wave breaking location, the wave/current blocking of currents/waves, the effect of wave-current interaction in the marine boundary layer on sediment resuspension, and sediment transport under a variable current field. Specifically, the wave module is comprised of the shelf-scale wave generation and transformation model, SWAN. Coastal circulation and sea level changes are represented by the shallow water hydrodynamics of the Advanced Circulation model (ADCIRC) and sedimentation processes are simulated by the Littoral Sedimentation and Optics Model (LSOM). MCEL is the distributed framework designed to facilitate model coupling. The coupled system is applied in two diverse geographic regions, the Mississippi Bight and the Arabian Gulf. Relevant obsevations are utilized for validation of each model component. Furthermore, modeled dynamics are evaulated for sensitivity to the dimensionality of the current field and the frequency of coupling.

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## Blain, Cheryl Ann

**Issues in Developing an Operational Forecast Capability for Coastal Waters**

Cheryl Ann Blain[1], Catherine Edwards[2], Brett Estrade[3] and Mark Cobb[4]

The application of a numerical model to the prediction of coastal circulation has economic advantages over the maintenance of dense and varied observational networks. A model that incorporates the range of important dynamical forcings and represents complex shorelines and bathymetry at fine scales can be exercised as a virtual laboratory for understanding the cause and effect of existing currents and subsequently for developing contingency plans under various emergency scenarios. Success of an operational forecast system depends on 1) understanding the model sensitivities to bathymetry and the relevant forcing mechanisms which are often unknown, 2) specifying appropriate offshore forcing for limited domains, and 3) crafting meaningful operational products. The sensitivity of coastal circulation to the source and spatial resolution of wind forcing, to the temporal resolution or existence of river forcing, and to the representation of bathymetric features are characterized. Offshore forcing from larger scale ocean models as well as forcing derived via data assimilation methods is investigated. Lastly, alternative operational products are explored for presenting environmental information to the user community. These issues are all addressed in the context of the development of a forecast capability for coastal waters of the Mississippi Sound in the northeast Gulf of Mexico. The basis of the forecast system is the finite element-based, 3-D hydrodynamic model ADCIRC, driven by tides, river inflow, and wind.

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## Book, J.W.

**Inertial Frequency Band Oscillations in the Northern Adriatic**

J.W. Book[1] and H. Perkins[2]

During winter/spring 2001 a bottom mounted ADCP was deployed at 57 meters in the Western Adriatic Current (WAC) as a part of a planning study that preceded a large international program studying the northern Adriatic Sea. The variability of the currents at the mooring site was dominantly driven by bora wind events. These intense, cold and dry wind events produced low frequency current bursts that enhanced the strength of the WAC and also produced bursts of energy in the inertial frequency band. The inertial oscillations primarily developed later in time than the low frequency bursts and persisted for several days after the low frequency bursts had decayed. The time averaged negative rotary spectrum has broad peaks centered on $f/2\pi$ with peaks near the surface and near 40 meters. Stronger events occurred around March and April 1st. During the later event, the depth nodal point of the oscillation deepened over the course of the event from 12 to 30 meters. An extremely strong inertial event, possibly driven by a different type of forcing, occurred in early June. Inertial band-passed filtered currents reached speeds of 44 cm/s during this event. The recently recovered array of bottom mounted ADCPs and other measurements from fall to spring 2002/2003 will provide further spatial and temporal data on the physics of inertial oscillations in the northern Adriatic.

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## Book, J.W.

**Tides in the Ulleung Basin of the Japan/East Sea**

J.W. Book[1], M. Wimbush[2], J.-H. Park[3], K.L. Tracey[4] and D.R. Watts[5]

From June 1999 to June 2001, 23 pressure-sensor-equipped inverted echo sounders (PIES) were deployed in a 2-D array covering the Ulleung Basin (UB) of the Japan/East Sea. The main purpose of the study was the temporal mapping of the thermal structure of the UB. However, tidal pressure fluctuations were also measured by this array. Tidal coefficients were extracted from each pressure time series, and combined with coefficients from coastal tide stations and some tidal current coefficients from shallower water in the southwestern part of the UB to form cotidal maps of the entire UB. This was accomplished by assimilating the tidal data into a barotropic tide model through a strong-constraint variational approach making use of an adjoint model. The data were fitted to the shallow water equations in a least-squares sense by adjusting only the incoming gravity waves along the model boundaries. From the model output, we computed amplitude and phase maps of surface-height fluctuations and barotropic currents for the principal tide constituents. Surface height prediction errors were ~0.7 cm for the PIES sites and ~1.3 cm for the coastal tide stations. Barotropic current prediction errors for the current sites were ~3.0 cm/s.

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## Boswell, Kevin M.

**The Use of Hydroacoustics for Estimating Nekton Use of Estuarine Habitats in a Louisiana Estuary**

Kevin M. Boswell[1] and Charles A. Wilson[2]

Knowledge of the distribution and biomass of fishes within an estuarine system is needed to make effective management use of the concept of Essential Fish Habitat (EFH). Fish distributions and species diversities within estuaries can vary with season, tide, lunar cycle, weather, and bottom type. Resolution of the influence of these and other variables on EFH is confounded by limitations of traditional sampling gears. Hydroacoustics is a useful sampling tool that avoids size and/or habitat selectivity issues encountered with traditional gear types. A survey was conducted in coastal Louisiana to evaluate the quantitative capabilities of hydroacoustics in shallow waters. Survey objectives were to 1) determine the nekton biomass associated with two different habitats, 2) compare hydroacoustic data to concurrently collected net data, and 3) determine effect and magnitude of ambient acoustic backscatter on nekton biomass estimates. Based on acoustic sampling, there was no diurnal difference in channel biomass; however, based on channel net samples there was a three-fold greater biomass at night as than day. Bay anchovy, dominated the net catches (90-97%) at all sites. The high sediment load and plankton abundances common to coastal waters did not bias acoustic estimates. Interpretation of the data suggests a positive outlook for the use of hydroacoustics as a sampling tool in ultra-shallow systems.

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## Bourassa, Mark A.

**Improvements in the New FSU Winds and Flux Climatology**

Mark A. Bourassa [1,2], James J. O'Brien [2], Rosario Romero [3] and Shawn R. Smith [4]

An objective technique is used to create a new monthly climatology for surface fluxes and related fields. The wind (pseudostress) products are improvements over the subjectively analyzed FSU winds. Fields of turbulent surfaces fluxes and the variables needed to calculate these fluxes are also generated. The fields are created through minimization of a cost function, which maximizes information from the observational data and minimizes smoothing. This approach ensures internal consistency between the turbulent fluxes and the related fields. Comparisons are made between the new FSU fields (based on volunteer observing ships and buoy observations), the old subjective FSU fields, individual TAO buoys, the NCEP reanalysis, and fields based solely on the SeaWinds scatterometer observations. The new (objective) FSU wind fields have stronger convergence zones (the ITCZ and SPCZ) as well as better zonal resolution. Revisions to our technique have also improved resolution in near-land regions. An ocean model, forced with a preliminary release of the winds, produced much more realistic currents than when forced with the old FSU winds. Differences between FSU and reanalysis winds and derivative fields are examined.

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## Brown, M.

**The IOC/IODE Training Curriculum in Marine Data Synthesis**

M. Brown [1]

The Intergovernmental Oceanographic Commission (IOC) of UNESCO manages a program of marine data management training in developing countries. Currently, marine scientists in 27 countries are following a 2- to 3-year curriculum of workshops and assigned exercises to develop personal computer and data analysis skills and to establish National Ocean Data Centers in their States. The basis of the training is IOC's "OceanTeacher" website (http://www.oceanteacher.org) and CD-ROM publication. OceanTeacher consists of an encyclopedic Resource Kit of general materials, covering all areas of marine data management, and manuals to lead students through the kit's many reference documents. To focus student activities, 50 tutorials are included in the kit covering the establishment and population of an example national data collection for Namibia, along Africa's southwest coast. The collection is initially populated with the World Ocean Database 2001 (WOD01), and further augmented with the eWOCE archive. Following duplicate elimination (usually in favor of eWOCE station retention), extensive quality-control exercises are employed, using Ocean Data View for analyses and on-the-fly quality-flagging of the records. Data subsets from the national collection and extracts from satellite data (usually HDF) are then gridded and contoured, using SURFER, to create standard products for local use by a new client community we are developing in these States. All data products created in the tutorials are designed to be used directly in GIS applications, principally to meet coastal zone management needs.

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## Brozena, J.

**Sea-Surface Topography in an Absolute Reference Frame: Applications to Coastal Oceanography**

J. Brozena [1], G. Jacobs [2] and J. Blaha [3]

Highly dynamic coastal ocean processes occur at temporal and spatial scales that cannot be captured by the present generation of satellite altimeters. Space-borne gravity missions such as GRACE also provide time-varying gravity and a geoidal msl reference surface at a resolution that is too coarse for many coastal applications. The Naval Research Laboratory and the Naval Oceanographic Office have been testing the application of airborne measurement techniques, gravity and altimetry, to determine sea-surface height and height anomaly at the short scales required for littoral regions. We have developed a precise local gravimetric geoid over a test region in the northern Gulf of Mexico from historical gravity data and recent airborne gravity surveys. The local geoid provides a msl reference surface with a resolution of about 10-15 km and provides a means to connect airborne, satellite and tide-gage observations in an absolute (WGS-84) framework. A series of altimetry reflights over the region with time scales of 1 day to 1 year reveal a highly dynamic environment with coherent and rapidly varying sea-surface height anomalies. AXBT data collected at the same time show apparent correlation with wave-like temperature anomalies propagating up the continental slope of the DeSoto Canyon.

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## Buckingham, C.E.

**Temperature Variability on the Malin Shelf**

C.E. Buckingham [1] and S.E. Rennie [2]

Temperature, pressure and current measurements were collected on the Malin Shelf north of Ireland during 11 to 24 July 2002, along with supporting meteorological observations. The temperature record contains variability at tidal frequencies that exhibits a distinct increase in magnitude over the course of a two-week period, while the M2 tidal amplitude decreased from spring to neap. Episodic bursts of high-frequency temperature variability at internal wave frequencies also become more common in the latter part of the field test with vertical displacements exceeding 8 meters. The physical cause of increased activity is investigated with an emphasis on tidal dynamics of the shelf.

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## Butterfield, D.A.

**The NeMO Seafloor Observatory at Axial Volcano, Juan de Fuca Ridge**

D.A. Butterfield[1], W.W. Chadwick, Jr.[2], R.Embley[3], S. Hammond[4], C. Meinig[5], S. Stalin[6], J.A. Huber[7] and J. Baross[8]

Creating effective deep-sea observatories poses many technical challenges. NeMO is an evolving seafloor observatory where new technology is being applied to maintain observations on a decadal time scale, return data in near real-time, and develop desktop-to-seafloor interactive experiments. Following the January 1998 eruption at Axial Volcano, we have conducted annual mapping and sampling expeditions, revealing some of the connections between volcanism, fluid chemistry, and microbiology. With funding from NOAA PMEL and West Coast & Polar Regions Undersea Research Center, we have installed a state-of-the-art, two-way communication system (NeMO-Net) linking three instruments on the seafloor to the internet. Acoustic modems link the seafloor instruments to a moored surface buoy, which uses Orbcomm and Iridium satellite systems to link to shore. The instruments include: a bottom pressure recorder monitoring vertical motion of the seafloor, looking for sudden inflation or deflation events that may signal the onset of an eruption or intrusion; two fluid/particle samplers with pH and temperature sensors, capable of sampling on command. Data from the three instruments are displayed on the web at http://www.pmel.noaa.gov/vents/nemo/realtime/.

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## Carder, K.

**Measurement and Prediction of Optical Environments Associated with Underwater Inspection**

K. Carder[1], D. Costello[2], D. English[3], P. Reinersman[4] and W. Hou[5]

The University of South Florida has deployed optical sensor payloads on Unmanned Underwater Vehicles (UUVs) for nearly a decade. The payloads include a suite of Inherent and Apparent Optical Property (IOP, AOP) sensors and two novel imaging systems. The Real-time Ocean Bottom Optical Topographer (ROBOT) payload, for example, is a laser-line imager for acquiring 3-D images of the ocean bottom. The Fast Laser Assessment of Ship Hulls configuration (FLASH ROBOT) is an upward-looking version with utility in harbor security. The Bottom Classification and Albedo Package (BCAP) payload collects multi-channel (6), intensified bottom imagery in both reflective and fluorescence modes and has utility in bottom object detection and classification. A challenge in any form of underwater imaging, including simple video, is to parameterize performance characteristics in terms of environmental variables. Collateral to that challenge is the need for predictive capabilities for environmental conditions, modelling capabilities to simulate different environments, and novel approaches to extract information from various forms of imagery. To that end, we combine laboratory and field measurements with modelling efforts including IOP and AOP calculation from remote sensing imagery, prediction of the ambient light field beneath ships and in channels, and automated target recognition from 3-dimensional data. The goal of these efforts is to combine available in-situ measurements with predicted environmental parameters to allow the selection of assets for underwater inspection that are appropriate to expected environmental conditions.

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## Casey, K.S.

**A New Global 4 km Resolution Sea Surface Temperature Data Set**

K.S. Casey[1] and E.J. Kearns[2]

A new reprocessing of the Advanced Very High Resolution Radiometer (AVHRR) data stream developed by the University of Miami s Rosenstiel School of Marine and Atmospheric Science and the National Oceanographic Data Center is now available. This reprocessing uses an improved version of the Pathfinder algorithm and processing steps to produce twice-daily global sea surface temperature (SST) and related parameters back to 1985, at a resolution of approximately 4 km, the highest possible for a global AVHRR data set. Current key improvements over the original 9 km Pathfinder SST data set include a more accurate, consistent land mask, higher spatial resolution, and inclusion of sea ice information. Additional improvements including better flagging of aerosol-contaminated retrievals will be implemented in future reprocessings of the satellite data. These improvements, example data and applications, and data access techniques will be presented.

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## Castro, B.M.

**The Cabo Frio Upwelling Ecosystem**

B.M. Castro[1], S.A. Gaeta[2] and I.C.A. Silveira[3]

Upwelling takes place in a shelf region around Cabo Frio (South Brazil Bight), associated with South Atlantic Central Water (SACW) intrusions towards the coast. Most conspicuous manifestations of these intrusions are the frequent summer events of wind-driven coastal upwelling. A multidisciplinary project has been studying those intrusions and their impacts on the continental shelf ecosystem. Observational methods include mesoscale, trophodynamic and current meter mooring cruises, besides Lagrangean sediment trap experiments. Results confirm the wind stress importance for triggering the Cabo Frio upwelling. Three shelf regions, with different dynamical regimes, were identified: Outer Shelf, where circulation is dominated by Brazil Current transport, meanders and eddies; Mid-Shelf, where currents are mostly wind driven, with high energy in low frequencies, and Inner Shelf, where the baroclinic pressure gradient set up by low salinity waters is an important forcing mechanism. The 3 regions are separated by two fronts: a Bottom Thermal Front and Surface Haline Front. SACW intrusions may occur through other mechanisms besides coastal upwelling, as meandering and eddies of the Brazil Current. Remotely sensed indicators of near-surface chlorophyll content (SeaWiFS), together with hydrographic measurements, have shown a clear seasonal variability in estimated surface chlorophyll, with higher values in winter, and color signatures related to mesoscale features throughout the year, with cyclonic eddies more noticeable during summer.

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## Chandler, Paul E.

**Proposed High Resolution 4-D Acoustic Imaging Systems**

Paul E. Chandler[1]

We are conducting initial investigations for an R&D effort, the long-term objective of which is to develop a family of highly capable and cost effective 4D acoustic imaging systems. The proposed effort is based upon our apparently novel plans to exploit axial rather than lateral resolution to obtain higher than otherwise achievable 3D spatial resolution within an observed volume. A representative system might employ three orthogonal active linear arrays, permitting targets to be resolved axially in real-time in each of three orthogonal look directions. These systems can be built at low risk using mostly conventional components. New real-time beamforming methods will be required and carry with them some additional technical risk. The greatest risk these systems face is the cost of their design and implementation. Amortizing R&D costs over multiple applications will be required. It is therefore our intent to educate the oceanographic community about our plans and to solicit their comments, critique, and collaboration. We hope to gain broad community participation as we fully explore potential applications and the system requirements for each identified application. Armed with this knowledge, we intend to develop a scalable and reconfigurable hardware and software infrastructure capable of supporting many applications. Proposed applications and specific solutions will be discussed during the presentation.

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## Chapman, P.

**The CREST Program: A New Coastal Research Initiative in Louisiana and Mississippi**

P.Chapman[1] and D.J. Reed[2]

The southern portions of Louisiana and Mississippi are at grave risk from coastal erosion and habitat loss, caused both by physical factors and changes in water quality. Eleven universities within these two states and NOAA therefore have created a cooperative program for Coastal Restoration and Enhancement through Science and Technology (CREST) to help policymakers, planners and coastal resource managers use the latest science and best technologies to ensure sustainable and productive coastal habitats and communities. In this way, advances in science and technology can be integrated directly into restoration programs to ensure that coastal habitat restoration is implemented cost-effectively and successfully sustains coastal resources. University partners are working closely with federal and state agencies and other interested groups to ensure information developed is available to all involved in ongoing and future coastal habitat restoration efforts. By cooperating in this way, it is hoped to improve the local knowledge base for coastal habitat restoration, to train the next generation of researchers, and to gain economically through the shared use of resources. Activities will include both large-scale, e.g. the effect of river diversions on nutrient and sediment distributions and the resulting biology of the receiving waters, and small-scale activities, e.g. the use of bagasse and post-harvest sugarcane residue in wetland restoration. Coordinating activities through CREST will provide a cost-effective way to continue the vital work of protecting the coastal zone along the northern Gulf of Mexico.

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## Chekalyuk, A.M.

**Advanced Oceanic Biomonitoring: Pump-and-Probe LIDAR and Phytoplankton Pigment Analyzer**

A.M. Chekalyuk[1], F.E. Hoge[2], R.N. Swift[3] and J.K. Yungel[4]

A pump-and-probe (P&P) airborne LIDAR has been recently developed at NASA Goddard Space Flight Center. It provides remote measurement of phytoplankton photosynthetic variables along with pigment and organic matter fluorescence, down-welling and upwelling hyperspectral measurements and surface temperature. The utilization of an airborne platform provides for rapid remote characterization of phytoplankton photosynthetic activity, biomass and diversity over large aquatic areas. The P&P LIDAR technique is one of the first practical implementations of 'superactive' remote sensing. This presentation summarizes results of six airborne measurement campaigns conducted in 1999-2001 in the Chesapeake Bay, Delaware Bay, Middle Atlantic Bight, and Gulf of Mexico. The P&P technology may be complimented a Laser Phytoplankton Analyzer (LPA), a laser fluorometer dedicated for advanced pigment analysis. It combines high-resolution spectral measurements of phytoplankton pigment fluorescence excited at several selected wavelengths with active assessment of physiological status of phytoplankton photosynthetic apparatus. Emission/excitation measurements provide a potential for assessing concentrations of photosynthetic accessory pigments (Chlorophyll-a,-b,-c, photosynthetic carotenoids and phycobilins) and identifying major phytoplankton functional groups. The LPA was extensively tested in laboratory experiments with phytoplankton cultures and their mixtures. In November 2002, the LPA was utilized for pigment fluorescence analysis of natural phytoplankton in a range if environmental conditions on a research cruise in the Middle Atlantic Bight and Delaware Bay.

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## Chen, Min

**The Diversity of Bivalve Assemblages in the Deep Northern Gulf of Mexico**

Min Chen[1], G.T. Rowe[2] and G.F. Hubbard[3]

Species diversity in the deep-sea benthos is known to be as high as that in other physically stable, shallow, tropical marine environments (Sanders, 1969). Recent studies in the northern Gulf of Mexico have found that diversity of bivalve mollusks increases from shallow continental slope depths, with especially low values in the Mississippi canyon, to a maximum at intermediate depths (1-2 km), followed by a decrease down to the deepest areas (3.7 km) in the Gulf of Mexico. A parabolic relationship was found between diversity (H'(S)) of bivalves and depth ($y = -0.24x^2 + 0.79x + 1.99$, $R^2 = 0.29$), but the maximum is found on the upper continental slope (1-2 km), rather than the upper continental rise (3 km), where a maximum has been observed in other ocean basins (Rex 1983). In accordance with dynamic equilibrium (Huston 1979), low species diversity may result from severe biotic and physical disturbances on the upper slope. High diversity at intermediate depths is probably maintained by moderate rates of displacement, with the approach to equilibrium interrupted by fairly high levels of predation disturbance. On the abyssal plain (3.5 to 3.7 km), rates of displacement are probably low, but infrequent predation permits sufficient time for the community to approach competitive equilibrium, resulting in a decline in diversity.

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## Chen, Mingshi

**An Ensemble Kalman Filter for a Nonlinear Reduced Gravity Model**

Mingshi Chen[1], Hans Ngodock[2] and Gregg Jacobs[3]

This paper uses an ensemble kalman filter (EnKF) method to assimilate data into an idealized nonlinear reduced gravity model of the Gulf of Mexico. The EnKF is a sequential data assimilation technique based on Monte Carlo drawings and the Kalman filter method to incorporate observation data into a dynamical system. The technique is an alternative to the traditional extended Kalman filter for nonlinear dynamics. It is used here to explore the impact of the ensemble construction. The ensemble can be generated by exclusively adding random perturbations to the initial condition of the system, to the external forcing or to the boundary conditions. Initial implementations will focus on the generation of dynamically balanced and dynamically significant ensembles, as well as the impact of the ensemble size on the analysis. Preliminary results will be presented.

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## Chiswell, S.

**Trans-Tasman Sea Larval Transport: Is Australia a Source for New Zealand Rock Lobsters?**

S. Chiswell[1], J. Wilkin[2] and J. Booth[3]

Two species of lobster are found around New Zealand and Australia. *Jasus edwardsii* is genetically indistinguishable between Australia and New Zealand, whereas *Sagmariasus verreauxi* may be genetically different between the two countries. Satellite altimeter data are used to test the hypothesis that Australia acts as a source of larvae for some New Zealand populations, and to investigate if there is a physical mechanism for the seeming lack of gene flow for *S. verreauxi*. The western Tasman Sea is seeded with numerical drifters to build up a statistical summary of the likely distribution of larval trajectories. Ignoring biological factors, about 9% of *J. edwardsii*, and about 2% of *S. verreauxi* larvae might be expected to arrive in New Zealand waters within their respective larval lifetimes. Even with extremely high mortality, these rates are high enough for trans-Tasman larval flow to contribute to and possibly maintain some New Zealand populations. Larval flow across the Tasman Sea should be sufficient to maintain trans-Tasman genetic homogeneity in both species. One reason that *S. verreauxi* may not be genetically homogenous is that they have to cross the Tasman Sea north of the productive Subtropical Front where there is not enough prey to sustain them.

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## Churnside, J.

**Strong Internal Waves Observed with an Airborne LIDAR**

J. Churnside[1] and L. Ostrovsky[2]

The National Oceanographic and Atmospheric Administration (NOAA) Fish LIDAR observed a strong internal wave in the Gulf of Alaska in May 2002. A strong scattering layer was present in the Gulf at a depth that varied between about 5 and 30 m. At one of the shallow regions of this scattering layer, this layer oscillated up and down with an amplitude of approximately the depth of the layer. This observation is compared with nonlinear theories of the propagation of internal waves. The simplest approach would assume a solitary internal wave packet in a two-layer medium with the depth of the upper layer defined by the depth of the scattering layer. The Benjamin-Ono theory of a weakly nonlinear internal wave fits the observations fairly well, but more sophisticated models are also considered.

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## Collins, Mona J.

**MASDA – MODAS Adaptive Sampling Decision Aid**

Mona J. Collins[1], Charlie N. Barron[2] and Jack G. McDermid[3]

The Modular Ocean Data Assimilation System (MODAS) produces oceanographic nowcasts based on climatology, remotely-sensed sea surface temperature and height, and in-situ measurements. Recent analyses have shown that the locations of in-situ measurements can have a profound influence on the accuracy of the MODAS synthetic profiles. Small-scale variability combined with sparse sampling and inappropriate covariance scales can lead to a spreading of unrepresentative anomalies. The MODAS Adaptive Sampling Decision Aid (MASDA) is being developed to guide the selection of Airborne Expendable Bathy Thermograph (AXBT) measurement locations to improve the accuracy of MODAS analyses while minimizing the number of required measurements. MASDA uses the MODAS temperature uncertainty to predict the optimum sampling locations. The hypothesis is measurements that minimize uncertainty also tend to minimize error. The MASDA approach is to recommend sequential sampling locations. Simulated measurements at potential locations are assimilated into MODAS and the resulting uncertainties are analyzed to determine which location minimized the total uncertainty. This environmentally driven sampling strategy is expected to maximize accuracy of MODAS analyses relative to MODAS analyses based on alternate sampling strategies with the same number of observations. Past AXBT surveys are being used to develop and test MASDA algorithms. Preliminary results showing improvement in MODAS accuracy using MASDA for selecting measurement locations, compared to more subjective location-selection methods, will be presented.

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## Cook, S.B.

**The Centers for Ocean Science Education Excellence (COSEE) Initiative: An Overview of Awards and Expectations**

S.B. Cook[1], S.E. Schoedinger[2] and E.L. Rom[3]

The National Science Foundation has provided funding to establish seven regional Centers for Ocean Science Education Excellence: two complementary partnerships in California, a New England regional effort, a Mid-Atlantic partnership, a Southeastern collaborative, a Florida initiative and a central Gulf of Mexico alliance. Additional budgetary and in-kind support is provided by the National Oceanic and Atmospheric Administration's National Ocean Service, Office of Ocean Exploration and National Sea Grant Office. The founding regional Centers represent a diverse mosaic of different infrastructures and catalytic approaches to the challenge of coordinating and linking ocean scientists with both formal and informal educators. Each Center will work to establish a solid framework for its distinctive programs. The various approaches of the centers will be reviewed. The Central Coordinating Office will take the lead in helping the network build a cohesive and focused national collaborative of scientists and educators with a major role to play in the development of a compelling national vision for ocean science education. The goals and outreach efforts of the Central Coordinating Office will be discussed.

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## Corkett, C.J.

**The Fisheries Manager As Engineer: Replacing An Inductive Monism (In Which Policies Are Reduced To Facts) With The Deductive Dualism Of A Fisheries Economics**

C. J. Corkett[1]

This paper adopts (from *Logic der Forschung*) a non-inductive view of the scientific method from which are derived two differing logical approaches to pragmatism. They are (i) a positive argumentation, taking the form of Syllogism A, that includes the deductive predictions of astronomy and meteorology, and (ii) a negative argumentation, taking the form of Syllogism B, from which are deduced the technological predictions that guide the engineer. The development of sustainable policies for the management of our resources, such as fish stocks, characteristically apes the deduced predictions of astronomy and meteorology, so that policies can be aaccurately based on quantified predictions. This naive non-argumentative view of method results in an *inductive monism* in which goals (such as the quest for sustainability), standards (such as the application of the precautionary principle) and policies (such as the total allowable catch of fish) are reduced to facts. This paper, by contrasting (a) the *deductive* engineering of a quality control process with (b) the *inductive* monism of a fish stock assessment, attempts to identify that unity of scientific method that would enable us to tackle our oceanic problems in a methodologically seamless fashion, a non-inductive theory of method whose embrace would stretch from the deductive argumentation of a Physical Oceanography to the *deductive dualism* of a Fisheries Economics.

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## D'Anna, Michael E.

**The System for At-Sea Environmental Analysis**

Michele E. D'Anna[1], David E.P. Colbert[2] and Michael D. Mandelberg[3]

The System for At-Sea Environmental Analysis (SASEA) was developed at the Johns Hopkins University Applied Physics Laboratory (JHU/APL) in the late 1980's to support analysis of oceanographic profile data during at-sea experiments and post-test analysis. Since its initial development, SASEA has proved to be an invaluable tool, providing state-of-the-art analysis, processing, and visualization of oceanographic profile data for generic and specialized applications. The core capabilities of SASEA include profile editing, analysis, database, and graphical display of oceanographic data. The Profile Editing module allows a user to apply advanced processing techniques such as data smoothing, and eliminating data spikes or redundant data values. The Analysis module includes algorithms that perform a variety of functions such as calculating profile density, Brunt-Väisälä frequency, and creating surface-to-bottom sound speed profiles. The Database Tools module includes options for creating, updating, and sorting data from a profile database, and methods to extract data from an existing profile database. The graphics module includes interactive profile plotting, contouring, and mapping tools with built-in extraction routines. To meet the community's increasing demands for an accurate, user-friendly ocean profile processing tool, JHU/APL has initiated aggressive software development and algorithm improvements to maintain SASEA as a state-of-the-art tool for analyzing, processing, and visualizing ocean profile data.

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## Dawson, Gretchen M.

**Applications of the Navy's Globally Relocatable Tide Model (PCTides)**

Gretchen M. Dawson[1], Ruth H. Preller[2] and Pamela G. Posey[3]

The Naval Research Laboratory has developed a globally relocatable tide/surge forecast system referred to as PCTides. The system uses a 2-dimensional barotropic ocean model to predict tidal elevation, storm surge and barotropic ocean currents. Global databases included in the system are a 2-minute bathymetry, global boundary conditions and global tide stations. Surface winds and pressures from the Navy's global and regional atmospheric forecast systems force the model. PCTides output includes timeseries of tidal height deviations and ocean currents at each grid point of the model and at higher frequency (usually 10-12 minutes) at specified point locations. PCTides has successfully completed its Navy operational evaluation by comparing forecasts along US coastal regions to real-time observations from the National Oceanic and Atmospheric Administration (NOAA) tide gauges. Based on comments from the operational evaluation, several improvements were incorporated into the system. In addition to its operational evaluation, PCTides has been run in a number of other locations where both tidal heights and currents were compared to observation. Specific examples of PCTides forecasts for various areas and improvements to the system will be presented.

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## DeBeukelaer, S.M.

**Remote Sensing Analysis of Natural Oil and Gas Seepage on the Northern Continental Slope of the Gulf of Mexico.**

S.M. De Beukelaer and I.R. MacDonald[1]

Sources of natural hydrocarbon seepage often denote the location of many unique geological, chemical and biological features of the marine environment. The goal of this research is to elucidate the spatial and temporal variation of natural oil seepage of the northern continental slope of the Gulf of Mexico. Synthetic Aperture Radar (SAR) images taken by the RadarSat satellite provide an economical approach to address this problem. A total of 11 SAR images extending over the Green Canyon MMS lease block were acquired in the summer of 2001 and 2002. All of these images were georeferenced and incorporated in a GIS project with bathymetry and known chemosynthetic community locations. The slicks evident on all of the images were traced and wind data was incorporated to resolve 1-km$^2$ areas of natural oil seep locations. Over 100 sources were evident on the images covering the geographic range of 90°W to 93°W and 26.5°N to 28.5°N. We were able to ground-truth representative seeps using visual and side-scan sonar observations collected with submarines NR-1 and Johnson Sea Link. Generally, there does not seem to be a correlation with depth nor an east to west gradient of seepage. The distances of the seep sources were compared to the biological data from the Deep Gulf of Mexico Benthos program in order to analyze the seeps' influence on seafloor ecology.

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## Deming, J.W.

**Factors Influencing Benthic Bacterial Abundance on the Northern Continental Margin of the Gulf of Mexico**

J.W Deming[1] and S.D. Carpenter[2]

An extensive data set on benthic bacterial abundance (n > 1000) for the northern continental slope of the Gulf of Mexico was acquired during cruises in 2000, 2001, and 2002. Bacterial abundance, determined by epifluorescence microscopy, was examined in 3-5 boxcores per station as a function of sediment depth (0–15 cm), station depth (212–3732 m), seafloor topography (canyons and basins), eastern versus western sectors, and high versus low overlying productivity. The clearest determinants of seafloor abundance, which ranged from $4.40 \times 10^{8}$ to $1.43 \times 10^{10}$ bacteria cm$^{-2}$ (integrated to 15-cm depth), were station depth and overlying productivity. Subsurface sediments were often inhabited by equivalent or higher numbers of bacteria (range of $1.00 \times 10^{8}$ to $1.80 \times 10^{9}$ bacteria cc$^{-1}$ sediment), of equivalent or larger cell sizes (range of 0.027 to 0.072 um$^3$), as those observed in surface sediments. Interannual variability was evident only at the shallower stations, while barophily, assessed using tritiated thymidine in surface sediments from depths of 767 to 2700 m, was detected only at the deepest station. Additional analyses in light of other data sets also obtained on these cruises are expected to expand understanding of the overall structure and function of benthic ecosystems on this important continental margin.

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## Dennison, W.C.

**Assessing Ecosystem Health in Coastal Waters**

W.C. Dennison[1] and F.J. Pantus[2]

We developed a means of assessing ecosystem health in coastal waters that provides quantifiable and spatial representations. This approach was developed for Moreton Bay, Australia and is being applied to Chesapeake Bay USA. A conceptual diagram of the ecosystem was created based on the best scientific understanding and community derived environmental values. Various management objectives for achieving ecosystem health were formed, using the conceptual diagram to structure the discussions. A variety of indicators were selected and reference values were developed using either a geographical or historical reference. Phytoplankton abundance, nutrient and turbidity status, sewage nitrogen extent, seagrass area and harmful algal bloom extent were measured, modeled and mapped. Spatial predictions were generated on a fine grid and the resulting maps of each indicator were separated into compliance and non-compliance zones using the relevant reference values. Reporting regions were established based on water depth, hydrodynamic residence time predictions and geographic features. The percentage area of each indicator compliance zone within the reporting regions (0-100%) was calculated. These areas were then added to create an integrated ecosystem health measure, which were used to develop annual report card values (A to F), widely reported in the media. These report cards were instrumental in prioritizing and soliciting stakeholder actions which have resulted in improvements in ecosystem health and may have widespread applicability for ecosystem assessment.

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## deRada, Sergio

**Principal Component Analysis of Observed and Atmospheric Model Winds of the U.S. West Coast Region**

Sergio deRada[1], John C. Kindle[2] and Stephanie C. Anderson[3]

Coastal ocean simulations are sensitive to the quality of the atmospheric fluxes used to force the model. The validation and analysis of these atmospheric products encompasses a variety of statistical and comparison methods of which Principal Component Analysis (PCA) is of particular value. In the work by Kindle, et al (GRL, 2002), Monterey Bay Aquarium Research Institute (MBARI) mooring observations were used in the evaluation of the triply nested (81/27/9Km grid) Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) within the Monterey Bay Region. This research extends and expands the work by Kindle, et al through the inclusion of 20 National Data Buoy Center (NDBC) observations along the entire U.S. West Coast region. The study focuses on the spatial structure and seasonal variation of the diurnal signal along the coast, resulting in an ensemble of comparisons using multiple buoys (MBARI and NDBC) and all three COAMPS atmospheric nests.

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## Detrick, R.

**Development and Testing of Deep-Water, Acoustically-Link, Moored Buoy Seafloor Observatory System**

R. Detrick[1], D. Frye[2], L. Freitag[3], J. Collins[4], W. Wilcock[5] and R. Light[n]

We are developing a relatively low-bandwidth (a few Mbytes/day), acoustically-linked moored buoy system that uses high-speed (~7 kbps) acoustic modems for two-way communication between instruments on the seafloor, or in the water column, and a surface buoy. An Iridium satellite system on the buoy will be used to telemeter data to shore several times a day. This system is ideally suited for a wide variety of applications where data telemetry requirements are relatively modest, but real-time or near real-time data are required. This system is also ideally suited for applications where the observatory may need to be relocated after a period of time, or deployed quickly for rapid response studies. Preliminary tests of this system will be conducted in September 2003 and a 15-month demonstration project is planned for a deep-water site in northeast Pacific in 2004-05. For this demonstration project several different types of sensors such as an ocean bottom seismograph, ADCP, CTD, temperature, chemical and pressure sensors, and hydrothermal flow meters will be interfaced to acoustic modems at two separate seafloor nodes. In addition, meteorological sensors will be mounted on the surface buoy, and current meters and temperature recorders will be placed on the mooring in the upper ocean. Through this project we hope to demonstrate the technical capabilities and scientific potential of an acoustically-linked moored buoy system for ocean observatory studies.

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## Diaz, C.

**Analysis of Abundance and Biomass of the Meiofauna from Two Depths of the Gulf of Mexico Using Two Sorting Methods**

C. Díaz[1] and E. Escobar[2]

Meiofauna samples collected from two depth zones [continental slope (n=6) and abyssal plain (n=6)] were sorted using a manual sorting strategy aided by stereoscopic microscope and a centrifugation Ludox AM® gradient strategy. Differences in abundance and biomass were recorded between depth zones and sorting strategy. The manual sorting strategies provided the largest values for the abyssal plain with 30±9 inds in contrast to the values obtained in the continental slope that were smaller 16±11 inds. Results using the centrifugation strategy had significant smaller values 4±3 inds and 10±5 respectively. The biomass values showed similar differences with largest values 19.52± mgC/m$^2$ strategy and 9.07±5.08 mgC/m$^2$ for the abyssal plain and he continental slope sites using the manual sorting strategies. The centrifugation strategy values were significantly lower, 4.05±4.21 mgC/m$^2$ and 5.50±3.35 mgC/m$^2$ respectively. This work concludes that manual sorting strategy remains as the most reliable method if values are to be used in models and monitoring of deep-sea sites in the tropical ocean.

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## Dickey, T.

**Scientific Cabled Observatories for Time Series (SCOTS)**

T. Dickey[1] and S.M. Glenn[2]

The Scientific Cabled Observatories for Time Series (SCOTS) Study was initiated by the National Science Foundation (NSF) in April 2002. The SCOTS Committee was asked to provide input for the NSF Ocean Observation Initiative (OOI) by exploring new science topics that could be most effectively addressed using the advantages afforded by regional cabled observatory technologies and approaches. A cabled observatory is defined operationally here as an unmanned system located in a fixed region. It uses electrical/fiber optic cables either laid on or buried just below the seafloor to provide substantial electrical power and real-time two-way communication links between a shore base and often multiple measurement platforms deployed offshore. The observational assets supported by the cable system will generally include a variety of stationary and mobile platforms enabling coherent interdisciplinary measurements over time and space (3-dimenisonal) scales sufficient to study a broad suite of processes on regions selected on the basis of scientific problems. The six themes enumerated by the Committee on Seafloor Observatories were adopted by the SCOTS Steering Committee with the new goal stated above. The six themes are: (1) Earth Structure and Dynamics of the Ocean Lithosphere, (2) Fluids and Life in the Ocean Crust, (3) Coastal Ocean Processes, (4) Turbulent Mixing and Biophysical Interactions, (5) Ecosystems Dynamics, and (6) Ocean, and Climate, and Biogeochemical Cycling. The Committee also reviewed the status of cabled observatory and related technologies in order to provide context for the activity. This poster will summarize some of the general results of the SCOTS activities, and provide brief summaries of the results of the six science theme and technology discussions.

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## DiMarco, S.F.

**Upper Ocean Currents in the Gulf of Mexico from 38 and 150 kHz Shipboard ADCP Observations**

S.F. DiMarco[1], O. Wang[2], N.L. Guinasso, Jr.[3] and J. Walpert[4]

A long range (500 m) and a medium range (200 m) acoustic Doppler current profiler were simultaneously ship-mounted on several deepwater Gulf of Mexico cruises during late spring and summers of 2000-2002. Data were collected aboard the R/V *Gyre* during the MMS-funded Deepwater Gulf of Mexico Benthic (DGOMB) Program. Two of the cruises had multiple legs which sampled the same ocean region about a month apart. The data provide an unprecedented view of the vertical structure and variability of upper ocean currents in the deep Gulf. Current features surveyed include the Loop Current, Loop Current Eddies, slope eddies, and currents along the continental shelf break. Evidence of topographic interaction of mesoscale features is event over the shelf and slope regions. Generally in the open ocean, near-surface currents are aligned with surface features seen in altimeter (sea surface height) maps. The data set also allows for a unique comparison of the measurements made by the two instruments.

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## Dubberley, John

**Oceanic Environmental Sensitivity of Tactical Decision Aid Design for Mine Warfare**

John Dubberley[1], Richard Keiffer[2] and Jorge Novarini[2]

In this presentation, the oceanic environmental parameters relevant to designing tactical decision aids (TDA) for mine detection are examined. This presentation overviews the fitness of various search algorithms for environmentally influenced mine detection and examines oceanic data variability's influence on mine hunts. The goal TDA should identify the most time efficient search path for a platform with a given knowledge of the environment. Specific examples to be discussed include how geoacoustic and bottom scatter will affect the detection of bottom placed mines, how sound speed profiles affect all acoustic signal propagation, and how ocean current patterns affect the distribution of floating mines. In conclusion this presentation discusses how extensively detailed must the environmental survey be in order to make search path analysis sensitive to the data. This work is being supported by the Office of Naval Research, Program Element No. 62782N.

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## Edson, J.B.

**The Air-Sea Interaction Tower at the Martha's Vineyard Coastal Observatory**

J.B. Edson[1], J.H. Trowbridge[2], A.J. Williams[3] and D.B. Peters[4]

The Air-Sea Interaction Tower (ASIT) was constructed off the south shore of Martha's Vineyard as part of the Coupled Boundary Layers and Air-Sea Transfer (CBLAST) program. The ASIT is located 3 km due south of Edgartown Great Pond in 15 m of water and extends approximately 22 m into the marine. It is specifically designed to make turbulent flux measurements in the ocean and atmosphere. The ASIT is directly connected to the Martha's Vineyard Coastal Observatory (MVCO) to provide data transmission and power directly from shore. Data from the ASIT is being integrated with the MVCO data and made directly available to all users via the MVCO web site at http://www.whoi.edu/mvco. The data will include wind speed and direction, air and sea temperature, waves height and direction, and currents at the ASIT. One of the main objectives of the CBLAST program is to improve our understanding of ocean-atmosphere interactions in low to moderate winds to improve marine weather forecasts and ocean circulation models. Towards this objective, we will instrument the ASIT from top to bottom with sensors capable of directly measuring the heat, mass, momentum, and radiative fluxes across the coupled boundary layers. The CBLAST main experiment will take place in the summer of 2003, and will also involve buoys, moorings, soundings, aircraft, and research vessels. The ASIT and the CBLAST program are funded by the ONR.

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## Elmore, P.A.

**Analysis of a Technique for Reducing Ambient Noise in Time Series Data with the Bartlett Spectrogram**

P.A. Elmore and J.J. Harding[2]

An analysis of a signal processing technique for reducing background noise from time series data is presented. The method subtracts the average power spectral density as calculated from the Bartlett spectrogram from the data in the frequency domain, and then forms a new time series from the resultant spectrogram and original phase information. We examine the improvements of the signal-to-noise ratio that occurs as the technique is applied multiple times to noisy time-series containing transient signals from synthetic data and real marine mammal recordings. The results show that improvements between 10 –15 dB can be achieved, making the technique useful for the analysis of underwater acoustic data where ambient noise reduction is desired. Limitations and pre-application considerations also are discussed.

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## Elmore, P.A.

**Scour Modelling for Mine Burial Prediction: a Sensitivity Study of Model Coefficients**

P.A. Elmore[1] and M.D. Richardson[2]

Equations that have appeared in works by Soulsby (R. Soulsby, Dynamics of Marine Sands, Thomas Teleford: London, 1997) and Whitehouse (R. Whitehouse, Scour at Marine Structures, Thomas Teleford: London, 1998) have been applied to predicting mine burial by scour. These equations contain coefficients that are deduced empirically, and, for the case of a free body at the ocean floor, are given only for one case (a 5:1 cylinder). These coefficients are likely to be different for other mine geometries, but the impact these differences may have on the output is unclear. Using oceanographic and burial data obtained from the recent NRL mine burial experiment off the coast of Martha's Vineyard, we examine how the output changes as these coefficients deviate from the values given by Soulsby and Whitehouse and compares with the mine burial data.

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## English, D.

**Optical Oceanography using Unmanned Underwater Vehicles**

D. English[1], K. Carder[2], D. Costello[3] and W. Hou[4]

The University of South Florida has deployed optical sensor packages on Unmanned Underwater Vehicles (UUVs) for almost a decade. The UUVs include Autonomous Underwater Vehicles (AUVs) operated by Florida Atlantic University, and an Autonomous Guided Underwater Vehicle (AGUV) and Remotely Operated Vehicles (ROVs) operated by the University of South Florida. The sensor packages have included the Real-time Ocean Bottom Optical Topography and the Benthic Classification and Albedo Package (BCAP), which collects downwelling irradiance, upwelling radiance, multichannel video, scattering, and fluorometry. The goals of these deployments have been to develop the capability to map the bottom albedo, the location of exceptional objects on natural or manmade surfaces, the light field of the water column, and some of the inherent optical properties (IOPs) of the water column. Techniques have been developed to estimate Apparent Optical Properties (AOPs) from BCAP measurements of the environmental light field. The direct measurements, combined with the derived AOPs and IOPs and other shipboard observations, have provided essential parameters for models of visibility, heat budgets, and water circulation. They have also been used to validate above-water remote sensing observations, to classify the bottom composition, and to detect distinctive objects on a sea bottom.

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## Färber-Lorda, J.

**The Relationship Between Trophic Conditions and Zooplankton Biomass in the Eastern Tropical Pacific. A general pattern?**

J. Färber-Lorda[1], M. Lavin, A. Trasviña[2], M. Guerrero[3], I. Romero-Vargas[4] and C. Almeda[5].

Data obtained along the Eastern Tropical Mexican Pacific, is analyzed to understand the relationship between Particulate Organic Matter (POM), zooplankton biomass and hydrography. Samples were obtained in the Gulf of Tehuantepec during winter (January-February), in the entrance of the Sea of Cortes in summer (June) and in summer (August) in the Southern California Current along the Pacific coast of Baja California. For POM, One depth was sampled in Tehuantepec (20m), three in the entrance of the Gulf of California (100, 10 and 1% light attenuation) and four in the Southern California Current (0, 20, 50, 100 m). A strong coincidence of higher POM with higher zooplankton biomass was found. In the Gulf of Tehuantepec, a significant relationship was found between lipids in POM (protein + lipids + carbohydrates) and lipids in euphausiids, also a significant relationship was found for POM and lipids in euphausiids, a significant multiple linear regression was obtained between euphausiid lipids and particulate proteins, lipids and carbohydrates. When stations were separated in three different water masses, no significant differences were found for neither for biomass nor for protein and lipids, only carbohydrates showed a significant difference. When samples were separated in time of sampling (leg I and leg II) corresponding to two different wind conditions, we did found a significant difference for biomass and for lipids in euphausiids. For the entrance of the Sea of Cortes we found a significant multiple linear regression between POM at three depths and zooplankton biomass, however, the regression index is not very high. When the stations were separated according to different water masses, we obtained a better regression index; thus trophic conditions are successfully tied to hydrography, according to water masses, this was not the case for the southern area of the Entrance of the Sea of Cortes, where we did not found a significant regression index, this area has a more complex hydrography. In the Southern California Current, hydrography has not yet been analyzed, thus a general equation for the entire area is presented.

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## Farrington, John W.

**Research and Education Integration: Need for a Flexible Approach**

John W. Farrington[1]

The ocean sciences communities are engaged in efforts to further integrate research with education, particularly in the K-12 arena. I support this effort. I am concerned that adopting recent suggestions for strict connections between individual research grants and education efforts may have negative consequences for both research and education that could and should be avoided. As an alternative, I suggest an approach to the integration of research and education adapted from the thinking about "basic" and "applied" research by the late Professor Donald E. Stokes, set forth in his book "Pasteur's Quadrant, Basic Science and Technological Innovation" (Brookings Institution Press, Washington, D.C. 1997).

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## Fisher, Charles

**Ridge 2000 and the NSF Ocean Observatories Initiative**

Charles Fisher[1] and the Ridge 2000 Steering Committee

Ridge 2000 is a community-based science initiative focused on integrated chemical, geological and biological studies of the Earth-encircling mid-ocean ridge system. Central to the Ridge 2000 Science Plan is the recognition that the origin and evolution of life in deep-sea ecosystems are tightly linked to the flow of energy and material from Earth's deep mantle, through the volcanic and hydrothermal systems of the oceanic crust, to the deep ocean. The program recognizes that the complex linkages between life and planetary processes on oceanic spreading centers can only be understood through studies integrated across a broad range of disciplines. As a result, the majority of the science proposals funded by the NSF Ridge 2000 Program will be conducted at one of a few designated sites. Because we will be focusing our efforts on a limited number of sites over an extended time frame, Ridge 2000 activities will be greatly enhanced through the application of technology being developed through the NSF Ocean Observatories Initiative and related programs. The ability to use instruments with greater power requirements and modify sampling regimes in response to data obtained in real time will significantly enrich the science that can be conducted at each of the Ridge 2000 Integrated Study Sites. In addition, this technology will allow a greater range of responses to the transient tectonic and volcanic events that occur intermittently along these very active areas of the deep-sea.

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## Fletcher, W.W.

**Accuracy of Surface Chlorophyll Measurements In Predicting Total Integrated Water Column Chlorophyll**

W.W. Fletcher[1], D.C. Biggs[2] and Chuanmin Hu[3]

For the northeastern Gulf of Mexico chemical and hydrography study, data on surface chlorophyll, salinity, and fluorometry were collected to characterize seasonal and interannual variation in phytoplankton stocks. In addition, satellite imagery was used to estimate surface chlorophyll for the time period of each cruise for comparison. Vertical fluorometer profiles were used as a proxy for subsurface chlorophyll concentration. These were then used to calculate total integrated chlorophyll to three depths: 35 salinity, 18% surface light transmission (1st optical depth) and 1% surface light transmission (compensation depth). These data were regularly collected at 98 stations, partitioned among 11 cross-margin transects in the NEGOM region. Samples were taken during nine oceanographic cruises during spring, summer and fall seasons over three years (1997-2000). Each cruise encompassed a number of hydrographic regimes, including Mississippi River outflow, continental shelf waters, and continental slope waters with episodic cyclonic and anti-cyclonic eddies. Satellite surface chlorophyll data had variable correlation with integrated water column chlorophyll. In most hydrographic regimes, the chlorophyll integration to the first optical depth had robust correlation with the satellite measurements. Under certain hydrographic regimes, most notably the waters of the continental shelf, the integration to the compensation depth did not always reflect the surface chlorophyll measurements.

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## Fougere, A.

**New CTD Instrument Incorporates an Advanced Non-Contacting Conductivity Sensor with Contained Volume Measurement**

A. Fougere[1]

Accuracy and deployment life of current CTD instruments are confined primarily due to limitations associated with the instrument's conductivity sensor, which is crucial in allowing the computation of salinity, density, and sound velocity from the acquired data. Traditional non-contacting (inductive) conductivity sensors are affected by proximity of objects that are placed or moved within the electric field external to the sensor. These "interfering" effects of known fixed objects can be corrected by careful instrument calibration; however, this technique leaves the unit susceptible to external field changes introduced after the calibration has been completed, or during deployment. All conductivity sensors (both non-contacting and electrode) are also susceptible to changes in the measured volume of seawater due to the effects of bio fouling. Bio-fouling calibration changes reduce the deployment life, especially in shallow, higher temperature waters. Non-contacting type sensors have the advantage of posting a biofouling event, and after the contamination is removed, the original calibration is maintained; electrode sensors, on the other hand, must be returned to the manufacturer for electrode re-generation and complete re-calibration. FSI has developed a innovative new conductivity non-contacting sensor which allows for a fully "internal" volume conductivity measurement, eliminating the effects of changes in the external volume, and, allowing aggressive anti fouling techniques to be applied during "non measurement" periods. The new sensor, referred to as the FSI " NXIC", or Non External Field Inductive Conductivity Sensor, is based on use of dual torroidal transformers packaged such that the electro-magnetic field is restrained within the sensor. The resulting inductive sensor allows free flushing, with no pumping requirement, and the effects of biofouling are limited to the internal surfaces of the cell, where biofouling can be aggressively controlled. The paper discusses the recent development of an "explosive" shock hardened version of the NIXC for use aboard U.S. Navy Fleet Submarines, and several commercial applications of the NIXC sensor, including data from initial deployments.

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## Frizzell-Makowski, L.J.

**Ocean Science and Technology at APL-A Methodology for Large-Scale Oceanographic Field Testing**

L.J. Frizzell-Makowski[1], J.L. Hanson[2] and S.A. Feher[3]

The Johns Hopkins University Applied Physics Laboratory has been supporting US Navy and DOD sponsored oceanographic field programs for the past 3 decades. Through these programs, JHU/APL has developed a methodology to support large scale, multi-organizational, oceanographic experimentations. This methodology includes performing detailed pre-test site characterizations, planning and coordinating supporting field measurements, collecting state of the art oceanographic measurements, conducting real-time data analysis to support test operations, and disseminating science data and detailed analysis results in an interactive CD-ROM format. In these experiments, APL has been responsible for equipping different platforms with instruments and innovative sensors, many of which has been developed at the Laboratory. The success of this methodology was demonstrated this past year as APL supported two large field programs that were conducted in littoral environments.

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## Fuhrman, J.A.

**Human Pathogens in the Marine Environment**

J.A. Fuhrman[1]

Pathogens in the marine environment include viruses, bacteria, and protists. Although some are native to the ocean (e.g. *Vibrio cholerae*), and some may come from ships, most probably originate from terrestrial sources, and these enter the sea in piped sewage, rivers and channels, runoff, and groundwater. Human exposure to these pathogens can be from eating contaminated shellfish (particularly when raw) and also recreational exposure like swimming and surfing. Current tests for contamination look for what are known as indicator bacteria (generally non-pathogenic bacteria likely to be present in sewage), and these have been broadly successful at limiting human exposure. However, reports indicate that such tests may miss human pathogenic viruses. This is consistent with limited biological oceanographic studies showing that bacteria and viruses are dispersed and removed by very different processes, so they should not be expected to "follow" each other. New molecular biological tests are suitable to test shellfish and recreational waters for viruses, and these can help (although they are relatively expensive). But ideally, proactive steps should be taken to keep pathogens away from shellfish beds and beaches. Oceanographers can help by investigating the physical, chemical, and biological processes that lead to pathogen distributions, providing a broad knowledge base for planners, engineers, and regulators.

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## Gaboury, I.

**Small-Scale Biological and Physical Structure in a Tidally Mixed Fjord**

I. Gaboury[1] and R. Lueck[2]

Knowledge of small-scale zooplankton distributions and their relationship to physical and biological parameters is important for understanding relationships and interactions in marine ecosystems, and requires high-resolution simultaneous measurements of these distributions. We used high-frequency (44 kHz and 307 kHz) echosounders mounted on a towed vehicle equipped with fine and microstructure sensors for temperature, salinity, velocity, and chlorophyll concentration to observe their spatial structure around the sill in Knight Inlet, British Columbia. Sampling the backscatter over a 1 to 20 m range in front of the towed vehicle allows us to observe undisturbed horizontal and vertical structures in zooplankton distributions, and to repeatedly sample volumes of water along the vehicle path. Data from the vehicle-mounted acoustic profiler reveal sub-meter scale patchiness in the mesozooplankton community, which is not resolved by traditional ship-mounted echosounders. The intensity of the acoustic backscatter signal compares well with the size and number density of zooplankton in the scattering layer determined by net sampling. We are currently comparing the zooplankton data to the corresponding turbulence and chlorophyll measurements to examine the nature of the relationships between their distributions.

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## Gallacher, P.C.

**Regional and Mesoscale Models Nested in a Global Model: Dynamics and Boundary Conditions**

P.C. Gallacher[1], M.R. Schaferkotter[2] and S. Piacsek[3]

Regional and mesoscale models are being used to study various aspects of Coastal Oceanography. We are using a regional model of the Mid Atlantic Bight with an embedded mesoscale model of the New Jersey shelf/slope to study the outer shelf dynamics, particularly the internal wave field, and its affect on acoustical propagation. The results of several simulations with different forcing and boundary conditions will be discussed. The results will be compared with data from the SWAT experiment and with tide gauges. Both the regional and the mesoscale models are set up using the Navy Coastal Ocean Model (NCOM). NCOM is designed for efficient nesting with the capability of one- or two-way nesting. The effects of remote forcing are included through active open boundary conditions. These boundary conditions prescribe the temperature, salinity and velocity fields from the Global version of NCOM and tidal amplitude and phase from the ADCIRC model. The boundary conditions also allow for the radiation and advection of temperature, salinity and velocity out of the domains. Surface fluxes are taken from Coastal Ocean and Atmosphere Prediction System (COAMPS) forecasts

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## Gallegos, Sonia C.

**A New Technique to Extract Optical Properties of the Water from Environmental Parameters**

Sonia C. Gallegos[1], Juanita Sandidge[2], Xiaogang Chen[3], Cynthia Daniels[4] and Chiu Fu Cheng[5]

In this paper we report the development of a real-time environmental model to extract spectral light attenuation coefficient from the surface to the bottom of the Yellow Sea. It illustrates a technique that can be useful in the extraction of optical parameters in highly turbid and optically complex coastal areas. The model, which is based on a back-propagation neural network algorithm, is trained on optical and oceanographic parameters collected at various locations in the Yellow Sea from 1996-2000. It relies for its real-time optical estimations on a tidal model developed for the Yellow Sea (ADJOINT) and a statistical model (MODAS) that produces real-time estimations of temperature and salinity at any depth around the world. Sediment and bathymetry databases provide measures of particle size distribution and depth. The model can ingest satellite data, but it is not a requirement for its running. The inclusion of satellite data produces more accurate estimates. However, access to the data is limited to once during daylight hours and to cloud-free periods that are rare in the Yellow Sea. The accuracy of the model increases with the amount and variety of the input data. The best estimates occurred in coastal areas. The less accurate estimates occur in open waters.

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## Gardner, W.D.

**POC Distribution in the Pacific: Estimates using *in situ* Optical Data and SeaWiFS Products**

W.D. Gardner[1], A.V.Mishonov[2] and M.J.Richardson[3]

Beam attenuation data collected on 7 WOCE lines during 12 cruises to the Pacific were used for assessment of the particulate organic carbon concentration. A regression of beam $c_p$ vs. POC using EqPac and HOT field data was applied in order to obtain spatial and vertical distribution of POC. Basin-wide POC data integrated over the upper water column down to one optical depth were compared with seasonally averaged ocean color products derived from SeaWiFS sensor. SeaWiFS data products were compared with integrated oceanic POC from calibrated transmissometer data to determine the best bio-optic product to use. A comparison between POC within one optical depth layer and POC standing stock from surface to the depth of background POC was made. Estimations of the POC seasonal dynamics in the upper layer over the entire Pacific was mapped based on monthly SeaWiFS mosaics.

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## Gledhill, Dwight K.

**Apparent Solubility of Bahama Bank Water Precipitate**

Dwight K. Gledhill[1], John W. Morse[2] and Frank J. Millero[3]

For close to 40 years controversy has surrounded the origin of turbid white parcels of water known as "whitings" occurring in the waters overlying Great Bahama Bank. Debate continues over whether such events represent dramatic biologically triggered direct precipitation of fresh $CaCO_3$ or are purely re-suspended sediments. The apparent solubility of the precipitating phase seeded from suspended Bank sediment was obtained from a closed-system free-drift rate experiment. Mineral solubility was estimated from the change in pH verses $t^{-1/2}$. The kinetically estimated solubility of the precipitating phase was observed to be about twice that of aragonite. This is compatible with the hypothesis that a high magnesian calcite surface phase (13 to 15 mol %) initially precipitates from seawater that may subsequently epitaxially convert to the lower solubility underlying aragonitic or calcitic phase. When this "kinetic solubility" is considered for the waters west of Andros Island, near Williams Island, it is found that they are close to equilibrium consistent with the observation that there is little change in the normalized TA in these waters which would be observed if significant precipitation were occurring. This observations tends to bolster the hypothesis that whitings are primarily re-suspension events since the waters are too near "kinetic" equilibrium to allow for significant quantities of fresh $CaCO_3$ to precipitate.

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## Glenn, Scott M.

**The New Jersey Shelf Observing System**

M. Scott Glenn[1] and Oscar M.E. Schofield[2]

The New Jersey Shelf Observing System is a coastal ocean observatory whose primary goal is supporting collaborative interdisciplinary oceanographic research. The observatory has both a sustained component designed to provide spatial datasets year round, and a process study component for more intensive measurements during short-term scientific experiments. The sustained component consists of tracking stations for the international constellation of ocean color and IR satellites, multi-frequency multi-static CODAR HF Radars, and long-duration subsurface Glider AUVs. The processes study component uses numerous platforms that include aircraft, ships, propeller-driven AUVs and relocatable mooring arrays. Process studies focused on recurrent coastal upwelling centers and their biological impacts from 1998-2001, and are planned to focus on the Hudson River plume, chemical contaminants, and their biological impacts from 2003-2007. Despite being a research-oriented observatory run by the scientists for the scientists, it maintains a significant societal impact through its website (marine.rutgers.edu/cool), receiving an average of over 60,000 hits/day during the busy summer months.

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## Glibert, P.M.

**Harmful Algal Blooms and Ecosystem Health**

P.M. Glibert[1]

Harmful algal blooms are increasing in frequency, duration, and magnitude in many parts of the world. Their impacts on ecosystems can be severe, ranging from hypoxia and anoxia to mass mortalities of fish and shellfish, accumulations of algae that shade seagrasses, reductions in benthic habitats, and human health concerns. Eutrophication is one of several mechanisms by which this expansion is occurring. In recent years, considerable insight into the dynamics of harmful algal blooms and their relationship to eutrophication has been gained. Three points bear emphasis. First, the relationship between changes in human population and in fertilizer usage and harmful algal blooms has become better understood through improved land use models. Second, the physiological strategies by which different groups of algal species acquire their nutrients have become better understood. Many harmful species have alternate mechanisms, including feeding and extracellular pathways, to acquire particulate and organic nutrients and energy. In many cases the organic component of the nutrient pool may contribute disproportionately to the development of harmful blooms. Finally, better monitoring tools are now available, including continuous *in situ* sensors. These insights and tools will help us develop predictive capability and improved models. The ability of a species, including a harmful species, to thrive in a particular environment, depends on its ability to exploit both the quantity and quality of available nutrients, the timing and intensity of the nutrient supply, and the interaction of other environmental factors and competitor or consumer species.

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## Goffredi, S.

**Development of Molecular Probe Technology for *in situ* Larval Detection**

S. Goffredi[1], R. Marin[2], R. Vrijenhoek[3], J. Ryan[4] and C. Scholin[5]

The dispersal, migration and development of most marine invertebrate life stages remains a mystery in large part due to the difficult task of detecting them in the water column. Nucleic-acid based technology has the potential to resolve this issue by direct identification and monitoring of embryonic and larval forms *in situ*. Previous efforts have led to the development of molecular probe technology capable of detecting and quantifying algal species in natural populations (Scholin et al. 1997; see also TOS poster). We endeavored to extend the scope of this technology to include the automated collection and detection of marine invertebrate larvae *in situ*. We present here research concerning near shore barnacle species, including the determination of target detection sequences and capture probes, the development of quantitative hybridization techniques for laboratory analysis, and the real time detection of barnacle larvae off the coast of Monterey California. Immediate applications of this research will include assessing the influence of environmental variability on nonnative species, as well as ecological monitoring of species involved in commercial fisheries. Future applications include monitoring of gene flow and distribution of deep-sea larvae, including organisms from cold seeps and hydrothermal vents, of which even less is known. Development of instruments that enable unattended application of molecular probes offers a powerful new method of studying the establishment and maintenance of marine invertebrate populations in the world's oceans.

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## Gould, R.W.

**Coastal Transport of Organic and Inorganic Matter from Ocean Color Remote Sensing**

R.W. Gould, Jr.[1], R.A. Arnone[2], R. Smith[3], S.D. Ladner[4] and P.M. Martinolich[5]

We have developed new algorithms to estimate the concentration of total suspended solids, and to partition the total sediment load into organic and inorganic components. Ocean optical properties are determined by the complex interactions of the dissolved and particulate components in the water, including sediments, phytoplankton and colored dissolved organic matter. Partitioning organic and inorganic components of suspended particles is important from both remote sensing and modelling aspects, particularly in coastal regions where temporal and spatial optical variability is great. The concentration and space/time distribution of the inorganic component, both river-borne and resuspended sediments, can be used to trace plumes and fronts, and can indicate regions of increased turbulence due to wave action and storm events. The distribution of the organic component does not necessarily mirror the distribution of the inorganic component, as they are influenced by different processes (physical vs. biological controls). We apply these new algorithms to SeaWiFS ocean color imagery and use the satellite products to trace coastal features, examine processes, and estimate horizontal particle flux.

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## Greenspan, D.

**JHU Spider – An Eight-Channel Airborne Marine Data Acquisition System**

D. Greenspan[1] and L. Peco[2]

The Johns Hopkins University Applied Physics Laboratory has designed and built a new PC-based marine data acquisition and analysis system that provides rapid Airborne eXpendable BathyThermograph (AXBT) surveys, sophisticated navigation, data processing, data backup and data communication capabilities. Spider is portable and can be installed in less than an hour. It can collect, display and record up to eight channels of AXBT data simultaneously and provide the corresponding time and 3-axis GPS information for each AXBT profile. Little operator input is required. A number of signal-quality indicators are available, and an electronic operator's log allows user input to be associated with specific events, locations, or profiles. Profile-related events are automatically logged. A second, peer-networked PC furnishes a platform for mission planning, navigation, and additional data-processing activities. The system is approved for use in U.S. Navy P-3 aircraft and has been utilized successfully on a number of missions. Sample data from the system and details of its construction and installation will be presented.

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## Haeger, Steve

**Ocean Modelling for Homeland Security**

Steve Haeger[1] and Scott Cross

Military, government, and civilian access to timely oceanographic information for coasts, ports, and harbors is an important component of the overall U.S. maritime homeland security strategy. Immediate access to accurate oceanographic information is particularly important to first responders and to those who must plan for contingencies. Observations and models of currents, tides, winds, and waves are available from a wide range of federal, state, local, academic, and non-governmental entities. The Naval Oceanographic Office (NAVOCEANO) has been collaborating with several agencies to optimize efforts toward improving both rapid response and long-term implementation of hydrodynamic and waterborne dispersion models. NAVOCEANO and National Oceanic and Atmospheric Administration (NOAA), in particular, have interacted closely to exchange models and prediction techniques, as well as to standardize exchange formats for circulation model output and observed data. These collaborations will eventually fold into a larger, emerging national-level plan between civilian and military interests to address the many types of modelling efforts required for planning, short-term crisis response, and long-term consequence management for both U.S. and foreign waters.

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## Hallock, Zachariah R.

**Internal Wave Parameters Inferred From ADCP Records**

Zachariah R. Hallock[1] and Robert L. Field[2]

A method for extracting internal wave characteristics from time series of current velocity profiles, measured by moored acoustic Doppler current profilers (ADCPs) is described. The method is applied to 40-day time series acquired at the shelf edge off the coast of New Jersey. Horizontal and vertical velocity components at each depth level are band-pass filtered to isolate high-frequency internal waves (periods between 2 h and 12 min). Filtered data are decomposed into depth-time empirical orthogonal function (EOF) modes which compare quite favorably with dynamical internal wave modes based on local buoyancy frequency profiles. Vertical displacement is derived by temporally integrating vertical velocity. Modal flux series, formed by the product of displacement and horizontal velocity, are analyzed to determine amplitude and direction of internal wave packets. Results compare favorably with concurrent moored thermistor chain and CTD measurements. The generation of a synthetic time-dependent profile of sound speed, based on ADCP vertical displacement series, is presented.

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## Hamill, B.

**Diel Changes in DOM Concentration in Near-Shore Surface Waters**

B. Hamill[1] and J. Cherrier [2]

Recent sampling efforts at Rutgers University's LEO 15 site (LEO) and on a transect to the Sargasso Sea from Woods Hole, MA (SS) were undertaken to evaluate how photorespiratory processes impact DOM cycling in natural systems. Previous laboratory investigations conducted with axenic cultures of T. weissflogii demonstrated that diatoms leak significant quantities of DOM over short time scales when subjected to stress-inducing high light. Conversely, control cultures (moderate light) exhibited accumulation rates of near zero for the same time period. Analysis of LEO and SS samples revealed DOM accumulation shortly after sunrise at rates significantly higher than that observed in laboratory control cultures, although not as high as the accumulation rate in experimental (i.e. stress-inducing light) cultures. At LEO net DOC concentrations increased 99.1 ?M seven hours following sunrise (~33% over ambient DOC concentrations at dawn). DON concentration increased almost 35 ?M during the first two hours following sunrise from near zero at dawn. At the SS site, net DOC concentrations increased 31?M in the five hours following sunrise ( ~ 27% over ambient DOC concentrations at dawn). Two hours after sunrise, DON concentration had increased to approximately 10 ?M from zero at dawn. The lower observed SS values could be due to lower phytoplankton abundances at this site. Although absolute DOM concentrations differed at both sites, patterns of DOM release were similar, suggesting that diel DOM cycling could be attributable to photorespiratory processes.

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## Hanson, A.K.

**SABRE: A Sensor Array for Bay Research and Education**

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Some oceanographic problems require or are most effectively investigated by using multi-disciplinary cabled observatories. Many interesting problems in the coastal environment require the simultaneous measurement of physical, biological and other conditions using *in situ* and acoustical remote sensing technologies. These requirements demand the power and bandwidth of cabled installations and the technological development of a new class of durable multi-parameter sensor arrays and sensor protection systems. They also require the education and training of a new class of oceanographers and ocean engineers skilled in the use of these new tools. SABRE is an interdisciplinary engineering and educational effort to develop a novel, cabled, underwater sensor array for intensive and sustained studies of fluid dynamics, chemistry and biology in coastal waters. The remotely controlled array will be designed for long-term deployment on cabled observatories for multi-disciplinary time series investigations of water properties and their response to various forcing conditions. Initially SABRE will consist of two integrated platforms, the Profiler and the Beamer. The Profiler rests in a docking station and periodically winches itself up through the water column to obtain profiles of temperature, salinity, oxygen, nutrients, in-situ optics, current velocity and turbulence. The Beamer, a bottom mounted acoustic platform, resolves air-sea and subsurface physical processes and continuously maps the vertical and horizontal distribution of zooplankton and fish. SABRE will be developed and tested on an existing underwater cabled network (NUWC/NPT) located in Narragansett Bay, RI.

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## Hanson, J.L.

**Analysis of Ocean Surface Directional Wave Spectra using Image Processing Tools**

J.L. Hanson[1]

The extraction of detailed wave climatology information from ocean surface wave measurements and predictions is important for many applications including naval operations, offshore design, ship routing, and harbor safety. In these applications wave spectral partitioning methods may be employed to characterize the individual wave systems present. To date these techniques have required cumbersome algorithms with slow execution times. A new wave spectral partitioning method has been developed that uses image-processing tools to extract wave system information from directional wave spectra. Treating the spectrum as an inverse topographic domain, efficient watershed delineation algorithms quickly map out the spectral region associated with each wave system. Tracking these spectral domains over time allows development of a wave climatology in terms of the specific wind sea and swell events characteristic of the study region. As a significant improvement over previous methods, this capability has been added to the APL-WAVES software tools for ocean surface wave analysis.

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## Harding, John

**Real-Time Operational Oceanography at the Naval Oceanographic Office**

John Harding[1], Ed Johnson[2], James Rigney[3] and CDR William Schulz[4]

Scientists of the Naval Oceanographic Office (NAVOCEANO) provide specialized operationally-significant products and services for military "warfighters." These products are also provided for civilian, national and international customers under some circumstances and with some constraints. Our scientists acquire global ocean and littoral data from sources such as: shipboard surveys by NAVOCEANO and others, from routine data collected by both operational Navy and commercial ships, from remotely-sensed data available from a variety of airborne and satellite sensors, and from drifting and fixed-location buoys. The analyses of these data range from the creation of historical climatologies and real-time maps of specific measured parameters to the assimilation of real-time data into ocean prediction systems for temperature, salinity, tides, waves, and currents. NAVOCEANO products are primarily requested from and delivered to the customer through the Warfighting Support Center (WSC). The WSC provides analyses of the oceanographic environment using multiple data sources. Dynamic and morphologic features of coastal areas are extracted from satellite imagery within the WSC, which then blends bathymetric, hydrologic, climatologic and predictive information from other departments and organizations into operational products tailored to specific mission requirements. These products are frequently geo-spatially enabled for automated information system use and delivered via web technology.

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## Henderson, D.

**NOAA's Marine Observation Network**

D. Henderson[1] and D. Gilhousen[2]

National Oceanic and Atmospheric Administration's (NOAA), National Data Buoy Center (NDBC), a part the National Weather Service, operates and maintains NOAA's Marine Observation Network (MON). The MON is an integrated, sustained ocean observation and information delivery system that serves all U.S. coastal waters, the offshore waters of the Pacific and Atlantic Oceans, and the Gulf of Mexico. The MON a major component of the National Oceanic and Atmospheric Administration's (NOAA) national backbone for marine observations is directly linked to NOAA's Advanced Weather Interactive Prediction System which provides information directly to the U.S. Emergency Managers Weather Information Network. The MON consists of headland and moored buoy data acquisition platforms, drifters, floats, and voluntary observing ships and real-time processing and information delivery systems. These stations, which often provide the only in-situ measurements in remote regions, help NOAA achieve its mission responsibilities and strategic goals. The MON serves cross-line office missions within NOAA and supports research and operational requirements of other federal, state, regional, local, academic and private sponsors. The introduction of new technologies, partnering and collaborating with other agencies, non-governmental organizations, and strategic alliances have increased NOAA's contribution to the U.S. Integrated Sustained Ocean Observing System and the effectiveness of the MON. This paper presents an overview of the MON capability, discusses new operational improvements, and highlights recent regional, national and international partnerships.

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## D. Hernandez

**Families Richness and Molecular Analysis of Tanaidaceans from the Gulf of Mexico**

D. Hernandez[1], E. Escobar[2] and T. Spears[3]

Research carried out in marine environments has shown that tanaids constitute one of the most numerous benthic infaunal groups. Their abundance is commonly maintained or grows with increasing depth in the continental slope and the abyssal plain. This study highlights the importance of this group of crustaceans in the deep Gulf of Mexico, having as its main objectives the description of tanaid families richness in the bathymetric gradient and the molecular analysis of two different populations of tanaids. Samples were obtained in two oceanographic cruises made on board the R/V *Justo Sierra*, comprising stations in two transects along the bathymetric gradient in the western Gulf of Mexico. A total of eight tanaid families were identified in the study area, which represents 46% of the families known to date in Intra Americas Sea and 33% of the families recognized worldwide. The Anarthruridae was the family with the highest abundance and frequency in the samples from both cruises. Classification and multidimensional scaling analyses, showed that the distribution was determined by depth (>70%). Specimens collected off the sublittoral habitats in Florida and Veracruz allowed us to recognize that the ITS-1 region of the rDNA operon and the V-7 expansion segment of the 18S gene are useful markers for the analysis of genetic variability among tanaid species; however, the V-7 expansion segment lacks the resolution required to distinguish intra-specific differences in the group.

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## Hickey, H.

**The Southern Ocean: A Possible Source Region for Tropical Atlantic Variability?**

H. Hickey[1] and A.J. Weaver[2]

The Atlantic Ocean shows enhanced variability on interannual and decadal timescales. The interannual variability is generally well understood, but the decadal variability, which shows promise as a long-term predictor of rainfall and drought in the surrounding regions, remains a mystery. In particular, the question remains as to what sets the decadal timescale. Advection of anomalies from the Southern Ocean is considered here as a possible source for Atlantic variability. Using the UVic climate model (an ocean GCM coupled to a simple (EMBM) atmosphere and a dynamic-thermodynamic sea ice model), a region in the eastern Atlantic is identified as being consistently sensitive to heat, freshwater and wind forcing in the Southern Ocean. Analysis shows that all three forcings cause anomalously high advection of intermediate water from the Southern Ocean into the Atlantic. Results suggest that this could represent the oceanic branch of a coupled mode of variability, linking the tropical Atlantic and Southern oceans.

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## Hoepffner, N.

**Operational Monitoring of the European Seas from Space**

N. Hoepffner[1] and F. Mélin

Increased concerns about the rapid and negative changes of coastal seas in Europe have highlighted the necessity for the development of integrated systems for research and operational use in monitoring the status of marine waters. Accordingly, a multi-annual time-series of sea surface color products derived from the SeaWiFS sensor is analyzed to assess the space/time variability of marine and coastal features. A combined land/sea processing package for optical satellite sensors has been developed to simultaneously retrieve the marine surface signature and the optically significant constituents, as well as the marine aerosol characteristics and the terrestrial vegetation activity. This processing chain has been applied to the top-of-atmosphere radiance data collected at the various receiving stations to provide a 2-kilometer resolution daily-to-seasonal characterization of the European waters. The performance of the code for the retrieval of aerosol characteristics, marine optics, and concentrations of optically active substances from SeaWiFS, has been thoroughly evaluated for a site located in the northern Adriatic Sea and compare favorably to NASA retrievals. Spatial and temporal variances of ocean color products are analyzed for several windows over Europe. The image-products are displayed on a web site, as daily series or ten-day and monthly composites, therefore accessible to the community. Time series analyses at specific sites show distinctive variability on various timescales and illustrate the role of satellite-measured ocean color in monitoring long-term trends in the trophic conditions and water quality of coastal waters.

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## Hogan, P.J.

**Simulated Pycnostads in the Japan/East Sea**

P.J. Hogan[1], H.E. Hurlburt[2] and A.J. Wallcraft[3]

A Hybrid Coordinate Ocean Model (HYCOM) has been configured for the Japan/East Sea. Results from several simulations have been used to investigate the formation of Intra-Thermocline Eddies (ITSs). These features, which are lens shaped and characterized by relatively warm saline water are simulated at approximately the same depth and location as those observed by recent Seasoar observations. The model results have been used to elucidate two formation mechanisms for these features which are not mutually exclusive. One is simple restratification of the mixed layer on seasonal time scales. Here, warm saline water gets overridden by colder fresh water, but the water that gets overridden maintains positive vorticity and hence forms pycnostads within the thermocline. The other mechanism for the formation of these features is frontal subduction of more saline water along the subpolar front. With this mechanism, localized pockets of warm saline water on the southern side of the subpolar front are overridden by cooler and fresher water on the northern side of the the front, and the location of the pycnostads is determined by meandering of the subpolar front.

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## Howe, B.M.

**Sensor Networks for Cabled Ocean Observatories**

B.M. Howe[1] and T. McGinnis[2]

The NSF Ocean Observatories Initiative (OOI) plans to provide basic backbone infrastructure of junction box nodes on the seafloor with power, communications and time distribution. The three major elements of the OOI are: a regional scale cabled observatory such as NEPTUNE; a sparse global array of buoys with seafloor nodes; and an expanded system of coastal observatories. To extend the spatial extent beyond the backbone nodes of these elements, sensor networks will be required to distribute the power and communications capability both on and below the seafloor and into the water column. After initial installation, most of the engineering interaction with the observatory will be installing, operating, servicing and recovering sensors and sensor network infrastructure. Sensor suites that can be attached to observatories will be needed, just as astronomical observatories with telescopes need suites of detectors. These suites must meet a large fraction of the community science requirements and must be robust, long-lived and inexpensive. Development of the supporting infrastructure to connect sensors to the backbone is essential to the implementation and operation of cabled seafloor observatories. Considerations for long-lived sensors and associated sensor network infrastructure for ocean observatories are presented.

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## Hwang, Paul A.

**Retention Rate Of Air-Sea Momentum Exchange In The Wind-Generated Ocean Wave System**

Paul A. Hwang[1], David W. Wang[2] and Shahrdad Sajjadi[3]

One of the most challenging measurements in wind wave research is the source functions, which are the driving force governing the dynamics of the wind wave system and determine the quantitative exchanges of air-sea energy and momentum. The dominant source terms for ocean surface waves are wind input, breaking dissipation, and nonlinear interaction. These source terms act on the wave field at the same time and are usually difficult to be differentiated. In this presentation, we derive the retention rate of air-sea momentum exchange using the fetch- and duration-growth laws. The dimensionless retention rate follows a square power law dependence on the dimensionless wave frequency, which is equivalent to the inverse wave age. The quadratic dependence of the retention rate is similar to the growth rate of individual wave components. The result suggests that an actively growing wave field can be represented by its significant wave parameters (variance or significant wave height, and peak or significant wave period). The proportionality coefficients ($\beta$) of the retention rate and growth rate of the two systems are comparable and in the neighborhood of 15.

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## Isern, A.R.

**The Ocean Observatory Initiative: A Permanent Presence in the Ocean for Research and Education**

A.R. Isern[1] and H.L. Clark[2]

Global processes that actively shape the earth and ultimately impact society must be investigated over the spatial and temporal scales at which they occur. To characterize the temporal behaviour of dynamic processes occurring in the ocean, new types of infrastructure are needed that are capable of providing long-term, high-resolution observations of critical environmental parameters. NSF's Ocean Sciences Division plans to initiate construction of an integrated observatory network to provide the oceanographic research and education communities with new modes of access to the ocean. This system has three elements: a regional cabled network, several deep-sea buoys, and new or enhanced facilities leading to an expanded network of coastal observatories. The infrastructure for all components of the Ocean Observatories Initiative consists of an array of seafloor junction boxes connected to cables running along the seafloor to individual instruments or instrument clusters. These junction boxes include undersea connectors to provide not only the power and two-way communication needed to support seafloor instrumentation, but also the capability to exchange instrumentation in situ when necessary for conducting new experiments or for repairing existing instruments. Depending upon proximity to the coast and other engineering requirements, the junction box is either terminated by a long dedicated fiber-optic cable to shore, or by a shorter cable to a surface buoy that is capable of two-way communications with a shore station.

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## Kaihatu, J.M.

**Nearshore Environmental Nowcasting using Unmanned Underwater Vehicles**

J.M. Kaihatu[1], K.T. Holland[2], Brian S. Bourgeois[3], Richard A. Allard[4], James D. Dykes[5] and Theodore R. Mettlach[6]

The need for an expedient, accurate depiction of the combined nearshore wave and hydrodynamic environment in near-real time has grown more acute with the increased military focus on amphibious operations and mine detection. A nowcasting system which marries high-resolution oceanographic and bathymetric information to a sophisticated nearshore environment model is described. The REMUS, an unmanned underwater vehicle (UUV) developed by Woods Hole Oceanographic Institution, will be the primary platform for the sensors. This data would then be ported as input to a numerical model for simulating the nearshore processes. Several models (e.g., Delft3D, SHORECIRC) will be available for this simulation. While the sensors on the UUV provide the necessary nearshore measurements, offshore forcing conditions for the model would be provided by the Distributed Integrated Ocean Prediction System (DIOPS), an object-oriented modelling system which provides model forecast fields. The product of the simulation would be a quantitative depiction of the nearshore wave and current fields in the area of interest, which would then be forwarded to amphibious units for assessment. The state of overall system development will be described.

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## Kaltenbacher, Eric

**A Compact Sensor For Real-Time 3-D Imaging Applications In Aqueous Environments**

Eric Kaltenbacher[1], Larry Langebrake[2], Dave Costello[3], Ken Carder[4], Jim Patten[5] and John Kloske[6]

We have developed a compact system for generating high-resolution 3-D images in aqueous environments. Our prototype real-time ocean bottom optical topographer (ROBOT) has been redesigned for improved working distances and tolerance to turbid waters. Using a green laser and sophisticated CCD camera to perform triangulation, we are able to produce dimensionally accurate images of a wide variety of objects. The sensor is well suited for deployment on autonomous underwater vehicles (AUVs) or on remotely operated vehicles (ROVs). In this paper, we briefly describe the design of the instrument and discuss current and potential applications for the sensor. In particular, we highlight use of the sensor for homeland security. We also present examples of field data collected from typical deployments.

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## Kang, H.S.

**Upwelling Along the Southeastern Coast of Korea**

H.S. Kang[1], W.J. Teague[2] and G.A. Jacobs[3]

Along the southeastern coast of Korea, cold surface water is frequently observed during the summer months. Local southerly winds and the shoaling of deep cold water toward the coast provide upwelling-favorable conditions. Existence of anomalous surface waters near the coast is confirmed by satellite SST images and by SeaWiFS chlorophyll-a concentration images. The Navy Coastal Ocean Model (NCOM) is used to examine possible upwelling events. NCOM includes realistic bottom topography, non-linear effects, synoptic atmospheric forcing, and turbulent vertical mixing. By placing a tracer below 1000 m, upwelling events are examined to explain mechanisms that bring the tracer upwards. A possible upwelling scenario is that a persistent strong deep western boundary current flows southward along the coast forming a cyclonic circulation in the Ulleung Basin (doming of isopycnals) that is favorable to the mixing across isopycnals with weak stratification (mainly wintertime). In addition, with southward deep currents along the coast, upward mixing is possible in the bottom Ekman layer. Once water from the deep layer reaches the upper layer, upwelling to the surface can be induced by the southerly winds and intensified northward flowing East Korean Warm Current. Thus, there is a secondary upwelling to the upper layer induced by deep circulation and cross isopycnal mixing and a primary upwelling to the surface triggered by southerly winds.

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## Keen, T.R.

**Operational Forecasting of Water Clarity**

T.R. Keen[1] and W.E. McBride[2]

We are developing a three-dimensional optical forecasting capability for the littoral ocean. This capability addresses the problem of the high spatial and temporal variability of water clarity that has been observed near the coast, where waves have an important influence on the resuspension of bottom sediments. This study uses the Littoral Sedimentation and Optics Model (LSOM) to calculate suspended sediment profiles, which are used to compute optical scattering coefficients. A diver visibility metric is then computed from the scattering coefficients. This method has been developed for an oceanographic and optical field study that took place at Oceanside, California during October 1995. A comparison of the predicted scattering coefficients to a bio-optical model suggests that LSOM is capturing the bottom sediment contribution to the optical field. We have subsequently performed operational testing of a forecasting capability for the diver visibility metric on the California coast in support of the Kernal Blitz 2001 exercise. Daily products were produced for a number of operational areas. The model predicted that water clarity would vary tremendously during a typical coastal operation. This result has important consequences for diver and instrument effectiveness during littoral operations.

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## Keener-Chavis, Paula

**Ocean Exploration through the National Oceanic and Atmospheric Administration: Collaborations for Excellence in Exploration and Education**

Paula Keener-Chavis[1]

The National Oceanic and Atmospheric Administration's (NOAA's) Office of Ocean Exploration launched eight multidisciplinary expeditions last year to little-known or unknown ocean regions. Scientists and educators explored the Galapagos Rift, the Arctic Ocean, the Gulf of Alaska seamounts, the Ring of Fire, and other areas as they sought to more completely know and understand our ocean. This presentation will focus on how NOAA is leading a new era of ocean exploration through these expeditions in direct response to the President's Panel on Ocean Exploration Report entitled *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration*. Expedition highlights and future program directions will be presented. Additionally, 10% of program funds are targeted to an education and outreach effort to unfold Key Objective 4 of the President's Panel Report. This objective specifically calls for reaching out in new ways to stakeholders to improve the literacy of learners with respect to ocean issues. Collaborations among scientists and educators to develop educational resources tied to the expeditions will be presented along with information on partnerships with the National Science Foundation's Centers for Ocean Science Education Excellence (COSEEs). Future program directions to build program capacity based on input received from a national workshop and program evaluation will also be addressed.

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## Kirkham, H.

**The NEPTUNE Power System for Cabled Ocean Observatories: Backbone Protection**

H. Kirkham[1], B.M. Howe[2], V. Vorpérian[3], T. McGinnis[4], M. Kenney[5], C-C. Liu[6], M. El-Sharkawi[7], S. Gupta[8], S. Lu[9], K. Schneider[10], A. Uphadye[11], P. Bowerman[12], G. Fox[13] and R. Kemski[14]

Cabled ocean observatories offer the potential to deliver unprecedented amounts of power to remote instruments and sensors. In the northeast Pacific, the NEPTUNE power system will be able to deliver up to 10 kW power to about 40 seafloor node locations distributed along a 3500 km backbone of standard telecommunications cable in a ring/mesh topology. The sub-sea backbone cable part of the power system includes circuit breakers so that cable faults can be isolated, and system operation can continue on unfaulted sections of the cable. A minimalist approach to the design of the backbone is essential to ensure adequate reliability. Here a configuration that places only the essential circuit breakers in the backbone is considered; a node's science interface module (with the 10 kV-400/48 V dc/dc converter, communications electronics, and connectors) is on a easily serviceable spur cable. The percentage availability of the entire observatory is improved by segregating backbone attributes from science interface elements, making it easier to bring the full force of mission assurance techniques to bear on the backbone.

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## Ko, D.S.

**Effect of River Runoff and Surface Salinity Flux on the Circulation and Salinity Distribution at East Asian Marginal Seas**

D.S. Ko[1], S.K. Riedlinger, W.J. Teague, G.A. Jacobs and R.H. Preller

The effect of fresh water runoff from river and the surface salinity flux on the circulation and the salinity distribution at the East Asian marginal seas are studied applying numerical ocean model. The model covers entire East Asian Seas and the West Pacific Ocean. At the eastern open boundary the model is coupled to a North Pacific ocean model. The areas of focus of this study are the Sea of Japan, the Yellow/East China Seas and the South China Sea. Four parallel experiments with/without river runoff and with/without surface salinity flux are conducted. For each experiment the model is started from the same initial conditions and with the same wind/heat forcing. Effects of the river runoff and surface salinity flux are evaluated based on the model inter-comparisons and on the comparisons to the observations. In the Sea of Japan, the effect of river runoff is found to be minimal. On the other hand, the effect of river runoff is significant in the Yellow/East China Seas with a large river discharge. In the South China Sea, the effects from both river runoff and sea surface salinity flux are found to be important.

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## Kohler, D.D.R.

**Active/Passive Data Fusion from LIDAR and HSI Sensors and the Retrieval of Bottom Classification in the Littoral Environment**

D.D.R. Kohler[1], W.P. Bissett[2], R. Steward[3], C.O. Davis[4], M. Montes[5], W.J. Lillycrop[6], B. Pope[7], A. Weidemann[8] and C. Mobley[9]

The optical complexity of the near shore coastal environment has been a challenging area for traditional passive remote sensing systems to accurately classify. Recent advances in passive HyperSpectral Imaging (HSI) has shown it to be a valuable tool in the characterization of these areas. However, the HIS algorithms to map this environment require that the simultaneous resolution of water type, bottom type, and depth. While these methods have produced admirable results (Kohler, 2001; Lee et al., 1999; Philpot, 1989; and Lyzenga, 1978), better constraining these equations should greatly improve the accuracy of the outcome. Bathymetric LIDAR systems have been demonstrated to reliably produce very accurate estimates of water depth (Guenther et al., 2000). Thus, the coupling of the two systems should at a minimum produce improved maps of in-water and bottom optical properties by better constraining the passive remote sensing mapping models. In the fall of 2002, the PHILLS passive hyperspectral sensor and the SHOALS bathymetric LIDAR were deployed over Looe Key, Florida. While the sensors were flown independently, the data was collected nearly simultaneous to illustrate the merits of a coupled system. Details of the experiment and data collected are discussed. Two techniques are described to retrieve bottom classification using the coupled data streams. The first is a simple, single scattering approximation of the radiative transfer equation. The second is a look-up-table approach that uses spectral matching between the remotely sensed HSI signal and a robust calculation of water-leaving radiance based on a distribution of water and bottom types.

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## Ladner, S.

**Coupling *In Situ* and Satellite Data to Validate Satellite Optical Properties**

S. Ladner[1], R.Gould, Jr.[2], R. Arnone[2], A. Weidemann[2], P. Martinolich[3] and B. Casey[3]

We have improved methods for validating satellite algorithms in coastal waters. Optical properties in coastal waters change rapidly on very fine temporal and spatial scales. It is therefore inappropriate to validate satellite optical algorithms at large spatial scales using *in situ* point measurements. The variation within the satellite region (1km) must be accounted for in the comparison with the point measurement. Inherent Optical Properties (absorption and scattering coefficients) were derived and validated from SeaWiFS and MODIS imagery covering a variety of regions and water types including coastal and open-ocean waters. We examine optical variability over small spatial scales (meters) using continuous underway measurements averaged and over large scales (kilometers) using remote sensing imagery. We determined the mean to variance relationship at various spatial scales over bin ranges from 30 meters to 20 kilometers. We define how the spatial correlation scales (for each binned spatial resolution) are coupled to the mean optical property. These relationships between the mean and variance enabled us to improve and more accurately validate *in situ* point measurements and the 1 kilometer SeaWiFS and MODIS optical algorithms especially in coastal waters.

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## Larsen, K.

**Depth Related Changes in Species Richness of Tanaidacea (Crustacea: Peracarida) in the Deep Gulf of Mexico**

K. Larsen[1]

The change in species richness of tanaidaceans, as a function of depth in the Gulf of Mexico is examined from recent studies in the northern Gulf of Mexico. Species richness is compared from intertidal brackish water environments to the abyssal floor. Species richness is used as a proxy to biodiversity due to the nature of the data. Species richness in the shallows was restricted to approximately 50 species, only two of which occur in low salinity conditions. Despite the few deep-sea surveys conducted in deep water in the Gulf of Mexico, species richness among the deep-sea localities is exceptionally high (224 species). Theoretical species/individuals (Rarefaction) and species/area curves were generated for 7 depth strata with 500 meter depth increments. Both species/individuals and species/area curves shows a decrease in theoretical species richness with depth until 1000 meter. From 1000 meter the species richness rose with depth to a local maximum at 2000 meters depth. From 2000 meter the species richness fell with depth to 3000 meter and then rose to another maximum.

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## Larkin, Frances Lee

**The Bridge: Incorporating Online Ocean Science Data into the Classroom**

Frances Lee Larkin[1] and Lisa Ayers Lawrence[2]

One of the basic tenets of science education reform is the need to incorporate current scientific information into school curricula. The ocean sciences offer extraordinary opportunities for enriching K-12 education, but most of our nation's two million science teachers do not have enough time or resources to access and interpret research data for use in their classrooms. The Internet offers great promise in helping connect educators to scientists and to current, even real-time, research activity. The Bridge (www.marine-ed.org/bridge), a web-based resource center and clearinghouse, is designed to bridge the gap between the ocean education and research communities. It improves teachers' and students' access to oceanographic data by linking to and working directly with ocean science programs and researchers. The Bridge database includes over 1,000 peer- and scientist-reviewed links to ocean sciences websites, organized in an educator-intuitive format. The Bridge staff develops classroom activities that help teachers incorporate current data into their lesson plans. Each month a new "Data Tip" highlights a topical collection of online data and provides background information and strategies for its analysis and interpretation. Data Tips, correlated with the National Science Education Standards, provide teachers with specific guidance in using authentic data in ways that are easily understood by and interesting to students. This presentation will describe the Bridge project and will highlight a specific Data Tip, *"The Dead Zone,"* illustrating how a scientific dataset can be easily incorporated into classroom instruction.

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## Lee, Zhong Ping

**The Relationship Between Gelbstoff And Pigments Of Open Ocean Waters**

Zhong Ping Lee[1], Paul Martinolich[2] and Robert Arnone[1]

For open ocean waters, or so-called "Case 1" waters, it is normally assumed that gelbstoff (also called yellow substance or colored dissolved organic matter) absorption coefficient is a fraction of that of phytoplankton pigments. This was based on historical discrete measurements. The relationship remains as a mystery for the vast open ocean waters, due to limited measurements. In this study, using data collected by SeaWiFS sensor, the absorption coefficient of gelbstoff and pigments of different oceanic area are derived by the latest analytical ocean-color inversion algorithm. The relationship between the two properties is further analyzed, which will improve the understanding and modelling of oceanic environments.

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## Ley Cooper, K.

**Exportation of Organic Material from the Water Column to the Deep Sea Sediment in the Central Gulf of Mexico**

K. Ley Cooper, M.F. Adame and E. Escobar

Deep sea fauna (>200 m) relies upon organic material generated either in the euphotic zone or *in situ* through chemosynthesis at hydrothermal vents and deep hydrocarbon seeps. It has been proved that a higher concentration of primary productivity in the water column is correlated with higher concentrations of organic material at the sea floor and in some cases related to high biomass and density of metazoans. In order to understand the dynamics behind exportation of organic material from the water column to the deep sea sediment, we evaluated, based on an export model, the photosynthetic organic material in twelve stations in the central Gulf of Mexico by measuring presence of pigments (chlorophyll a) in the euphotic zone at discrete depths in the water column, and in sediment. Additionally we evaluated the elemental composition (Corg, Norg) of organic matter in sediment as well. Results from these analysis, have established the relationship between organic material present on sediment and maximum chlorophyll levels in the water column. Preliminary results show comparatively low chlorophyll values for all depths (mixed layer mean= 0.050 µg/l, upper thermocline mean= 0.125 µg/l, thermocline mean= 0.044 µg/l, lower thermocline mean= 0.005 µg/l, at 600 m mean= 0.003 µg/l, bottom water mean= 0.003 µg/l), our results also suggest that maximum chlorophyll concentrations (0.26 g/l) are found right above the thermocline, and that maximum variations occur in the first 700 meters (mean= 0.056, =0.059) which is where we shall focus our attention. Finally we intend to correlate with infaunal biomass in abyssal sediment.

## Loughry, L.

**Isopod Species Diversity and Abundance Compared to Depth and Physiography: Northern Gulf of Mexico Continental Slope Study**

L. Loughry[1], A.W. Ammons[2], G. Wilson[3], G.F. Hubbard[4] and G.T. Rowe[5]

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Isopods can be found in all parts of the Gulf of Mexico. They are an important component of deep-sea macrofaunal crustacea in both individual numbers and numbers of species. From 1983-1985 the sediments were sampled in the northern Gulf of Mexico at depths 339-2945m. At each site, isopods were removed, counted, and identified to species. Isopod species diversity and abundance were compared relative to depth and regional physiography. The general unimodal pattern in species diversity as a function of depth is at best equivocal in the northern Gulf of Mexico, compared to other comparable continental margins.

## Mahoney, Kevin L.

**Variations in Remote Sensing Reflectance During a Red Tide Event off Florida**

Kevin L. Mahoney[1], Steven E. Lohrenz[2], Oscar M. E. Schofield[3] and Gary J. Kirkpatrick[4]

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The dinoflagellate *Karenia brevis* is responsible for frequent red tide events off the west coast of Florida and other coastal waters. The events leading to development of *K. brevis* blooms remain unclear because of the inability to detect and monitor blooms as they form. Currently, detecting *K. brevis* blooms is slow, laborious, and spatially limited, relying primarily on shipboard surveys and direct microscopic observations. Recent work suggests that *K. brevis* populations exhibit distinctive spectral signatures in ratios of backscattering to absorption. However, the implications of such findings for detection and monitoring of red tide events using in situ optical and remote sensing algorithms remain unclear. A critical variable for which information is currently lacking is the manner in which diel vertical migration of *K. brevis* populations influence water-leaving radiance. During October 2001, a cruise was conducted during a red tide event off the coast of Tampa, Florida as part of the Florida ECOHAB Program. The objectives were to observe variations in reflectance related to the vertical distribution and abundance of *K. brevis* and to compare the measured AOP's to those modeled for *K. brevis* using Hydrolight 4.1

## Mahr, Jr., Ray

**Vertical Profiling Systems for Oceanic Observation**

Ray Mahr, Jr.[1] and Chris Chase

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With thousands of surface drifting buoys and deep-ocean profilers successfully deployed in recent years, the Global Ocean Observing System (GOOS) has become a reality. Over 1,000 drifters are now deployed and approximately 3,000 deep diving profilers will be deployed in the next few years. Since, these sensor systems provide very coarse time-series data (w/limited number of parameters), the next major thrust for GOOS program is to collect data at much higher sampling rates. Two major efforts are underway in the oceanographic community to meet these requirements for more comprehensive, and higher-rate, time-series data. One uses bottom deployed "ocean observatories" linked to shore by fiber optic networks; the second uses integrated instrumentation packages that are autonomously powered, vertically profile many times daily and regularly telemetry data during long-term deployments (one-year or more). InterOcean's developing a Vertical Profiling System (VPS) that satisfies GOOS program objectives and performance requirements. Two basic configurations are Integral VPS, which interfaces with bottom-networked systems, and Autonomous VPS (a self-contained system). Three major VPS components are: bottom-mounted underwater winch; instrumentation for collecting data during profiling sessions (a twenty-minute profile every three-hours); and buoyancy package that raises instrumentation package toward surface. The major difference between the two systems is that the autonomous system surfaces to transmit data via satellite (Iridium, Argos, etc). Centralized sensor, data, and system/telemetry control is handled using new S4-VP3 technology, which also performs all on-board data processing. Measured/profiled parameters include CTD, directional wave, and expansion capabilities for eleven additional sensors; greatly increasing present profiling capabilities.

## Malone, Tom

**The Integrated Design Plan of the Coastal Module of GOOS**

Tom Malone[1]

The capacity of coastal ecosystems to support goods and services is declining, in part due to global scale increases in human activities and changes in the ocean-climate system. Sustaining and restoring healthy marine ecosystems in the face of these large scale drivers of change requires a more holistic, unified approach to resource management and environmental protection, especially in coastal ecosystems where habitat alterations, water pollution and problems associated with harmful algal blooms and invasive species are most severe. For these reasons, a new, more integrated, approach that considers both environmental effects and the effects of human activities is needed. Implementing an ecosystem-based strategy requires the capability to engage in adaptive management, a process that depends on routine and rapid detection of changes in the environment and living marine resources and on the provision of timely predictions of change. We do not have this capability today. The "developed" world is on the cusp of a revolution that may make such an approach feasible. The revolution is occurring on two related fronts: (1) advances in observing and modelling capabilities, and (2) the emergence of the Global Ocean Observing System (GOOS). The development of the coastal module of GOOS and its importance to advance in marine science are the focus of this presentation.

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## Martin, P.J.

**Navy Coastal Ocean Model (NCOM) Development**

P.J. Martin[1]

NCOM is a hydrostatic, free surface, baroclinic ocean model that has been developed for use in the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) and also for general application. Some recent improvements to NCOM are that (a) Flux-Corrected Transport (FCT) has been provided as an option for advection of scalars to avoid advective overshoots, (b) the vertical buoyancy gradient, which is used for vertical mixing, is computed using expansion coefficients rather than as a correction to the in situ density to provide a more numerically stable calculation, and (c) horizontal filtering of the vertical buoyancy gradient is used to suppress checkerboard mixing. The current status of the model, these changes, and some model test results are presented.

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## Massion, E.

**Critical Technology Developments for Regional Scale Ocean Observatories**

E. Massion[1], P.M. Beauchamp[2], A. D. Chave[3], S. J. Gaudet[4], B.M. Howe[5], H. Kirkham[6], T. McGinnis[5], A. Maffei[3], P. Phibbs[9] and D.H. Rogers[10]

A new generation of regional scale observatories is being developed to supplement the traditional, ship-based expeditionary research model with one that enables observations over geographically significant extents and time scales from microseconds to decades. In order to fully exploit this new observing capability, an unprecedented level of functionality must be provided that will stimulate the development of a new generation of instruments and observing methodologies. This presentation will describe the status of current efforts toward developing the critical technologies. These include submarine implementations of a multi-gigabit/second data network, a power network capable of providing up to 10 kW at each science node, a comprehensive data management and archiving capability and the system engineering necessary to ensure that these technologies meet the user defined functional requirements in an optimal way.

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## Mayrand, E.

**Adjustments In Cytochrome C Oxidase, Lactate Dehydrogenase And Total Glutathione In Rock Crab (*Cancer Irroratus*) Exposed To Pollution**

E. Mayrand[1] and J.-D. Dutil[2]

We investigated physiological responses of the rock crab that may be indicative of tolerance to xenobiotics. Male crabs were caged at two adjacent sites differing in chemical loads (heavy metals, butyl-tins and hydrocarbons). A third group was caged in a race-way tank supplied with filtered seawater considered free of contaminants. After 5 weeks of feeding, dry flesh content (DFC) per ml of merus increased significantly at all 3 sites, compared with day 0 and week 1, but the control group had higher DFC than the crabs caged at the most polluted site. Cytochrome C oxidase activity per g of leg muscle was lower in crabs caged at the most polluted site than in crabs caged at the least polluted site. Lowering the aerobic metabolism in a stressful environment might help to reduce the production of reactive oxygen species. Lactate dehydrogenase activity in leg and heart muscle was affected neither by time nor by site. Total glutathione (GSH + GSSG) per g of digestive gland was highest in crabs caged at the most polluted site. Those crabs also had heavier digestive gland (dry weight) than the crabs caged at the least polluted site. Only 2 out of 35 crabs died during the 5 weeks exposure at the most polluted site. Increased concentration of protecting molecules such as glutathione and larger digestive gland, the organ responsible for glutathione synthesis, may confer effective defences against xenobiotics.

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## Merz, C.R.

**COMPS - The West Florida Shelf's, Real-Time, Coastal Observing System**

C.R. Merz[1], M. Luther[2], J. Scudder[3], V. Subramanian[4], R. Weisberg[4], R. Cole[5], J. Donovan[6] and R. He[7]

The University of South Florida/College of Marine Science's (USF/CMS) Coastal Ocean Monitoring and Prediction System (COMPS) was implemented in 1997 as a State of Florida legislative initiative to improve advanced storm warning capabilities along the Gulf of Mexico's west Florida coast. Coupled with complementary funding, the COMPS real-time coastal observing system has grown to eight coastal stations and four offshore weather buoys. Additional sites and a HF Radar for surface current measurements offshore Tampa Bay are planned. National standards are used to collect, process, and archive data. Data collection platforms transmit data hourly to USF/CMS via the NOAA/GOES satellite. Coastal stations record tide levels referenced to a national datum along with meteorological, water temperature, and salinity measurements. Offshore buoys record meteorological, water temperature, salinity, and in-water current measurements. In addition, nowcast and forecast sea level and circulation models are in operational test mode. Data and model products are disseminated in real-time to federal, state, and local emergency management officials via the Internet (URL http://comps.marine.usf.edu), direct FTP, as well as site-specific methods. COMPS provides real-time data for local emergency management use, improved flood and marine forecasting, search and rescue, tracking of hazardous material spills, and oceanographic research studies. COMPS fulfills requirements of the planned US Integrated Ocean Observing System (IOOS) and provides an example of the practical value of university research.

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## Michelena, Eduardo D.

**The Accurate Measurement of the Moisture in the Atmosphere Using the Global Positioning System**

Eduardo D. Michelena[1]

The total amount of moisture in the form of water vapor distributed throughout the atmospheric air column above a monitoring site can be ascertained by using precise measurements made by stationary surveying-grade Global Positioning System (GPS) receivers located on the ground. The accuracy of these determinations is enhanced by co-located Meteorological (MET) sensors that report the atmospheric pressure, temperature, and relative humidity also at ground level. The communication to a central network computer of the time series of the GPS and MET data is via dedicated land-lines or through the Internet. Further processing of these data is done to obtain successive determinations, with a five-minute time resolution, of the Integrated Precipitable Water Vapor (IPWV) contained in the air mass above each monitoring station. These derived values of IPWV are reported as inches or centimeters of rain and represent the entire amount of water vapor in the atmospheric column. In the United States, most of the atmospheric IPWV measuring sites are located at US Coast Guard Differential Global Positioning System (DGPS) electronic aid-to-navigation monitoring stations. This is where high accuracy GPS receivers are installed for navigational purposes. The position-error information (the GPS "noise") that is transmitted to DGPS users from these reference stations is the "signal" that is analyzed to compute, when combined with the measurements of other variables, the atmospheric moisture content.

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## Milan, B.

**Comparisons of Fish and Decapod Crustacean Distribution Between Smooth Chordgrass, *Spartina alterniflora*, and Black Mangrove, *Avicennia germinans*, Marsh Edge in Central Louisiana**

B. Milan[1] and R.F. Shaw[2]

Although Spartina salt marshes dominate at temperate latitudes and mangroves are restricted to tropical and subtropical coastlines due to cold intolerance, the two vegetation types do occasionally co-exist. If global average temperatures increase as projected (IPCC, 2001; +1.4 – 5.8°C by 2100), ecologically and economically important species, which use present day Spartina marshes as nursery grounds may be impacted as black mangroves, expand their northern limit. This study is a rare example of an estuarine biocomplex response to Global Climate Change (GCC). A GCC related shift in vegetation range which then "complexes" with a resultant shift in estuarine habitat utilization by juvenile finfish and decapods. Flume nets and seines were used to sample the fishes and macrocrustaceans twice monthly within adjacent mangal and salt marshes located on the edge of Bay Champagne and surrounding tributary canals on the central coast of Louisiana. Data was collected from October, 2000 through October, 2001. Certain species have shown differential utilization between habitats within the same source/ supply of water. The newly-created habitat from mangrove expansion may result in a fundamental change in species utilization and fish nursery ground function, which may have ecological and economic ramifications for Louisiana's coastal wetlands.

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## Mishonov, A.V.

**Assessment and Correction of the Historical Beam Attenuation Data from HOT – ALOHA & BATS Stations**

A.V. Mishonov[1] and W.D. Gardner[2]

Comprehensive analysis, quality control, and adjustment of the beam attenuation data from the Hawaii Oceanographic Time-Series (HOT) and from the Bermuda Atlantic Time Series (BATS) data sets collected during the last decade using different instruments has been performed. These data were collected at fixed locations in the Atlantic and Pacific Oceans and provide important data on seasonal and interannual variations, and cover all seasons. The unprocessed or pre-processed data reside in the appropriate laboratories, but we have observed several different characteristic errors in the data, making some of the data unreliable for modelling and analysis in their present condition. The adjusted data used for assessment of the regional and seasonal Beam Attenuation - Particulate Organic Carbon relationships. After final checking and format adjustment the data will be posted on HOT, BATS and TAMU web-servers. We will analyze the data for seasonal and interannual variability. These data also will become available to the scientific community for the purpose of modelling ocean carbon cycles or evaluating the output from existing models.

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## Moline, M.A.

**AUV Flight Path Optimization for Sampling Biological Fields in the Coastal Ocean**

M.A. Moline[1], S. Blackwell[2], W. P. Bissett[3], S. Glenn[4], M. Purcell[5], C. von Alt[6] and O. Schofield[4]

As a necessity in advancing development, autonomous underwater vehicles (AUVs) have been operated and maintained by teams of engineers. As these platforms transition into observational networks, for example, users must maximize their utility in the context of a specific application. Until recently, sampling on biologically relevant vertical (cm) and horizontal (m) scales in the near coastal ocean was not feasible. In an effort to maximize the utility of AUVs, we will determine optimal flight paths, ascent/decent angles, vehicle speed and power output for sampling biological variability off Central California. Biological data (fluorescence and bioluminescence) measured from a REMUS AUV will be used to model and validate the best approaches for using AUVs in these environments. Recently collected AUV data illustrated that variance in biological fields (cross-shore transects) does not vary significantly (P=0.101) over a 4-hour period, making *in situ* performance assessment possible. Results reported here are also relevant to ship-based undulating sampling systems.

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## Money, N.

**Underwater Range Finding: A Novel Technique for Profiling and Ranging Using Lasers**

N. Money[1], C. Crichton[2], M.A. Player[3] and J.Watson[1]

There is a continuing need for fast accurate methods of making measurements in the sub-sea environment. Conventional techniques for measuring distance sub-sea have traditionally used either taut wire or acoustic methods, although effective both these methods have their limitations. Taught wire is slow to deploy and not suitable for deep water. Acoustics are susceptible to interference and limited by the relatively slow propagation of sound through water. CDL in conjunction with the University of Aberdeen are developing a compact underwater range finding system based on a DPSS (Diode Pumped Solid Sate) passively Q-switched laser. This lightweight, low power system is being designed specifically for spool piece metrology, however possible applications include pipeline survey and profiling. Measurement is done using a time of flight approach with a timing chip capable of 125 ps single shot resolution; this offers a number of advantages over other systems. Scan rate is limited only by mechanical constraints on the rotation speed of the mirror, rather than the speed of sound. Considerable time savings are possible by the use of auto target acquisition and due to the fact that a baseline does not need to be set up. This paper will present findings on the capabilities of such systems, and preliminary information on the practical system design and performance.

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## Morey, S.L.

**Continental Slope Effects on Gulf of Mexico Loop Current Eddies**

S.L. Morey , J. Zavala-Hidalgo[2] and J.J. O'Brien

High-resolution numerical simulations of the Gulf of Mexico are used to examine the life cycle of the Loop Current Eddies (LCEs). The simulations use the Navy Coastal Ocean Model, a hybrid sigma and z-level primitive equation ocean model. In particular, the role of bottom topography on the LCEs is investigated. These energetic baroclinic anticyclonic eddies have depth scales of several hundred to one thousand meters and are not significantly affected by the ocean bottom during their westward propagation. When they reach the western continental margin, however, the ocean bottom over the continental slope rises to intersect the active upper ocean and the eddies begin to "feel" the bottom. The role of bottom topography on the decay of the LCEs is explored. Multiple numerical simulations demonstrate the impact of vertical resolution on modelling the eddy-slope interactions.

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## Munk, W.

**Sea Level: An Enigma**

W. Munk[1]

Recording tide gages now go back for several centuries. There are three contributions to the long-term changes: (i) steric rise associated with the thermal expansion of a warming ocean, (ii) eustatic rise associated with the melting of glaciers and ice sheets, and (iii) rebound of the Earth (to which the gages are attached) associated with the removal of the ice sheets since the last glacial maximum. The three contributions are of comparable magnitude, and difficult to disentangle. The traditional figure of 1.5 to 2 mm/year is inconsistent with available evidence. Satellite measurements (GPS, TOPEX/POSEIDON...) have added a new dimension and promise to solve the enigma.

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## Munk, W.

**Acoustic Monitoring of the Oceans BETWEEN Moorings**

W. Munk.[1] and Matt Dzieciuch[2]

Transmissions from abyssal acoustic sources (3 to 4 km) to receiving arrays at ranges of order 1000 km are sensitive to upper ocean processes in the intervening waters, particularly to mixed layer formation and scattering within the mixed layer. Estimates so derived of average conditions between moorings can augment the local in situ observations at the moorings.

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## Ngodock, Hans E.

**The Ensemble Kalman Filter and the Representer Method for Data Assimilation with a Nonlinear Reduced Gravity Model**

Hans E. Ngodock[1], Gregg A. Jacobs[2] and Mingshi Chen[2]

The intent of this study is to compare two advanced data assimilation methods on the same experiments. There exist several assimilation techniques that can be grouped in two classes: sequential and variational. Here the variational method is considered in a weak constraint formulation, because of all kinds of error sources in the forward model. Our objective is to test the representer method against the ensemble Kalman filter (EnKF). The comparison will be done with the same assimilation problem (dynamical model and measurements). It is known that both techniques should yield the same solution at the final analysis time for a linear model. For a nonlinear model, the EnKF still can be used directly, contrary to the representer method that can only be applied to a linearization of the model. On one hand, the EnKF, computes the analysis and its statistics (mean and variance). On the other hand, the representer method computes the analysis and the needed corrections to the dynamics, initial and boundary conditions, as well as some parameterization, which the EnKF cannot do by conception. However, the representer method has to resort to ensemble-based techniques to compute the statistics of the analysis. Both methods will be compared in their ability to fit the model solution to the data and to handle nonlinearities and increased resolution (computational cost). The results will indicate how close and imposed model error covariance (representer method) can compare with a simulated one using the model dynamics (EnKF). The model is a nonlinear reduced gravity model for an idealized circulation in the Gulf of Mexico. Some results will be discussed.

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## Nunnaly, C.C.

**Macrobenthic Ecology of Cold Seeps in the Northern Gulf of Mexico**

C.C. Nunnally[1] and G.T. Rowe[2]

Cold seeps in the Gulf of Mexico have been intensely studied since they were first described by Paul et al. (1985) and Kennicutt et al. (1985), but little of the ecology has focused on associated sediment in fauna. Structural and functional characteristics of benthic macrofaunal communities were studied to gain a better understanding of the broader influence of cold seeps in the northern Gulf of Mexico. Density of macrofauna at seeps does not decrease with depth, and proves to be greater than most any other site surveyed. Diversity has shown to increase with water depth in the benthos (Hessler and Sanders, 1967; Sanders 1968). Two seeps, Garden Banks 425 (GB 425) and Green Canyon 234 (GC 234) exhibit decreased diversity when compared to sites within a similar depth range. Sediment community oxygen consumption, determined using *in situ* benthic flux chambers, exhibited much higher rates of SCOC than from the continental shelf and slope away from seeps, suggesting a supplemented supply of carbon to the benthos.

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## Nunnaly, C.C.

**Sediment Community Oxygen Consumption from the Deep Northern Gulf of Mexico**

C.C. Nunnally and G.T. Rowe[2]

Total sediment community oxygen consumption was measured at twelve sites in the Gulf of Mexico spanning from the continental shelf and slope to the abyssal plain. Benthic chambers measured oxygen consumption in-situ when deployed from both manned submersibles and an autonomous benthic lander. Total community respiration ranged from highs of 212 mg-C m-2 d-1 on the outer continental shelf and 218 mg-C m-2 d-1 on the upper continental slope, to a low of 2.5 mg-C m-2 d-1 on the Sigsbee Abyssal plain. A least squares linear regression indicates a significant relationship with depth, where Log10 SCOC = -0.46x + 2.20, r2 = 0.865, $p < 0.01$. Paired shipboard and in-situ incubations suggest that fluxes can be measured in incubations aboard ship with reasonable accuracy down to depths of 500 to 1000 meters. Deeper shipboard values were equivocal. Comparisons are made of SCOC values at equivalent depths in other ocean basins.

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## Orcutt, J.

**Dynamics of Earth and Ocean Systems (DEOS) Data Collection and Management**

J. Orcutt, F. Vernon, J. Berger and I. Hansen

The Dynamics of Earth and Ocean Systems (DEOS) program was developed in 1997 to promote long-term observations in the oceans. DEOS, now under the sponsorship of the Consortium for Ocean Research and Education (CORE), supports NSF planning for the Ocean Observations Initiative Major Research Equipment and Facilities Construction program, advocates the collection of long-term time-series data with the recognition that this is the only viable approach to observe transients and changes and to enhance the signal-to-noise ratio of weak signals. Moored ocean buoys as well as seafloor-cabled systems are technically feasible approaches for making sustained time series observations in the oceans and will be an important component of any long-term ocean observing system. The need for real-time delivery of heterogeneous, packetized data, integrated with processing, acquisition, and archiving systems is shared with many other signal domains used in environmental monitoring, including image acquisition, GPS surveys, weather monitoring, and infrasound. As part of the NSF/ONR ROADNet project, we have begun applying the Antelope Environmental Monitoring System to this problem using a concept termed VORB. We demonstrate prototype-monitoring applications that integrate near-real-time, remote image acquisition throughout southern California including offshore. We discuss application of this technology to satellite acquisition of image, GPS, and real-time ship's position and attitude data from the R/V Roger Revelle, in order to demonstrate the potential of the new monitoring technologies.

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## Peacock, T.

**The ROSEBUD Remotely Operated Vehicle: a Versatile Platform for Optical Oceanography**

T. Peacock [1,2,4], D. Costello[2], K. Carder[3], E. Kaltenbacher[4] and S. Butcher[5]

The University of South Florida has deployed the ROSEBUD Remotely Operated Vehicle (ROV) for nearly a decade. ROSEBUD was conceived, designed and constructed to be a cost-effective, low-maintenance, "pick-up truck" ROV capable of deploying a diverse array of optical oceanographic instrumentation while only requiring a small (34 foot) surface-support vessel, the R/V Subchaser. To date, ROSEBUD has been deployed hundreds of times and performed thousands of missions in waters ranging from Chesapeake Bay to the Exuma Islands. The latest series of deployments involved rather significant modifications to accommodate deployment of the FLASH ROBOT payload, the Fast Laser Assessment of Ship Hulls (FLASH) configuration of the Real-time Ocean Bottom Optical Topographer (ROBOT). ROBOT is a laser-line imaging system developed at the University of South Florida that acquires 3-dimensional imagery of underwater surfaces. In this contribution, specifications for the ROSEBUD vehicle will be detailed. Additionally, the various payloads and ancillary optical instrumentation will be described with emphasis on the FLASH ROBOT payload and the Bottom Classification and Albedo Package (BCAP) payload. Finally, a representative sampling of the diverse scientific results will be presented.

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## Penta, B.

**Modelling Bio-optics in Monterey Bay, California**

B. Penta[1] and F.P. Chavez[2]

A new semi-analytic method of modelling spectral light transmission in ocean models has been developed as part of the Simulations of Coastal Ocean Physics and Ecosystems (SCOPE) project. This National Ocean Partnership Program (NOPP) funded project seeks to develop a 'next-generation' coupled coastal physical-biological model for the coastal upwelling ecosystem within the Monterey Bay National Marine Sanctuary (MBNMS). Time series of *in situ* biological, physical, chemical, and bio-optical observations are key to the development, initialization, and validation of the model. A brief description of the bio-optical model component and several relevant time series are presented. Analyses of computed light fields and the results of using the spectral light model in the coupled physical-biological model are shown.

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## Perkins, H.

**Circulation of the North Adriatic Sea during Winter 2002-03**

H. Perkins[1] and J.W. Book[2]

Wintertime circulation in the North Adriatic Sea is largely driven by strong, cold, dry winds (Bora) lasting for a few days but recurring throughout the winter months. Each such event provides locally strong surface stresses (tenths of a $N/m^2$) and heat loss to the atmosphere (hundreds of $W/m^2$), leading to both wind and density-driven circulation. Our own measurements indicate the former predominates. The conclusion is based however on a single ADCP deployed during a winter (2000-01) that was characterized by generally weak Bora. The instrument, deployed off the Italian coast just north of Ancona, shows variations in the alongshore current that are strongly correlated with wind stress elsewhere, most notably with that at the mouth of Kvarner Bay. This presentation will give a preliminary report from an array of some dozen recently recovered ADCPs, which better resolve the overall circulation and its dependence on Bora forcing. The data is part of a large international observing effort made during winter 2002-03.

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## Piacsek, S.

**The Hydrostatic and Nonhydrostatic Limits of Ocean Models as Tested on Buoyancy-Driven Flows**

S. Piacsek[1], P.C. Gallacher[2] and D. Dietrich[3]

Coastal ocean models are tested on two classical fluid problems to ascertain the limits of their usual hydrostatic (H) approximation (pressure determined only by the weight of the overlying fluid, no vertical momentum equation). One is the classic lock-exchange problem (light and dense fluids separated by a wall which is then removed), the other is convection driven by surface cooling. Beside hydrostatic models, we also examine the so-called quasi-hydrostatic (QH) models which have a vertical momentum equation, but the vertical velocity and pressure are determined by an iteration procedure; and fully nonhydrostatic (NH) models in which the pressure is determined from an elliptic equation that results from the divergence of the momentum equations. In general, for vertical to horizontal grid ratios $r = dz/dx > .20$, the hydrostatic approximation is shown to fail. Both NH and QH models behave like hydrostatic models for $r < .10$ . The spreading rate of the plumes in the lock-exchange problem is fastest for the hydrostatic approximation, and about the same for the NH and QH models. Preliminary results indicate that only the NH models exhibit the full spectrum and amplitude of the Kelvin-Helmholtz instabilities that grow on the plume - ambient fluid interface.

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## Pomponi, S.

**The Oceans and Human Health: Marine-Derived Pharmaceuticals**

S.A. Pomponi

The marine environment has proven to be a rich source of novel chemicals with pharmaceutical properties. Several marine-derived compounds are in development, primarily as cancer drugs. Recent funding initiatives underscore the need for integrated, multidisciplinary research to understand marine processes and systems as they relate to the production of chemicals with biomedical potential. Challenges for marine-derived drug discovery include accessing unique environments, organisms, and chemical classes; developing tools and sensors for rapid, *in situ*, and non-destructive sampling; understanding the role(s) these compounds play in the marine environment and using that knowledge to gain insight into potentially novel therapeutic applications; and pushing the frontiers of combinatorial biology to create new biodiversity and provide tools for supply of compounds selected for drug development.

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## Posey, Pamela G.

**Improving the Navy's Sea Ice Forecasting System – PIPS 2.0 to PIPS 3.0**

Pamela G. Posey [1], Ruth H. Preller[2] and Gretchen M. Dawson[3]

The Polar Ice Prediction System (PIPS 2.0) is the operational model used by the Fleet Numerical Meteorology and Oceanography Center (FNMOC) for sea ice forecasting. The PIPS 2.0 coupled ice-ocean model forecasts ice conditions for most of the ice-covered areas in the northern hemisphere. The horizontal grid resolution of the model varies from 15-27 km and uses 15 vertical levels. PIPS 2.0 is driven by atmospheric forcing from the Navy Operational Global Atmospheric System (NOGAPS). A 120-hour forecast each day of ice drift, ice thickness and ice concentration is produced each day. The Naval Research Laboratory is presently validating an improved coupled ice-ocean model (PIPS 3.0) to replace the current PIPS 2.0 system. The PIPS 3.0 system, grid resolution of ~ 10 km, will include improved arctic physics and will assimilate real-time ice concentration and ice drift data. PIPS 3.0 will also incorporate improved ocean and atmospheric forcing. Specific examples of PIPS 2.0 and PIPS 3.0 forecasts will be presented.

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## Powell, S.M.

**Deep-sea Demersal Fish Fauna of the Northern Gulf of Mexico**

S.M. Powell[1], R.L. Haedrich[2] and J.D. McEachran[3]

As part of the Deep Gulf of Mexico Benthos (DGoMB) project, fishes were sampled in May and June 2000. 37 stations were occupied using a 40 foot semi-balloon otter trawl along transects which ran from shallow to deep water and from northern Florida to off southern Texas. 1065 individuals in 119 demersal fish species were taken. Cluster analyses showed fish fauna is zoned with depth. Assemblages were identified on the shelf (188-216 m), upper slope (315-785 m), mid-slope (686-1369 m), and in a deep zone (1533 – 3075 m). The most abundant species found on the shelf was the caproid *Antigonia capros*. On the upper slope *Caelorinchus caribbaeus* and *Steindachneria argentea* were dominant. On the mid-slope, the fauna is dominated by Macrouridae: *Nezumia cyrano* and *Coryphaenoides zaniophorus*. The deep zone is dominated by Ophidiidae: *Dicrolene kanazawai* and *Acanthonus armatus*. Species richness is highest on the upper slope (48 species) and decreases with depth; the deep zone has 32 species. Abundance is greatest on the upper slope, especially in the Mississippi Trough and DeSoto Canyon, and declines greatly with depth. Data on fishes support the DGoMB hypothesis relating to depth zonation, refute the hypothesis relating to east-west abundance, but, because of limited samples, is inconclusive regarding fauna in and out of basins. There do not appear to be species of commercial interest in the deep demersal fish fauna.

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## Proctor, R.

**THE POL Coastal Observatory**

R. Proctor[1] and J. Howarth[2]

We describe a Coastal Observatory (2002-2006) in Liverpool Bay (Eastern Irish Sea) that integrates (near) real-time measurements with coupled models in a pre-operational coastal prediction system. The aim is to understand a coastal sea's response to natural forcing and the consequences of human activity. The foci are the impacts of storms, seasonality, and variations in river discharge (freshwater and nutrients) on the functioning of Liverpool Bay. Measurements include: In situ surface waves, and vertical profiles of current, temperature, salinity, turbidity, nutrients and chlorophyll; Shore-based HF radar measuring waves and surface currents out to a range of 50 km; instrumented ferries measuring surface properties; coastal tide gauges; satellite data – infra-red (for sea surface temperature) and visible (for chlorophyll and suspended sediment). In cooperation with the UK Met Office, a suite of nested 3-dimensional models (the Proudman Oceanographic Laboratory Coastal Ocean Modelling System - POLCOMS) is run daily, focusing on the Observatory area by covering the ocean/shelf of northwest Europe (at 12 km resolution), the Irish Sea (at 1.5 km) and Liverpool Bay (at 200-300m resolution). Baseline implementation is a 3-dimensional wave-current model with interaction between wave (WAM) and current modules. Nutrient and plankton dynamics are simulated with the ERSEM (European Regional Seas Ecosystem Model) component of POLCOMS. All measurements and model outputs are displayed on the Coastal Observatory web-site (coastobs.pol.ac.uk).

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# CONFERENCE ABSTRACTS

## Redalje, D.G.

**Growth Dynamics of the Harmful Bloom Forming Dinoflagellate *Karenia brevis* in Florida Gulf of Mexico Coastal Waters**

D.G. Redalje[1], S.E. Lohrenz[2], M.D. Tuel[3] and M.J. Natter[4]

As part of the ECOHAB Florida project, we examined the dynamics of the harmful algal bloom forming dinoflagellate, *Karenia brevis*, in Gulf of Mexico coastal waters of Florida during late summer and early fall of 2000, 2001 and 2002. Blooms were located during survey legs of the cruises conducted each year. Process study cruises were conducted directly after the surveys were completed. During each process cruise, blooms were located and "mapped" using microscopic and electronic cell counts obtained from hydrographic station water samples. Blooms were then followed for several days using a surface tracking drifter. Primary production, carbon specific growth rate and carbon biomass measurements were made using 24 hour sunrise to sunrise *in situ* incubations. Growth rates were generally very low (0.15-0.3 per day) in each year. Variations in production (0.4 – 1.3 gC $m^{-2}$ $d^{-1}$) scaled more with phytoplankton biomass because the growth rates were relatively invariant over the three year study period. Phytoplankton carbon biomass represented a relatively small portion of the POC, generally <30%, suggesting that bacteria, zooplankton and detritus made up the larger portion of the POC in these blooms.

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## Renaud, Philip

**The Transformation of Naval Oceanography**

Captain Philip Renaud[1], M. Shank[2] and T. Bennett[3]

Naval oceanography is on the threshold of a transformation. Twenty years ago, the Naval Oceanographic Office (NAVOCEANO), the principal shore command of Naval oceanography, collected moderate amounts of oceanographic and hydrographic data via survey ships, processed the data, and generated climatologies and paper-based charts. During the 1990s the volume of data grew exponentially, and the production and distribution processes became faster and more digital. Increasingly, ocean modelling and remote sensing supplemented surveys as tools for describing the ocean. In the coming decade, these trends will accelerate. Strategic planning is NAVOCEANO's approach to meeting the challenge. NAVOCEANO began with internal and external assessments. The assessments showed that to be relevant to the warfighter, NAVOCEANO needed to collect and process the data, and prepare a knowledge product within hours. A knowledge product tells the warfighting customer what the ocean environment means to the operation. The assessments identified several strategic focus areas. Over time, one of these focus areas will lead to a NAVOCEANO Operations Center, which will process huge amounts of disparate data in real time via highly automated software. A highly trained ocean analyst will fuse these data with modeled fields to build a four-dimensional depiction of the environment that will be incorporated into the warfighter's Common Operational Picture.

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## Renduchintala, SuryaNarayana

**DA_MAP: Data Analysis and Model Assessment Portal**

SuryaNarayana Renduchintala[1]

An important missing component in today's METOC (Meteorology and Oceanography) community is not the data itself, but a transparent layer or processes between data collection and data application; that is, the processes to easily register (create metadata), search, access and visualize or apply the data. A data registration mechanism is needed to allow a user to register their datasets to a metadata repository. Registration should allow the user to readily create a metadata record defining the data with reference to temporal and spatial domain, parameters, format, availability, etc. A metadata repository will facilitate the availability of data globally via some search mechanism. A data search/access mechanism is needed to find the data required by a user for the purpose of research and application. Finally, data visualization should also be automated, interactive and efficient. Our effort to fill this void with a quality assessment tool is called the Data Analysis and Model Assessment Portal (DA_MAP).

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## Richardson, M.D.

**Mine Burial by Scour**

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Scour burial experiments were conducted off the Scripps Pier (1999) and at the Martha's Vineyard Coastal Observatory (MVCO) (2001-02) and are planned for MVCO (winter, 2002-03) and off Tampa, Florida (Jan-March, 2003). In the experiments at MVCO and Scripps Pier, instrumented mines equipped with three solid-state compasses to measure heading and three-axis accelerometers to measure and roll and pitch characterized mine movement and percent burial was measured by three rings of paired optical sensors externally mounted at 15° intervals around the mine. Burial will be measured by acoustic sensors at the planned experiments off Tampa. Sediments ranged from fine sand (MVCO, Tampa, and Scripps Pier) to coarse sand (Tampa and MVCO). Mine burial at MVCO and the Scripps Pier was dominated by wave-induced scour and compare well with scour models based on amplification of basic sediment transport equations.

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## Richardson, M.J.

**Particulate Organic Carbon in the North-East Gulf of Mexico: Developing Algorithms Between Bio-Optical Data and Satellite Ocean Color Products**

M.J. Richardson [1], W.D. Gardner [2] and A.V. Mishonov [3]

During the North-East Gulf of Mexico project (NEGOM) data on beam attenuation and particulate organic carbon (POC) were collected in 9 cruises from November 1997 to November 2000. In each seasonal cruise about 100 CTD casts were completed along 11 lines normal to the coastline between mid-Florida and the Mississippi River from about 20 m on the shelf to the 1000 m isobath. This provided a wide range of particle concentrations and types from turbid river runoff to carbonate shelf to clear, open-ocean waters. Full hydrographic data, including transmissometer and optical backscatter measurements, were collected at each station. Water samples were filtered to obtain concentrations of total particulate matter (PM) and POC and optical data was converted to PM and organic carbon concentrations. In-situ measurements of POC and PM concentration were compared with SeaWiFS data to derive algorithms for estimating POC and "suspended" particulate matter. The large data set provides an excellent opportunity to define and test algorithms for particle concentrations in a wide spectrum of optical provinces on both seasonal and inter-annual time scales.

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## Rigney, James P.

**The Emerging Role of Ocean Forecasters in Operational Oceanography**

James P. Rigney [1], Robert B. Lorens [1], Steven D. Haeger [1] and Dennis G. Krynen [1]

The last decade has seen the emergence of both real-time applications for oceanographic information and the maturing of real-time oceanographic observation and modelling systems that are capable of providing that information. For naval applications, oceanographic information is needed as input to quantitative tactical decision aids as well as to the broader decision-making process. Improved computational capacity, data sources, and model physics have resulted in significant improvements in ocean models and their adoption as operational tools at the Naval Oceanographic Office (NAVOCEANO). Experience with a variety of circulation models over the past decade, however, indicates that for many naval applications requiring highly specific time and space predictions, providing the most useful information for decision makers requires the analysis and interpretation of model output (sometimes from more than one model) in conjunction with real-time data, climatologies, and a thorough understanding of ocean dynamics, physics and model tendencies. There are parallels between preparing these operational ocean analyses and forecasts and the forecasts traditionally prepared by operational meteorologists. This paper provides examples from NAVOCEANO's operations of the emerging role of ocean forecasters and discusses some of the tools for enhancing ocean forecasting.

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## Roger, D.

**GAPS, A New Concept for USBL**

D. Roger, F. Bellier, M. Audric and T. Gaiffe

Taking advantage of its great experience in acoustic positioning and inertial sensors, IXSEA OCEANO introduces a new concept for the Ultra Short Base Line positioning: the Global Acoustic Positioning System, in which all the necessary sensors – acoustic, inertial, GPS, - are integrated in the same housing and provide an accurate positioning of underwater vehicles. The advantages of this concept are numerous. It is compact, mobile, plug and play (no more calibration even when the system is moved from the ship) and can even provide more accurate and reliable data of the ship position and attitude than a traditional USBL system because the acoustics, inertial and GPS measurement are now merged in a single process. Innovative solutions based on iXSEA OCEANO unique acoustic chirp techniques and in-house master of inertial sensors allow an outstanding price to performance ratio for this portable but higher end performance-class system.

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## Ross, Tetjana

**Acoustic Scatter from Turbulence**

Tetjana Ross [1] and Rolf Lueck [2]

Despite the existence of models predicting acoustic scatter from turbulence, and experiments showing that artificially generated turbulent temperature fluctuations scatter sound, most oceanographers still consider that—if scatter from oceanic turbulence does occur—it will be insignificant compared with biological sources of scatter. Acoustics is commonly used for assessing fish and zooplankton abundances—surveys and instruments being designed with the implicit assumption that all scatter is biological. As there is evidence that zooplankton locate food more easily in turbulent areas, the fact that elevated scatter is commonly observed in turbulent areas is often attributed to zooplankton congregating in these 'high food zones'. We simultaneously measured turbulent microstructure and acoustic scattering strength in a local fjord. Plankton net-hauls indicate that there are far too few zooplankton in the turbulent regions to account for the scattering intensity. At both 44.7 and 307 kHz, we observe scatter that is unambiguously correlated with turbulence. Somewhat surprisingly, turbulent scatter is much stronger at the higher frequency, illustrating the importance of salinity microstructure—long neglected in turbulent scattering models—and shedding light on the form of the turbulent temperature-salinity co-spectrum (which has never been measured directly). At 307 kHz, backscatter from salinity microstructure was often stronger than the signal from a zooplankton scattering layer, illustrating how turbulence could easily confound acoustic zooplankton biomass estimates.

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# CONFERENCE ABSTRACTS

## Rossby, T.

**The Merchant Marine and Marine Research**

T. Rossby

Science and society have long been aware of the role the oceans play in moderating climate. Indeed, recent studies indicate that under certain conditions the oceans can also induce very large changes in global climate on astonishingly short timescales, decades and less due to major adjustments to the structure and intensity of the thermohaline circulation. We clearly need to improve our understanding of the ocean as a time-dependent system. In this talk we outline how the merchant marine can assist us in this quest. The beauty of commercial vessels is that they enable regular and repeat sampling in the horizontal, the most costly dimension of all. Using examples from the Gulf Stream and the North Atlantic to illustrate the extraordinary help container vessels are providing marine research we suggest that the time is ripe for a more deliberate collaboration with the merchant marine to track the state of the ocean and its variability over a wide range of space and time scales. In particular, we need instrumentation optimized for use in a not-to-interfere automated environment. Ships can also serve as data links or transponders to communicate with underwater instrumentation along their routes, but techniques to do this need to be developed. At the risk of a bit of science fiction we conclude the talk with some illustrations of how a future VOS system can assist future research needs in Oceanography.

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## Rowley, Clark

**Global Upper Ocean Heat Content Analyses for Use in Tropical Cyclone Intensity Forecasting**

Clark Rowley[1]

It is widely acknowledged that ocean surface temperatures play an important role in determining the intensity of tropical cyclones, but a measure of the thickness of the layer of warm ocean surface water is a more useful indicator of the energy available for storm intensification. It has also been demonstrated that using upper ocean heat content as a predictor improves the skill of statistical hurricane intensity models. The Naval Oceanographic Office produces daily operational three-dimensional analyses of ocean temperature and salinity that can be used to determine the upper ocean heat content. Here, we describe an experimental system being used to present upper ocean heat content information to tropical cyclone forecasters. The development system derives the hurricane heat content by integrating the ocean heat content from the surface down to the 26° C isotherm, referenced to the heat content of 26° C water. The heat content, surface temperature, and surface height anomaly fields are presented graphically on an internet WWW site for selected regions, and values are extracted along the forecast track for active storms. Independent *in situ* profile data are used to validate the hurricane heat content values, and the validation results are provided on the site as well. The URL for the site is http://www7320.nrlssc.navy.mil/hhc/.

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## Russo, A.

**Multidisciplinary Study of the Northern Adriatic Hypoxic Event**

A. Russo[1], R. Onken[2], M. Marini[3] and S. Tibaldi[4]

The Adriatic Sea is a shallow basin of the Mediterranean Sea, located between the Italian peninsula and the Balkans. The small volume of the Northern Adriatic receives the largest river runoff of the Mediterranean, predominantly from the Po river. During the last decades, wide areas under the influence of the Po plume have frequently been exposed to episodic hypoxia (oxygen concentration below 2 ml $l^{-1}$), occurring typically in fall. These events negatively impact the fisheries and biodiversity. In fall 2002, a series of oceanographic surveys were conducted, allowing for a detailed study of the area potentially exposed to anoxic events. More than 650 CTD casts were performed, some of them with bio-geo-chemical sampling. The data were assimilated into a high-resolution primitive equations model, which was run in real-time forecasting mode with atmospheric fluxes provided by a high-resolution weather prediction model. The model results reveal for the first time direct relationships between the hypoxic area and sea current dynamics. The buoyancy added by the Po river outflow is critical, being able to limit the vertical mixing and the dissolved oxygen supply toward the sea bottom.

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## Rypina, Irina I.

**Acoustic Propagation Simulation in Studying Sperm Whales Vocalization in the Gulf of Mexico**

Irina I Rypina[1], Ilya A Udovydchenkov[2], George E Ioup[3], Juliette W Ioup[4], Natalia A Sidorovska[5] and Jerald W Caruthers[6]

Gulf of Mexico bottom-moored hydrophone measurements were made by the Littoral Acoustic Demonstration Center in the summer of 2001. The recordings of frequencies up to 5859 Hz were done for 36 consecutive days with three Environmental Acoustic Recording System Buoys 50 m off the bottom, in water depths of 600, 800, and 1000 m. The data are rich in sperm whale vocalizations. The spectrograms of the whale click sequences contain several interesting features. In particular, the frequency content of single clicks and clicks-within-sequences is analyzed. Propagation studies were conducted for the purposes of distinguishing between propagation and vocalization individuality features in the received signal structure. The influence of the anthropogenic noise on sperm whale vocalizations can possibly be inferred from experimental records.

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## Sanders, William M.

**Bounds on Parameter Estimation Errors in Seabed Inversion Using Acoustic and Electromagnetic Observations**

William M. Sanders[1]

Seabed characterization has been primarily approached with acoustic technology. However, current understanding of acoustic inversion techniques reveals an inability to provide a complete description of realistic seabed structure. Whereas these techniques can often estimate acoustic compressional wave speeds, they are not as capable of revealing densities or other parameters for anything but the simplest environments. Recently it has been suggested that electromagnetic resistivity measurements can be used in conjunction with acoustic inversions to achieve a more accurate and complete description of effective sediment parameters. Whereas analysis using actual observations is in progress, this study performs a theoretical analysis of the improvement in accuracy possible from such a joint inversion over acoustic-only inversions. This is performed for simulated environment s, using operational parameters reflecting the capabilities of current technologies (e.g. acoustic bandwidths). The assumptions used herein are 1) all errors are Gaussian; 2) there is a linear relationship between the environmental parameters and the observations; 3) the errors can be bounded by either observational errors or by theoretical errors (by using an imperfect model for inversion). Under these assumptions, the covariance of the *a posteriori* errors can be computed. Hence, by comparing these covariances for joint inversion to those for acoustic-only inversions can reductions in uncertainty for the two methods be compared.

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## Santos, A. Miguel

**Satellite Applications to the Portuguese Domestic Swordfish Longline Fishery**

A. Miguel P. Santos

The relationship between the aggregation and availability of swordfish (*Xiphias gladius L.*), bigeye (*Thunnus obesus*), and albacore (*T. alalunga*) tuna off Continental Portugal and the oceanographic environment are investigated, namely in relation with coastal upwelling processes. Catches and *in situ* observations obtained during three fishing seasons (1990-1992) off northwestern Iberia by a longline fishing vessel are analyzed in conjunction with contemporary NOAA-AVHRR satellite imagery. A decreasing trend in swordfish *cpue* and an increasing one in tuna species were observed during the study period in apparent association with the progressively increasing intensity of the upwelling regime from year to year. Swordfish *cpue* were significantly higher in the warm side of surface thermal fronts associated with events of intensification/relaxation of upwelling, when those fronts converged towards the coast during relaxation episodes, that took place 1-2 weeks after periods of intensification. Larger *cpue* of tuna species occurred under situations of generally persistent and strong upwelling, and fishing efficiency was higher in the close vicinity of mushroom-like structures at the edge of the filaments of upwelling. The use of this information for fisheries applications is discussed.

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## Schoeberlein, H.C.

**Air-Sea Forcing of Wind Turbulence Obtained from Motion-Compensated Ship Anemometers**

H.C. Schoeberlein[1], L.H. White[2], J.L. Hanson[3] and M.A. Baker[4]

Measurements of wind speed and direction at a 1 Hz data rate were made in September 2002 from a research ship off the Bahamas Islands using dual anemometers. The motion of the anemometers was simultaneously measured at 1 Hz using a six-degree of freedom motion measurement package. Ship anemometer data were motion compensated for wave-induced ship motion using coherent noise cancellation techniques to characterize wind fluctuations over time scales shorter than the characteristic ship motion. The dependency of the spectral content of wind fluctuations on atmospheric boundary layer and wave parameters is examined.

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## Scholin, C.

**Remote Detection of Microorganisms Subsurface in Near Real-Time Using DNA Probe Arrays and the Environmental Sample Processor (ESP)**

C. Scholin[1], R. Marin III[2], J. Ryan[3], E. Massion[4], S. Jensen[5], D. Cline[6] and B. Roman[7]

Development of instruments that enable long term, unattended, in situ, application of molecular probes with real-time telemetry of results will offer an exceptionally novel approach for detecting water borne microbes as well as the genes they harbor and express. The Environmental Sample Processor (ESP) was developed in an effort to meet this challenge. The ESP collects discrete water samples remotely, subsurface, concentrates microorganisms and automates application of DNA (or other) molecular probes to enable identification and quantification of particular species captured. The instrument transmits results of DNA probe array assays in real-time to a shore based location for processing, interpretation and dissemination. In addition, the ESP archives discrete samples for nucleic acid, microscopic and toxin analyses for verifying real-time data from the probe arrays. This presentation focuses on field applications of the ESP prototype with an emphasis on detection of harmful algal bloom (HAB) species representing three different classes of algae. Probes for detection of invertebrate larvae have also been deployed using the ESP (see contribution by Goffredi et al.). The "second generation" ESP, currently under development, will have the capacity for sample collection and processing up to depths of 4000 m.

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# CONFERENCE ABSTRACTS

## Schulz, B.

**Field Results of Cooperative 3-D Searches Using Multiple Autonomous Underwater Vehicles**

B. Schulz[1], B. Hobson[1], M. Kemp[1], J. Meyer[1], R. Moody[1], H. Pinnix[1] and M. St. Clair

Nekton Research is currently performing underwater plume studies with multiple autonomous vehicles working collaboratively. These missions are being performed by a novel search and data acquisition system called UMAP (Underwater Multi-Agent Platform). UMAP is comprised of a school of MicroAUVs equipped with multi-parameter water quality sensors and the supporting deployment infrastructure. UMAP allows 3-D searches and data collection with high spatial and temporal resolution in both inshore and near-shore environments. Current deployments have focused on plume boundary identification and source localization. The progress of Nekton's UMAP program is reported herein, including results of the multi-AUV deployments, descriptions of the overall system, the search strategy, and the MicroAUVs.

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## Sell, K.S.

**Temporal Influences of Seasonal Hypoxia on Sediment Biogeochemistry in Coastal Sediments**

K.S. Sell[1] and J.W. Morse[2]

Bottom water hypoxia and its influence on the environment have been topics of increasing concern for many coastal regions. Traditionally, the focus of research has been directed mainly at the effects of hypoxia on biota in the water column and benthic fauna, but not on associated changes in sedimentary biogeochemistry. This research addresses both spatial and temporal variability in sediment biogeochemistry off the Louisiana coast near the Mississippi Bight and at the southeastern region of Corpus Christi Bay, TX, where seasonal hypoxia occurs. In addition to traditional laboratory techniques for determination of dissolved inorganic carbon, benthic oxygen demand, total reactive sulfide, reactive Fe/Mn, sulfate reduction rates, and sulfate to chloride ratios, solid state microelectrodes were used to simultaneously measure concentrations of dissolved $O_2$, $Mn^{2+}$, $Fe^{2+}$, and $H_2S$ in multiple small-interval depth profiles. Sediment microcosm studies were made where oxygen concentrations in the overlying water were manipulated and electrode depth profile measurements were made over the time of the experiments. An upward migration of dissolved $Mn^{2+}$, $Fe^{2+}$, and $H_2S$ through the sediment column and, at times, into the overlying water was observed as the oxygen levels decreased. A corresponding retreat of these redox species occurred when the overlying water was re-oxidized. Results will be presented in the context of the Edridge-Morse model for benthic–pelagic coupling previously developed for processes in the hypoxic region of the Louisiana shelf.

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## Shriver, J.F.

**An Operational Real-Time Eddy-resolving 1/16° Global Ocean Nowcast/Forecast System**

J.F. Shriver[1], O.M. Smedstad[2], H.E. Hurlburt[1], E.J. Metzger[1], R.C. Rhodes[1], A.J. Wallcraft[1] and A.B. Kara[3]

A real-time eddy-resolving global ocean nowcast/forecast system developed at the Naval Research Laboratory (NRL) has been running operationally at the Naval Oceanographic Office (NAVOCEANO) since 27 September 2001. The system uses the NRL Layered Ocean Model (NLOM) with 1/16° resolution and 7 layers in the vertical. Real-time satellite altimeter sea surface height (SSH) from Jason-1, ERS-2 and Geosat-Follow-On provided by NAVOCEANO's Altimeter Data Fusion Center (ADFC), are assimilated into the model. The assimilation consists of an optimum interpolation deviation analysis of SSH with the model as a first guess, a statistical inference technique for vertical mass field updates, geostrophic balance for the velocity updates outside of the equatorial region and an incremental updating of the model fields to further reduce gravity wave generation. The sea surface temperature (SST) assimilation consists of relaxing the NLOM SST to the daily Modular Ocean Data Assimilation System (MODAS) SST analysis performed at NAVOCEANO. Real-time and archived results from the model can be viewed at the NRL web site http://www.ocean.nrlssc.navy.mil/global_nlom. The results show the model has predictive skill of the mesoscale variability for at least one month.

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## Smith, George B.

**Multiple Convolutions for Multi-Path Compression**

George B. Smith[1], Joan A. Wiemann[1], James A. Showalter[1] and Robert L. Field[2]

Blind deconvolution algorithms, already prevalent in communication, image and seismic processing, can be useful in the field of underwater acoustics as pre-processors for transient signal classification algorithms in shallow water since they remove the distortion of the signal caused by multi-path propagation with little or no knowledge of the environment. In this work, the existence of a domain is demonstrated in which multi-path from a large number of arbitrarily located hydrophones averages out. This algorithm consists simply of a geometric average in the frequency domain of all the received signals. This roughly corresponds to convolving all the data channels together for multi-path smoothing. Computer simulation studies show significant improvement in classification performance when propagation effects are mitigated by the use of this blind technique. Classification operating characteristics analysis shows that this algorithm performs adequately in noise. Finally, analysis of field data verifies the predicted compression effects.

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## Smith, S.R.

**Seasonally Averaged Circulation and Baroclinic Structure in the Northern Gulf of Mexico**

S.R. Smith[1] and G.A. Jacobs[2]

Acoustic measurements from moored and shipboard acoustic Doppler current profilers (ADCPs) are used to estimate the seasonal circulation and vertical structure of the northern Gulf of Mexico. In addition to the ADCP data, Eulerian velocities, computed from historical drifter data, and sea surface height (SSH) information from satellite altimetry are included in the seasonal flow field estimations. A weighted least squares technique is used to combine these data sets with a system of dynamics governed by the linear, time-independent, multi-layered, baroclinic, shallow water equations. The solution weights are based on the expected errors to the dynamical equations and measurements. The forcing for the dynamics are wind stress and density gradients, which are provided by the Navy Global Ocean and Atmospheric Prediction System (NOGAPS) and computed from the Modular Ocean Data Assimilation System (MODAS) respectively. A conjugate gradient inverse method determines the flow field that best satisfies the weighted data and dynamics for each season. These best fit solutions include both the Northeast Gulf of Mexico Shelf and the Texas-Louisiana Shelf regions. By including the area just south of Louisiana in the solutions, the seasonal flow, along with its vertical structure, can be estimated between these two regions.

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## Snedden, Gregg A.

**Effect of Fluvial Input, Meteorological Forcing, and Non-Local Sea Level Fluctuations on Water Level Variability a Louisiana Deltaic Estuary**

Gregg A. Snedden[1], William Wiseman[2] and Jaye E. Cable[1]

Estuarine sea-level variations are forced by a variety of phenomena, including river discharge, tidal exchange, meteorological forcing, and remote forcing caused by non-local sea-level fluctuations. We used empirical orthogonal function (EOF) analysis to characterize spatial and temporal variability of water level data from seven stations along the longitudinal axis of the Breton Sound estuary. EOF analysis is an ordination technique that projects variation of several correlated variables onto fewer, uncorrelated ones. Two principle water level oscillation modes were identified with the analysis. Preliminary analyses indicate the first mode accounts for over 50% of the water level variation, and this mode represents a uniform water level response across the entire estuary. The second mode accounts for approximately 28% of the variance, and it describes periodic oscillations in sea-level difference between the seaward and landward ends of the estuary, with the node of these oscillations located near the longitudinal midpoint of the basin. Amplitudes of the first mode show an annual cycle, with negative values during late-winter to early-spring and positive values from late-summer until early-winter, and this mode is strongly correlated with seaward wind stress and non-local sea level. Strong loadings on mode two coincide with large fluvial inputs at the landward end of the estuary or initial passage of strong frontal systems. These data indicate that different forcing functions elicit a dual-mode water level response in the estuary, and that the importance of each mode at any point in time is determined by the relative strengths of the forcing functions.

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## St. Jean, S.D.

**Indicators of Environmental Quality and Carrying Capacity in the Richibucto Estuary**

S.D. St. Jean[1], E. Mayrand[2] and S.C. Courtenay

The impact of an oyster aquaculture facility on the surrounding bivalve population was investigated. During May 2002, two cages per site, each containing 70 blue mussels (*Mytilus edulis*) were placed among oysters being cultured at 3 different densities. Classical indicators of physiological state (GSI, HSI, Cf and water content), activity of the mitochondrial enzyme cytochrome C oxidase (CCO) and of lysosyme in the digestive gland and the gills were measured. Energy stores in the mantle were measured using lipid and glycogen content. Immunocompetency was evaluated by measuring Phagocytic Activity (PA), Lysosome Retention (LR), production of Reactive Oxygen Intermediate (ROI), total proteins and a bacterial challenge. Preliminary analysis showed that although there were no differences in chlorophyll, tissue moisture, and glycogen content among mussels from the three sites, Cf, CCO, GSI were higher and HSI was lower at the high density site. Lysosyme in the gills was elevated in mussels from the high-density group, probably reflecting greater effort directed towards defence against pathogens. This difference was not reflected in the PA, LR or total protein in the haemolymph, but levels of ROI were depressed in mussels caged near the high-density site. These mussels had a lesser efficiency clearing bacteria from haemolymph. The study showed clear influences of density related factors on surrounding, non-target bivalve productivity, health and functioning.

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## Stavn, R.

**Biogeo-optics: Organic Matter Scattering in Case 2 Waters**

R. Stavn[1] and R.W. Gould, Jr.[2]

There are many issues in the parameterization of the optical properties of Case 2 (coastal) ocean waters. Proper optical parameterization is critical for the development of adequate remote sensing algorithms for coastal waters. We have been developing new areas of optical investigation: geo-optics and biogeo-optics. We are building a database on the mass concentration of both suspended mineral and organic matter in coastal and open ocean waters of the Gulf of Mexico and other areas. These data are then multiply regressed against the spectral scattering coefficients obtained from the WET labs AC-9 instrument. We obtain the scattering coefficient of suspended organic matter from the multiple regression which is independent of the chlorophyll concentration. We are thus able to evaluate the predictive ability of any chlorophyll-based organic scattering algorithm. The significant factor here is the ability to partition the scattering coefficient into mineral and organic components made possible by our analysis. We have been able to evaluate many interesting chlorophyll-based algorithms of Loisel and Morel to determine their efficacy in predicting the portion of the scattering coefficient attributable to organic matter. We will discuss the chlorophyll-based algorithms which appear to do the best job of describing organic scattering in Case 2 waters. In some cases knowledge of the chlorophyll concentration may not be adequate.

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# CONFERENCE ABSTRACTS

## Sydor, M.

**Determination of Chlorophyll, Dissolved Organic Matter, and Suspended Inorganic Solids from Reflectance of Coastal Waters: Spectral Analysis of Bulk Reflectance from Coastal Waters.**

M. Sydor[1]

We characterize the optical properties of chlorophyll, dissolved organic material, and inorganic suspended solids. We use these characterizations in quantitative analysis of reflectance from Coastal Water. The results allow us to predict the concentration of each constituent using reflectance data alone. The technique is based on sequential multi-parameter fit to reflectance in the ~ 850, 600, 400, and 676 nm regions of the spectrum. We begin in the near infrared region of the spectrum where we have only one unknown, the scattering coefficient b. Subsequently, we isolate other regions of the spectrum where the reflectance can be linked to the optical properties of the constituents. The technique provides a global method for optical analysis of coastal water over the entire 400 – 900 nm spectral range. The results for absorption and scattering coefficients derived from the spectral analysis agree closely with measured absorption and scattering coefficients for the Mississippi Sound, Lake Superior, and Great Bay, New Jersey. Application of the technique to AVIRIS data for Great Bay NJ, yields realistic distributions for the magnitude and the spectral shape of the absorption coefficient for phytoplankton.

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## Synolakis, C.E

**What Have We Learned in the Last Tsunami Decade**

C.E Synolakis

Tsunamis are notorious for exporting "death and destruction at distant coastlines", for tsunamis sometimes travel across the world's oceans without dissipating sufficient energy to render them harmless. In the past ten years, twelve major tsunamis have struck coastlines around the Pacific rim causing more than 3000 deaths and an estimated $1 billion US (2001) in damage. Fortuitously, these tsunamis have either struck less developed coastlines or developed coastlines at low season with less or no visitors along the coast. Within the contiguous 48 states of the US, the most significant event last century was the 1964 Alaskan tsunami, which killed 9 people in Crescent City, California and caused more than $30 million US (1984) dollars in damage. Tsunamis have been responsible for more deaths in the US than earthquakes. Before the 1995 Kobe Japan and the 1999, Izmit, Turkey earthquakes, it had been estimated that tsunamis cause between 5% to 15% of the earthquake damage worldwide. The 1992-2002 events have provided valuable field data to calibrate numerical model to predict tsunami coastal effects. Yet, accurate estimation of tsunami inundation heights and currents in real time as events untold remains one of the holy grails of hydrodynamics. Here I will present field survey results and discuss how they have affected our understanding of tsunamis and their modelling and how they have contributed to improving our early warning capabilities.

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## Szabados, M.

**NOAA Ocean Service's Operational Oceanography Helping to Predict and Assess Natural Hazards**

M. Szabados, S.K. Gill and K.A. Tronvig

Operational oceanography is the core of the National Oceanic and Atmospheric Administration's (NOAA's) ocean activities. Oceanography is a broad field in which many sciences focus on the common goal of understanding the oceans. Operational oceanography can be defined as transforming the knowledge of oceanographic principles into products for practical applications. NOAA's role in operational oceanography is to provide the knowledge and information necessary to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources such that the Nation's economic, social, and environmental needs are met. Predicting and assessing natural hazards to help protect life and property is an essential application of NOAA's operational oceanography. Real-time water levels are observed and disseminated serving as a tool for the monitoring of coastal storm surge and flood events, evacuation decision-making, and safe navigation. They are essential for monitoring tsunami and El Niño events. Water level information, when combined with the knowledge of local tidal currents and waves, allows coastal managers to properly analyze beach erosion rates so that protective measures can be taken and where necessary, restoration can be designed properly. This paper illustrates the importance of these NOAA operational oceanographic programs in mitigating damages caused by natural hazards.

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## Teague, W.J.

**Transport Observations Across the Korea/Tsushima Strait**

W.J. Teague[1], G.A. Jacobs[2], H.T. Perkins[3], J.W. Book[4], P.A. Hwang[5] and J.M. Dastugue[6]

The Tsushima Current flows from the East China Sea to the Japan/East Sea via the Korea/Tsushima Strait. Volume transports and the variability across the strait are of high interest. Between May 1999 and March 2000, ADCP measurements were made in the strait to examine the transport. The Tsushima Current transport, averaging 2.65 Sverdrups, is split into two cores by Tsushima Island which divides the strait into eastern and western channels. Transport in the western channel is 23% higher than in the eastern channel over the measurement period. Some seasonality in transport variability is observed for both the western and eastern channels. Transports are largest in fall and smallest during winter. Transport variations across the strait are large, particularly in the lee of Tsushima Island where a countercurrent commonly exists. A wake zone that averages 40 km in width is observed downstream of Tsushima Island and appears to follow island wake zone dynamics. Reynolds numbers can range from 22 to 90 in the wake zone and eddy shedding can occur throughout the year. EOF analyses indicate total transport variations in summer are due mainly to transport variations near the Korea coast, while in winter, contributions to total transport variations are more uniformly distributed across the strait.

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## Tronvig, K.

**A Need for Water Levels and Vertical Datums to Restore and Sustain Healthy Wetland Ecosystems**

K. Tronvig[1] and M. Szabados[2]

Wetlands play a crucial role in the productivity of coastal waters, biogeochemical cycling, and geomorphological stability. They act as nurseries for fish and crustaceans and feeding grounds for birds; they store pollutants and nutrients; and they serve as buffer zones to flood events and wave action. However, these fragile ecosystems have been degraded over the centuries due to both anthropogenic use and natural hazards. Due to their intrinsic natural value, restoring and sustaining healthy wetland ecosystems has become a National priority. Wetland vegetation is sensitive to the frequency and duration that it is inundated, suggesting that understanding the hydrodynamics of the system is critical. This paper illustrates the need for accurate water level information and vertical datums to successfully restore and sustain healthy wetland ecosystems. Tidal datum elevations referenced to geodetic datums enables the generation of Digital Elevation Models (DEMs) which are beneficial in the planning and construction phases of wetland restoration efforts. High water and long-term sea level analyses are required to determine where to appropriately plant the different vegetative species and ensure that sea level rise is appropriately considered in the extended planning phases. Accurate water levels are also essential for monitoring the wetland for long-term conservation purposes and contribute to assessments on flora and fauna successes and/or failures.

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## Tuddeman, P.

**Global Heartbeat Program**

P. Tuddenham[1] and K. Bishop[2]

Global Heartbeat (www.globalheartbeat.org) is a hands-on environmental science and education program for middle and high school students that promotes awareness of ocean health, coastal environmental issues, and human health implications. The Global Heartbeat Program uses a technique (Computer Assisted Physiological Monitoring, or CAPMON) by which the heartbeats of certain marine invertebrates such as crabs and mussels are measured with an infrared sensor that is glued to the shell of the animal. An organism's health is related to the health of its habitat, so by monitoring its health, the condition of its ecosystem can also be evaluated. In this way, Global Heartbeat may provide an early indication of possible ecological degradation and negative impacts on marine biological diversity. Participants will submit the data they collect to a central website that will collate and visually present these data. This website will also include educational materials to support student learning and online discussion forums where scientists can talk with students and answer questions. The program is designed to engage students, educators, and scientists in cooperative research by forming a pollution monitoring network and raising awareness about the relationship between ocean and human health.

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## Tyner, Elizabeth C.

**Bay Scallop Bio-monitoring Sensor**

Elizabeth C. Tyner[1], Norman J. Blake[2] and Eric T. Steimle[3]

The sensitivity of the Bay Scallop ( *Argopecten irradians concentricus*) to environmental changes makes it an ideal candidate as a bio-monitor. Scallop behaviour can act as an indicator of the general health of the population and their estuarine environment. Because of the substantial ecological significance of scallops, the ability to monitor their *in situ* behaviour represents a critically important capability for managers who must assess the health of an ecosystem. We are developing sensors to monitor the adduction/gape behaviour of scallops. This is accomplished by using a Hall effect sensor and a small magnet attached to the outer shell of the scallop. The Hall effect sensor detects changes in magnetic fields generated by the gape of the scallop. This sensor will be used to develop base line behaviour models. The knowledge gained by the success of this project will assist in the restoration of depleted population through a better understanding of scallop response to environmental changes and provide addition information for complete coastal management plans.

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## Tziperman, Eli

**Sea Ice – The Glacial Cycle's Climate Switch**

Eli Tziperman[1] and Hezi Gildor[2]

The major glaciations that have occurred over the earth every 100,000 years during the past 1 million years are the largest natural climate variability signal in recent geological history. During each glaciation, global sea level dropped by approximately 120 meters and this large amount of water has then accumulated as 2-3 km high ice sheets over land; global temperature varied by many degrees, and the concentration of $CO_2$ in the atmosphere changed by 30%. In spite of the large amplitude and obvious significance of these events we still do not have an accepted theory for them. A novel mechanism and model for the glacial-interglacial oscillations will be described, explaining many of the observed glacial cycle features. The glacial oscillation in the proposed mechanism is shaped by the rapid growth and melting of sea ice which switches the climate system from a slow growing land ice-sheet phase to a fast retreating ice-sheet phase (creating a "relaxation oscillation"). The role of Milankovitch insolation changes, the thermohaline circulation, atmospheric $CO_2$ changes, and the observed transition from 41 kyr glacial cycles to 100 kyr cycles about one million years ago are all discussed and explained.

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## Udovydchenkov, Ilya A.

**Acoustic Propagation Modelling in the Gulf of Mexico**

Ilya A Udovydchenkov[1], Irina I Rypina[1], Natalia A Sidorovskaia[2] and Jerald W Caruthers[3]

For several decades monitoring and modelling the dynamics and physical structure of the Gulf of Mexico have been major efforts undertaken by oceanographers of the United States. Some aspects of the ocean acoustic tomography in the Gulf of Mexico are discussed. The possibility of modelling of the sound propagation at the presence of eddies that are believed to fuel hurricanes is considered. The normal mode acoustic model SWAMP (Shallow Water Acoustic Modal Propagation by N.A. Sidorovskaia and M. F. Werby) was used for long range and low frequencies (~400 km, 500Hz and 1000Hz) propagation simulation. Discussion of the experimental design of a feasible tomographic system is present.

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## VanCooten, Suzanne

**A Summary of National Data Buoy Center (NDBC) Observations During the 2002 Atlantic Basin Hurricane Season**

S. Van Cooten[1] and D. Gilhousen[2]

The 2002 Hurricane season provided unique observational opportunities for the National Weather Service's National Data Buoy Center (NDBC) data collection platforms. In June 2002, NDBC deployed a moored buoy 42 nautical miles east of Saint Augustine, Florida, to support the National Oceanic and Atmospheric Administration (NOAA) Coastal Storms Initiative (CSI) program. This 3-meter buoy was in place to record meteorological and oceanographic data from Tropical Storm Eduoard and Hurricane Kyle. The NDBC buoy array across the Gulf of Mexico and NDBC Coastal-Marine Automated Network (C-MAN) sites along the United States Gulf of Mexico coastline recorded meteorological and oceanographic data from Tropical Storms Hanna and Bertha and Hurricanes Isidore and Lili. Hurricane Lili generated the highest wind speeds ever recorded by a NDBC buoy. Buoy station 42001, located in the central Gulf of Mexico, recorded sustained 10-minute average speeds of 51 meters per second and peak (5-second) gusts of 67 meters per second as the buoy encountered the eastern eye wall of Hurricane Lili. Wind measurements from a second anemometer and post calibration of the anemometers validate that NDBC accuracy standards were met. These winds generated significant wave heights of 37 feet, which represent the average of the highest one-third of all of the wave heights during the 20-minute sampling period.

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## Vardaro. M.

**Long-term Observation of Temporal Changes in Hydrate Mound Topography and Ecology**

M. Vardaro[1], I.R. MacDonald[2] and L.C. Bender[1]

In order to record the changing topography, biodiversity and population density of an exposed gas hydrate mound in the Gulf of Mexico, we deployed a deep-sea time-lapse camera that can record images at a pre-set interval. The digital camera recorded one picture every six hours for three months in 2001 and every two hours for one month in 2002. Temperature probes were deployed at the site over the entire experimental period. The data recovered provide an unprecedented record of hydrate mound processes. Biological activity was calculated by identifying fauna observed in the time-lapse record and recording the number seen in each image. An average of 4.6 (±3.0) organisms were seen in each frame during the three-month deployment, while 3.6 (±4.2) were seen per frame in the one-month deployment. Turbidity was measured by analyzing the luminosity of the water column above the mound. A 24.1-hour diurnal pattern can be seen in the record, indicating a tidal component to deep-sea currents. The temperature data revealed a significant time lag and dampening effect between temperature changes in the water and those seen within hydrate or sediment, allowing heat flow calculations to be made. Temperature spikes at regular intervals and long-term trends appear to confirm the tidal influence on deep Gulf waters. The ability to directly observe temporal changes in a hydrate community demonstrates the value of long-term time-lapse photography in the study of deep-sea ecosystems.

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## Vinogradov, Sergey

**Physical Oceanographic Conditions in the Northeastern Gulf of Mexico During LADC-1 Experiment in the Summer of 2001**

Sergey Vinogradov[1]

The Littoral Acoustic Demonstration Center (LADC) project deployed three bottom-moored environmental acoustic systems off the Mississippi River Delta at water depths of 600m, 800m, and 1000m. Self-recording environmental sensors were attached to the moorings to obtain time series data of temperature, conductivity, and pressure at specified depths for the period from July 17, 2001 to August 21, 2001. The research vessels collected additional oceanographic data including 38 CTD and 77 XBT during mooring deployment, recovery, and two environmental surveys. Other supporting oceanographic data are the variations in sea-surface and air-temperature time series taken from NOAA buoys in the vicinity of the LADC experiment and TOPEX/Poseidon satellite altimetry images. This poster will discuss the impact of eddies in Gulf of Mexico and atmospheric events such as the passage of tropical storm Barry to support LADC acoustic propagation studies. (This work was supported by ONR under the LADC project.)

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## Wadhams, P.

**Long-lived Convective Chimneys in the Greenland Sea and Their Climatic Role**

P. Wadhams[1]

The longest-lived convective chimney yet detected in the world ocean was first mapped in the central Greenland Sea (75°N, 0°) in March 2001 and has been observed during the succeeding summer, winter and summer for a total of 18 months. It is 10 km in diameter and extends to a depth of 2500 m. Hitherto, it was believed that Greenland Sea winter convection had been shutting down, reducing both in volume and depth (to 1200 m or less), and that this was due to a reduction in salt forcing from ice production in the region, the so-called Odden ice tongue. The consequences were expected to include a weakening of the Atlantic thermohaline circulation and a cooling impact on the climate of NW Europe. The recent chimney discovery makes it necessary to re-assess the role of the Greenland Sea in the climate of the northern North Atlantic region. A central question is that of the dynamics and structure of the chimney itself: how it formed, how water is convected through it, how long it will last, and how many other chimneys exist in the region. We attempt answers to these questions based on the most recent survey work.

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## Walker, Sharon H.

**Gulf of Mexico-Center for Ocean Sciences Education Excellence (COSEE)**

Sharon H. Walker[1], John Dindo[2], Michael Spranger[3], Richard Tinnin[4], Jessica Kastler[5] and Dan Brook[6]

This COSEE-Gulf of Mexico effort will use the thematic areas of habitats and organisms, marine technology, and physical parameters that exist within the five, Gulf Coast States to promote an enhanced awareness and understanding of ocean sciences. This is one of the seven COSEEs funded in the U.S. and is being supported by NSF, NOAA-OAR-Sea Grant and ONR/NOPP. This COSEE will physically be located at The University of Southern Mississippi's Scott Aquarium in Biloxi. Satellite COSEEs will be located at the Dauphin Island Sea Lab, the University of Texas' Marine Science Institute, the University of Florida Sea Grant Extension Program and its Museum of Natural History, and the Louisiana Marine Sciences Consortium. Additional assistance will be provided by Mississippi State University, the University of New Orleans, the Louisiana Public Broadcasting Station, the U.S. Navy, the National Marine Educators Association, and the National Science Teachers Association. Over a two-year period, this COSEE collaborative will reach 240 "first-tier" teachers and their 360,000 students, a potential 4,800 "second-tier" teachers, and their 504,000 students, a potential of hundreds of researchers, 700 informal educators, 34 undergraduate students, and approximately 800,000 interested public, thereby creating an improved understanding of the oceans' dynamics and the scientific research being conducted within the partnering institutions and outreach facilities. Each of the satellite COSEE facilities has ocean scientists, graduate and undergraduate students, and ocean sciences educators who will implement the objectives of this effort.

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## Walrod, J.

**Sensor Network Considerations for Coastal and Ocean Observatories**

J. Walrod[1]

Worldwide, there are approximately 70 coastal and ocean observatory projects at various stages of planning and implementation, including approximately18 regional observatories around the United States. These systems are comprised of a wide variety of architectures, sensors, networks, and communication links. This paper examines real-time network architectures and protocols for ocean observatories from a viewpoint of national coordination and standardization. Network considerations include real-time sensor data transport, interoperability within and across regional networks, coordinated infrastructure planning for national use, user access, network administration and maintenance, upgrades and expansions, synchronization and time tagging of sensor data, gridlock and position tagging of sensor data, smart sensor support, power consumption, data rates, reliability, and fault-tolerance. Sensor network protocols and architectures are presented for emerging coastal and ocean observatory networks.

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## Wesson, Joel

**Observations of a Freshwater Tidal Plume by Salinity Remote Sensing**

Joel Wesson[1], Derek Burrage[2] and Don Johnson[3]

We report simultaneous observations on consecutive days of the freshwater plume outflow from Apalachicola Bay (Florida) and its characteristics using STARRS (Salinity, Temperature and Roughness Remote Scanner) and *in situ* observations from August, 2002. STARRS is an airplane mounted passive microwave sensor. It is used here to rapidly map the bay and freshwater outflow. Waters in the outer part of Apalachicola Bay are contained by barrier islands with a few narrow passages between them. Flow of water through these passages is modulated by the tides. After the freshwater has been held inside the barrier islands by the tide, it is released as a pulse that spreads from the release point (West Pass) and flows along the barrier islands. Differences between the outflows on consecutive days appear to be due to substantially different winds on the two days.

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## White, L.W.

**A Method for Estimating Winds from Ocean Wave Spectra**

L.H. White[1] and J.L. Hanson[2]

Most commercially available directional wave buoys do not measure winds. As this is an important quantity for marine safety, a method has been developed that allows wind speed and direction to be estimated directly from wave buoy observations. The method employs a wave spectral partitioning technique to separate the wind sea and swell energy components of the directional wave spectrum. Wind speed is computed from the isolated wind sea spectrum using an inverse wave modelling approach. Wind direction is derived from the high-frequency tail of the wind sea spectrum. Verification of this method is demonstrated using winds and directional wave spectra collected from National Data Buoy Center (NDBC) weather buoys. This capability has been added to the APL-WAVES software toolkit for ocean surface wave analysis.

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## Wilson, W.D.

**IOCARIBE-GOOS: A Growing GOOS Regional Alliance**

W.D. Wilson[1], G. Garcia[2] and C. Toro[3]

A new GOOS Regional Alliance has been formed by member states of the IOC's Regional Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE). The Caribbean and Gulf of Mexico nations have a vital economic and social dependence on the seas and coasts. The GOOS concepts of integrated observing systems and shared data and products are well suited for this region, linked by its common marine boundaries. A strategic plan for IOCARIBE-GOOS, *"The Case For IOCARIBE-GOOS"* was developed, and endorsed by IOCARIBE-VII in March 2002. A Steering Committee has been formed to begin implementation of the strategic plan. The plan and other documents are online at ioc.unesco.org/goos/IOCARIBE/carigoos.htm. In keeping with the user-driven nature of GOOS, the strategic plan addresses issues of special importance to the region, including tourism, fisheries, pollution, coastal populations, weather forecasting, storms and hurricanes, and marine biodiversity. There is an emphasis on developing and linking national GOOS programs, and on GOOS as a fundamental tool for integrated coastal area and EEZ management. There is also a strong commitment to training and capacity building. An immediate activity of the Steering Committee will be developing an Initial Observing System that addresses aspects of all system elements – the *observing, communications and data management*, and *applications* subsystems, and *capacity building*. The steering committee will also begin to develop and implement concept-demonstration projects that will contribute to the long-term goals and stability of IOCARIBE-GOOS.

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## Wolk, Fabian

**Spatial Resolution of a Bio-Optical Probe for Fluorescence Measurements**

Fabian Wolk[1], Hidekatsu Yamazaki[2] and Li Hua[3]

In order to investigate the structure and spectral characteristics of sub-meter-scale oceanic phytoplankton patches, we developed an optical probe that is capable of resolving centimeter-scale distributions chlorophyll a fluorescence. The probe works on the principle of back-scatter fluorometry. A set of collimated light beams is arranged so that the light beams' intersection creates a sampling volume in the free flow, away from the probe's housing. To understand the composite spatial response of the probe, it was mounted next to a fast-response thermistor and both sensors were towed through a warm, fluorescent plume. The ratio of the power spectra of temperature and fluorescence determined the transfer function of the sensor. The transfer function is similar to a first-order, single-pole low pass filter (Butterworth filter), with a half power point of 30 cpm. Hence, the composite spatial resolution of the probe is 0.03 m. Similar tests involving a new laser fluorometer probe are in progress. The laser probe is expected to have a spatial resolution of less than 0.005 m.

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## Wood, A.M.

**Optical Biogeography of Phytoplankton Communities on the West Florida Shelf**

A.M. Wood[1], S. Lohrenz[2], R. Gould[3], R. Arnone[4] and W.K.W. Li[5]

In fall, 1998, we examined the correlation between taxonomic composition of phytoplankton communities, properties influencing ocean color, [(particulate absorption, pigment concentration, particulate carbon, colored organic matter (CDOM)], and the distribution of water masses identified using a classification system based on measurement of chlorophyll concentration and inherent optical properties (total absorption, CDOM, backscattering) by remote sensing. Outer shelf environments were dominated by small cells, the <3 μm size fraction accounted for most of the particulate absorption. *Prochlorococcus* were abundant, dinoflagellate species were typical of tropical ocean waters, and *Synechococcus* was present at ~$10^4$ cells $ml^{-1}$. A contrasting community was observed in coastal waters; these were identifiable as highly colored and particle-rich water masses by remote sensing. In these communities the >3 μm size fraction accounted for a greater proportion of total particulate absorption, *Prochlorococcus* were negligible, typical neritic dinoflagellate species were common, and phycoerythrin-containing picocyanobacteria were an order of magnitude more abundant than they were in outer shelf waters. The data suggest that, while *Synechococcus* may be an important component of oceanic phytoplankton, they can be even more successful in coastal waters. Increasing eutrophication of coastal waters may increase the aerial extent of these communities, a phenomenon that should be detectable by remote sensing.

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## Wright, L.D.

**The SURA Coastal Ocean Observing Program (SCOOP): Phase 1**

L.D. Wright[1], O.B. Brown[2] and J.P. Draayer[3]

The SURA Coastal Ocean Observing Program (SCOOP), an initiative of the Southeastern Universities Research Association (SURA) is intended to integrate and facilitate sustained coastal observations and modelling from the Gulf of Maine to the Western Gulf of Mexico. The goal is to establish an eastern U.S. component of a national coastal observing program to understand and model our coastal waters. SCOOP will provide the IT infrastructure to integrate the observing systems that now exist, or will soon exist, in the east. It will promote the effective and rapid fusion of observed data with numerical models and facilitate the real-time dissemination of observed and modeled information to operational, scientific and lay users. SCOOP will provide a robust data grid and modelling network to integrate and add value to the numerous subregional observatories that exist throughout the East and Gulf Coasts. An operational emphasis will be on Predicting Hazards in Coastal Waters. Two cross cutting scientific issues will focus on the effects of storms and river inputs. The net value of coastal observing systems will depend on the effectiveness with which the observed data are assimilated into community models in near real time. It is the output from these models that will be of greatest value to operational users by providing spatially distributed "nowcasts" and short-term forecasts. SCOOP offers a means of skill testing and refining different models against observational data from different subregions.

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## Yu, Peng

**New Grid Method for Topex/Poseidon Data Applied to the Gulf of Mexico**

Peng Yu[1], Jorge Zavala-Hidalgo[2] and James J. O'Brien[3]

Satellite altimetry data have been very useful in the study of oceanic eddies. However, eddies are only detected while they cross the satellite tracks but are missed when they are between tracks. A new satellite data processing method combines EOF analysis and an eigen-based interpolation algorithm. Here, the method is applied to the T/P along-track sea surface height (SSH) anomaly data. For each EOF mode, space and time information is obtained, and then interpolated to a high-resolution grid. Finally, the field is reconstructed into the new grid by summing the significant modes. The method was tested by performing three simple experiments and another experiment using synthetic SSH from a realistic high-resolution model. Finally a reconstruction of SSH from satellite data was applied to the Gulf of Mexico.

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## Yu, Zhitao

**A Study of the Role of the Internal Tidal Variability and Bottom Fish Catch on the North Flank of Georges Bank**

Zhitao Yu , Brian Rothschild[2] and Wendell Brown[3]

The fish catch data obtained by a fleet of New Bedford trawlers on the north flank of Georges Bank is remarkable for its huge variability. The fish catch per unit effort (CPUE) data suggest that patches of fish vary in location with time sometimes periodically. We also have pressure/temperature/time fish-tag evidence of relatively rapid depth changes by codfish. We believe signals like these are some complicated combination of fish abundance, fish behaviour and/or environmental factors. The ocean environment on the north flank of Georges Bank is highly variable due to several processes including a robust internal tide with vertical excursions of 10s of meters and kilometer lateral water displacements. In order to develop a first order understanding of the possible role of the internal tide variability on the bottom fish CPUE variability, historical time series observations and contemporary numerical ocean model simulations are being compared with high resolution fish and bottom temperature data obtained by the trawlers between November 2000 and 2001. We will report on preliminary findings of that study.

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## Zamudio, Luis

**Hurricane Juliette and Coastally Trapped Waves along the Mexican West Coast**

Luis Zamudio[1], Harley E. Hurlburt[2], E. Joseph Metzger[3] and Ole Martin Smedstad[4]

An operational real-time eddy-resolving (1/16°) global ocean nowcast/forecast system and a hybrid coordinate numerical ocean model are used to study the evolution of two coastally trapped waves generated by Hurricane Juliette along the Mexican West Coast. Results indicate that the first wave was generated along mainland Mexico and it propagated poleward as a free coastally trapped wave; it also generated anticyclonic eddies near Cabo Corrientes and the María Islands. Upon entering the Gulf of California the wave weakened cyclonic eddies and after reaching the shelf break north of Guaymas, it reversed direction and propagated southward along the east coast of the Baja California Peninsula (BCP). Next, the wave generated an anticyclonic eddy at Cabo San Lucas. Finally, the wave weakened while exiting the gulf and propagated northward along the BCP West Coast. The second coastally trapped wave was generated by Juliette's poleward winds along the BCP West Coast, but was subsequently greatly weakened by Juliette's equatorward winds.

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## Zavala-Hidalgo, Jorge

**On the Interaction of Cyclonic Eddies with the Loop Current**

Jorge Zavala-Hidalgo[1], Steven L. Morey[2] and James J. O'Brien[3]

It is extensively documented that the Loop Current in the Gulf of Mexico sheds eddies aperiodically. Probable causes of this aperiodic shedding are variations in the vorticity flux from the Caribbean Sea, changes in the transport through the Yucatan Strait, the wind forcing, and the interaction of the Loop Current with mesoscale features in the eastern Gulf. Here, through the analysis of altimetry and SST data, it is shown that the formation of the cyclones on the western side of the LC is related to its dynamics, with their time of generation during the last stage of the anticyclone separation from the LC. The longest documented eddy shedding period, between February 1998 and August 1999, is associated with the presence of a large cyclone that remains north of the LC during several months. The presence of this relatively big cyclone during 1998 blocks the penetration of the Loop Current to the north. A positive of the sea surface height anomaly developed along the slope of the West Florida shelf (WFS), and there was a leaking of mass and momentum from the Loop Current between the cyclone and the slope of the WFS. Model results from a very high resolution simulation of the Gulf of Mexico using NCOM are analyzed to study this process.

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## Zingarelli, R.A.

**An Energy Repartition Method to Augment Simple Acoustic Surface Loss Models, and its Application to Near-Surface Acoustic Ducts**

R.A. Zingarelli[1]

Modelling approaches that approximate rough surface scattering with a simple loss mechanism have seen successful use in acoustic prediction systems, in that this method does a reasonable job of capturing the overall coherent component losses at long ranges under wind-driven or ice-covered sea surfaces. However, under some oceanographic conditions problems can arise when using this method, because it assumes that any energy scattered away from the surface reflection angle is absorbed. Frequently this is largely the case, but in the presence of a surface duct, interactions with the scattered energy can have a significant effect. Here, a means based on coherent scattering theory for repartitioning the energy lost within this type of simple surface model is presented. Application of this method to an existing surface loss routine in a parabolic equation model is described. Finally, examples of the method's effects in surface ducted and non-ducted environments will be presented, and compared with benchmark results generated using conformal mapping to simulate wind-driven surfaces.

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