layer of rapidly varying temperature separating it from the NSDW. Reflections seen in the seismic data result from abrupt, but subtle, changes in sound speed caused by change in temperature on the order of 0.1°C in the boundary layer. These results suggest that the boundaries between major water masses can be seismically imaged if they contain fine-scale thermohaline structure.

OS41A MCC: 3000 Thursday 0800h

General Ocean Sciences: Instruments, Techniques, and Programs I

Presiding: **R M Fitzgerald,** University of Texas at El Paso**; D Barrick,** CODAR Ocean Sensors, Ltd**; J Diebold,** Lamont-Doherty Earth Observatory

OS41A-01 0800h

Voyage into the Unknown: Ocean Exploration for the 21st Century

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Findings and recommendations from the new National Research Council (NRC) report will be presented. In 2001, at the request of Congress, the NRC organized a committee of 15 volunteers to assess the feasibility and value of implementing a major, coordinated, international program of ocean exploration and discovery. After examining existing ocean programs and strategies for national and international cooperation between governments, institutions, and ocean scientists and explorers the committee identified strengths, weaknesses, and gaps. Priority areas for ocean research and exploration were identified. The NRC report presents the rationale and outlines goals for initiating a new, international ocean exploration program, it's administration and organization both domestically and internationally, technical needs, and the financial support required to initiate such a program.

URL: http://www4.nas.edu/webcr.nsf/ProjectScopeDisplay/OSBX-U-01-04-A?OpenDocument

OS41A-02 0815h

NOAA Ocean Exploration 2003: A Scientific Overview

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A little over three years ago, a panel of leading ocean scientists, explorers, and educators developed a national strategy for ocean exploration. Their report, "Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration," opened the door to a new way of thinking about ocean exploration and inspired the National Oceanic and Atmospheric Administration (NOAA) to embark on a mission to expand knowledge and appreciation of the ocean. This year, in collaboration with over 100 partners including university, international, federal, state and tribal science agencies, private research and outreach organizations, civic groups, aquariums and museums, NOAA engaged in major multidisciplinary expeditions and multiple projects around the world aimed at mapping the ocean in new ways, understanding ocean interactions, developing sensors and tools, and reaching out in new ways to stakeholders to communicate findings. Expeditions and projects undertaken this year continued to build on inaugural work in 2001 and 2002 and continue to set a precedent for high quality discovery-based ocean research and exploration. This presentation will focus on expedition highlights and future program directions.

URL: http://oceanexplorer.noaa.gov

OS41A-03 0830h

R/V EWING seismic source array calibrations: 2003

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In the Northern Gulf of Mexico, May, 2003, an NSF-funded effort was carried out to obtain calibrated measurements of the various airgun arrays deployed by R/V EWING during its seismic surveys. The motivations for this were several: to ground-truth the modeling upon which safety radii for marine mammal mitigation are established; to obtain broadband digitized signals which will accurately define the full spectral content of airgun signatures; to investigate the effects of seafloor interactions and their contribution to the acoustic noise levels from seismic sources. For this purpose, a digital, remotely telemetering spar buoy was designed and assembled; affording interactive control over the choice of two hydrophone channels, four fixed gain settings and four digitizing rates [6,250 - 50,000 Hz.] Three deployments were planned: a deep-water site, suitable for comparison of actual signals with modeled results; a shallow-water [25 - 50m] site where the effects of bottom interaction would be strongest; and a continental-slope site, which represents the favored habitat of many cetacean species. Methodology was developed which enabled the sequential discharge of four subarrays of 6, 10, 12 and 20 airguns. A separate run was made with two "GI" airguns, the favored high resolution survey source. An Incidental Harassment Authorization and a Biological Opinion, including an Incidental Take Statement were issued for the project by National Marine Fisheries, and a suite of marine mammal observation and mitigation procedures was followed. The deep and shallow water sites were occupied, and some 440 airgun signals were recorded. The slope site work was cancelled due to weather too poor for accurate marine mammal observation, but calibration was subsequently carried out with an exploration industry source vessel in a similar environment. Preliminary results indicate that the mitigation modeling is accurate, though somewhat conservative; that the radiated energy from airgun arrays, known to be strongest at very low frequencies, continues to diminish as frequencies increase up to 25 kHz, and that interactions with the seafloor, while complex, are understandable.

OS41A-04 0845h

Application Of A Satellite Ocean Color Technique For Monitoring Coastal Waters: Great Barrier Reef Case Study

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Remote sensing is often considered as a means of addressing the limitations of ground-based monitoring networks by obtaining synoptic measurements of optical signals from the targeted water bodies. These optical signals, usually measured as water reflectance, must then be transformed, through appropriate methodologies, into estimates of water coloring substances and consequently, water quality parameters. In optically complex coastal waters, methods to accurately retrieve optical properties remotely are still evolving. Analytical and empirical relationships between apparent and inherent optical water properties are combined to develop a bio-optical model, using to Sea-viewing Wide Field-of-view Sensor (SeaWiFS) visible spectral bands. In this study the inverse bio-optical model was incorporated in the processing software SEADAS to allow for iterative atmospheric correction and subsequent retrieval of chlorophyll concentration, inorganic sediments load and dissolved organic matter absorption. The vicinity of Hinchinbrook channel, central Great Barrier Reef zone, Australia, was used as a case study, where presence of particulate matter and colored dissolved organic matter imply inadequateness of SeaWiFS standard chlorophyll algorithm. The new algorithm was validated using sea-truth measurements of water-coloring constituents acquired during various seasons throughout 2002-2003. In situ and corresponding remote observations agree within their uncertainty boundaries. The method was then applied to study fluxes of particulate and dissolved organic and inorganic matter following flood events of the adjacent Herbert River during austral summers of 1999 and 2002.

OS41A-05 0900h

A Global Ocean Model Based on Icosahedral-Hexagonal Grids With a Hybrid Vertical Coordinate

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This talk will present results from a new ocean general circulation model (OGCM). The ocean model uses an icosahedral-hexagonal grid to tile the surface of the sphere and hybrid (floating) coordinates to discretize the vertical depth of the ocean. The use of icosahedral-hexagonal grids leads to a highly uniform and isotropic discretization of the sphere and eliminates problematic grid singularities found in other grid systems. The hybrid coordinate used to discretize the vertical direction spans the limits between an Lagrangian-coordinate, such as isopycnal coordinates, and an Eulerian-coordinate, such as z-level coordinates. As a result, the model can be integrated forward in time for several days using Lagrangian vertical coordinates to minimize vertical diffusion and dispersion. At fixed time intervals, the vertical layers are mapped back to z-level coordinates and the integration continues forward in time. This type of coordinate is referred to as an Arbitrary Lagrangian Eulerian coordinate and is being developed at LANL. The model contains much of the functionality of a full production ocean model including convective adjustment, implicit vertical mixing, UNESCO equation of state. and subgrid scale mixing parameterizations. The results show realistic ocean circulations using 40962 grids cells in the horizontal (nominal 1 degree grid) and 33 layers in the vertical. The ocean is forced using monthly mean NCEP wind stresses and restoring to Levitus temperature and salinity in the top 5 meter layer. The results demonstrate that not only is this a viable approach to ocean modeling, but also provides an alternative approach to overcome many of the classical problems in ocean modeling.

OS41A-06 0915h

Development of Ocean Noise "Budgets"

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The National Oceanographic Partnership Program recently sponsored the third U.S. National Academy of Sciences study on the potential impact of manmade sound on the marine environment. Several recommendations for future research are made by the 11-member committee in their report titled Ocean Noise and Marine Mammals (National Academies Press, 2003). This presentation will focus on the subset of recommendations related to a "noise budget", i.e., an accounting of the relative contributions of various sources to the ocean noise field. A noise budget is defined in terms of a specific metric of the sound field. The metric, or budget "currency", typically considered is the acoustic pressure spectrum integrated over space and time, which is proportional to the total mechanical energy in the acoustic field. However, this currency may not be the only one of relevance to marine animals. Each of the various ways in which sound can potentially impact these animals, e.g., temporary threshold shift, masking, behavior disruption, etc, probably depends upon a different property, or set of properties, of the sound field. Therefore, a family of noise budgets based on various currencies will be required for complete evaluation of the potential impact of manmade noise on the marine environment. Validation of noise budgets will require sustained, long term measurements of the underwater noise field.

OS41A-07 0930h

The Use of Normal Mode Analysis to Extend HF Radar Coverage Over Enclosed Bays

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A technique referred to as Normal Mode Analysis (NMA) has recently been developed for representing total vector CODAR HF radar data. This technique has been applied to Corpus Christi Bay. These modes satisfy the coastal boundary constraint of no flow normal to the shore, and inherently represent both divergent and rotational flow as two sets of ortho-normal basis functions. The use of NMA allows the measurement of flows in mostly enclosed bays, like Corpus Christi, where wind-driven and tidal currents predominate. Furthermore, it extends the measurement coverage into regions where only one, or even no radar is able to provide coverage. The PDE2D software, which is based on a Finite Element Method, is used to obtain the eigenfunctions for the Corpus Christi Bay. Comparisons are made with the real-time total-vector maps produced by the HF Radar data over the common coverage area.

OS41A-08 0945h

Toward Better High Frequency Dealiasing in altimeterMeasurement of Sea Level Heights

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Ocean motions that has High Frequency (HF) with periods less than 20 days are aliased in the TOPEX and JASON measurement of sea level heights. Previous research has showed that most of these motions have a barotropic signals especially in high latitudes and a barotropic model is needed to dealiase these signals. We are visiting back this subject in which we show that in the tropics there are HF motions that cannot be captured by a barotropic model. Hence, a baroclinic model is needed for the removal of HF signals from the sea level height spectrum observed by satellite altimetry.

OS41B MCC: Level 2 Thursday 0830h

General Ocean Sciences: Tropical Oceanography and the Impacts of El Niño II Posters *(joint with A)*

Presiding: **W Han,** Program in Atmospheric and Oceanic Sciences, University of Colorado**; C L Perez,** Columbia University

OS41B-0801 0830h POSTER

The Ocean Response to a Brief Westerly Wind Event in the Tropical Pacific Ocean

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The ocean response to atmospheric intraseasonal variability in the tropical Pacific Ocean is investigated using the URI Ocean General Circulation Model. The model performance in simulating the oceanic annual cycle so important for providing the background variability upon which the intraseasonal time scales can be properly studied, is evaluated by examining its sensitivities to 1) details of the air-sea flux parameterization, 2) different sources for the wind forcing products, and 3) the meridional extent of the model domain. The model fields of temperature, salinity and currents in the tropical Pacific agree reasonably well with observations and thus provide adequate initial conditions for the model experiments with anomalous intraseasonal atmospheric forcing. We build up our understanding of how high-frequency forcing of wind affects the ocean's annual variability by increasing the complexity of experiments. We start with a simple experiment in which a resting ocean is forced with a brief (10-day) wind burst and proceed with experiments for a circulating ocean forced with wind anomalies superimposed upon climatological air-sea fluxes. The main effect of the realistic background ocean conditions is that the strongest response to anomalous wind forcing is observed along the equator in the vicinity of the eastern edge of the western Pacific warm pool. The largest ocean anomalies result from the displacement of the strong temperature and salinity gradients in the Eastern Warm Pool Convergence Zone (EWPCZ). It is argued that this zonally non-uniform ocean response is primarily due to significant vertical and longitudinal variations of the salinity field associated with the western Pacific freshwater pool. Eastward advection, by remotely forced Kelvin waves and nonlinear interactions between these waves and a zonally-varying background ocean stratification, is identified as an important mechanism of the EWPCZ displacement.

OS41B-0802 0830h POSTER

An Uneven ENSO Oscillator From Changes in Climatology

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A new 'uneven ENSO oscillator' concept is introduced to describe the uneven changes in the ENSO warm phase and cool phase due to changes in the climatology, e.g. the Pacific climate regime shift around 1976. Using a neural network model for nonlinear canonical correlation analysis of the tropical Pacific wind stress anomalies and sea surface temperature anomalies, we compared the 1981-99 period to the 1961-75 period. During 1981-99, the location of the equatorial easterly anomalies during the ENSO cool phase was unchanged from the earlier period, but westerly anomalies during the warm phase were shifted eastward by up to 25°. Based on the delay oscillator theory, such an eastward shift would lengthen the duration of the warm episodes by up to 45%, but leave the duration of the cool episodes unchanged, hence an uneven ENSO oscillator. The Lamont coupled model of the tropical Pacific was then used to study how changes in the model climatology would produce an uneven oscillator. The eastward shift in the westerly anomalies during the warm episodes and the lengthening of the warm episode duration were indeed found in the coupled model when the 1981-99 climatologies were used instead of the 1961-75 climatology. In particular, it was mainly the change in the wind stress climatology rather than the change in the upper ocean climatology which caused the eastward shift in the westerly anomalies. The uneven ENSO oscillator theory has implications not only for how ENSO changed under decadal/interdecadal variations in the climatology, but also under longer term climate change.

OS41B-0803 0830h POSTER

Fast and slow ENSO modes

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Climate variability in the tropical Pacific has a rich frequency spectrum that partly results from coupled modes with different time scales. We examined the contributions of the thermocline feedback (the vertical advection of anomalous subsurface temperature by the mean upwelling) and zonal advective feedback (the zonal advection of mean sea surface temperature by anomalous current) in determining the time scales of the coupled modes. Firstly, using a dynamical ocean model, we study the dependence of maximum amplitudes and locations of equatorial zonal current and thermocline on the time scales of the wind forcing. Then we examine in a linearized intermediate air-sea coupled model the impacts of these feedbacks on the co-existence of leading coupled modes of different time scales. For slowly varying wind forcing, amplitudes of zonal currents are very weak and locate at western Pacific, whereas the thermocline response is strong. The zonal advective feedback thus tends but to be of secondly importance in a slow mode of interannual periodicity although it plays a dominating role in a fast coupled mode of near annual periodicity. The changes in the basic state of the coupled system can have significant impacts on the relative importance of the two main feedbacks and thus the periodicity and stability of the leading modes the coupled tropical Pacific climate system.

OS41B-0804 0830h POSTER

Monthly mapping of temperature and salinity by objective analysis with Argo floats and TRITON buoys data in the Pacific Ocean

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Objective analysis was applied to derive monthly temperature and salinity fields in the Pacific Ocean, using the Argo float, the TRITON buoy and other available CTD cast data. These products were opened to the public in JAMSTEC-Argo web site. Error of the estimated values by the objective analysis based on optimal interpolation (OI) method had become smaller because of increasing number of the Argo floats. To confirm the capability of this objective analysis, we compared our mapped data with observed CTD data along 137E routinely obtained by Japan Meteorological Agency, which were excluded from the objective analysis for this comparison. The analyzed fields are generally corresponding well with the CTD temperature and salinity sections. Thus, in spite of some assumptions in statistical parameters for salinity field due to sparse historical salinity data, salinity distribution is reproduced well. From these products, we calculated dynamic height anomaly, and compared with sea surface height data from Topex/Poseidon satellite. The patterns of both maps are consistent, although we found large difference in regions of small