OS33A-02 1330h POSTER

Improved technique for the measurement of ammonium species to marine and fresh waters and its application to coastal and saltmarsh environments

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Since elevated nitrogen deposition has been identified as a critical environmental problem of global concerns, sensitive determination methods for ammonia are needed to improve our temporal and spatial resolution of coastal ecosystems. Because of the high variability of physical and chemical proprieties of coastal waters and problems linked to the conservation of samples, the accurate determination of ammonia in estuaries and brackish waters remains an acute analytical problem not entirely solved. We present here an automated application of the fluorometric technique recently published by Holmes et al., (1999) using a transportable microplate fluorescence reader. The proposed technique is simple, rapid, free from amine interferences and salt effects, and can be used in the nanomolar to micromolar range on almost all types of water matrices. Compared to the manual Holmes's method, our protocol offers a simplified sampling procedure with an accurate calibration curve for each sample analysis, and allows an adequate analytical blank determination for each series of measurement. To illustrate the precision and the efficiency of this technique, water samples were collected at many stations on the St. Lawrence Estuary and analysed on board the Coriolis II oceanographic ship. Measurements were also conducted in salt marshes along the south shore of the Estuary. Preliminary results show ammonia concentrations ranging between <0.01 and 4.24 $\pm$ 0.01 μM in the estuarine waters following a distinct concentration pattern related with both indigenous and exogenous sources. Moreover, measurements obtained on reddish turbid waters sampled in salt marshes near Rimouski show an important release of ammonium during tidal flushing. Observed ammonium concentrations varies between 0.74 $\pm$ 0.01 μM at low tide and 10.61 $\pm$ 0.08 μM at high tide. The analytical error remained lower than 1% in spite of strong salinity gradients and high load of particulate matter. Knowing physicochemical proprieties of sampled waters, the improved ammonia technique is used within the framework of a broad study concerning the characterisation of the nitrogen cycle in high latitude coastal waters and the influence of anthropogenic inputs...

OS33A-03 1330h POSTER

Generation and Propagation of Internal Bores and Solitons in the South China Sea.

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The generation of internal bores and solitons by the interaction of the barotropic tide with sills in the Luzon Strait was studied with numerical models, along with their westward propagation across the South China Sea. The model domain extends from 116E-123E and 18N-23N, and includes the sills, gaps and islands of the Luzon Strait between Taiwan and the Philippines. Two classes of initial conditions were considered: (1) horizontally homogeneous density profiles representing an average over the domain, obtained from CTD's and/or climatology; (2) geostrophically balanced 3-D fields obtained from model solutions. Resolutions were typically 100m in the horizontal and 10-20 m in the vertical. The primary generation region was found to be the sill just south of Taiwan, and the sills between islands of the Batan Group in the Strait. The simulation results were compared with current meter records and CTD observations taken during the 2000-2001 ASIAEX experiments; these observations included both shallow and deep water locations.

OS33A-04 1330h POSTER

Seasonal Evolution of the Circulation, Heat and Salt Budgets in the North Water Polynya, Baffin Bay

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From 1997 to 1999 an international field program was conducted in the North Water (NOW) polynya, in Northern Baffin Bay, Canada. For three consecutive years, this polynya was sampled by a large community of scientists concerned about impacts of global changes on this fragile ecosystem. The objective of this work is to obtain a better understanding of the seasonal circulation, heat and freshwater transports in the NOW polynya. To attain this objective, we developed heat and freshwater budgets using a box model. The region was divided in 3 layers (12 boxes) between which exchanges were allowed. The box configuration was chosen to reproduce and distinguish the two main currents: the Baffin current flowing South from Nares Strait and the northward flowing, warmer West Greenland current flowing along the West Greenland coast. Current speeds were estimated from mass distribution and current meter data, using the geostrophic method and a variant of Wunsch (1977)'s inverse method. The freshwater content includes the melting ice cover given by satellite observations data. The heat budget include the surface exchanges (short and long waves and turbulent fluxes) obtain from the GEM (Global Environmental Multiscale) model. We present preliminary results based on a set of freshwater discharge scenarios.

OS33A-05 1330h POSTER

SUNTANS on Monterey Bay

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An elevated level of tidal energy dissipation in coastal regions has been observed, yet it is largely unexplained. One such location is Monterey Bay, CA, where the bathymetry consists of rough and complex terrain that is critical in some areas of the canyon, ridge, and slope regions. It is also an area that experiences strong oceanic internal tides. It has been postulated that the interaction of internal tides and non-tidal internal waves (collectively known as internal waves) with the bathymetry may be responsible for the heightened dissipation within Monterey Bay. Previous numerical internal tide simulations of this area using the Princeton Ocean Model (POM) have not been able to fully confirm or deny this hypothesis. To better simulate the life cycle of the internal wave field we have used the Stanford Unstructured Nonhydrostatic Terrain-following Adaptive Navier-Stokes Simulator (SUNTANS). SUNTANS is applied to Monterey Bay and the surrounding area to produce results of the internal wave velocity field in three dimensions. SUNTANS uses an unstructured grid in the horizontal plane (structured in the vertical). With unstructured grids it is relatively easy to efficiently include strong variations in grid density so that coarse grids can be used away from highly refined grids in the critical areas needed to capture internal wave formation, propagation and breaking. By defining the offshore and lateral boundaries far from the Bay, sensitivities of these boundary conditions are minimized. The resulting large domain allows for the identification of possible offshore generation sites. Locally-generated internal waves may then interact with bathymetry, which scatter further internal waves. SUNTANS is nonhydrostatic, which allows the high frequency internal wave field to be more accurately represented and makes breaking processes a numerical reality. It is hoped these improvements will provide a much improved picture of the evolution of internal tides in the vicinity of complex bathymetry. Preliminary results are encouraging; they show internal waves locally generated within the Monterey submarine canyon.

URL: http://suntans.stanford.edu/

OS33B CC: 220 C-E Wednesday 1330h

Extreme Waves and Dynamics of Ocean Circulation Posters

Presiding: **E A OKAL,** Northwestern University**; D Straub,** McGill University

OS33B-01 1330h POSTER

Three-dimensional Energy Transfers in Quasi-horizontal Flow

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The transfer of energy between balanced and unbalanced modes has important implications for large-scale ocean dynamics. It is known that the inertial runaway of QG models arises from an insufficient transfer of balanced energy towards dissipative, small-scale modes. Yet uncertainty remains as to the magnitude of these transfers and their importance compared to processes such as bottom friction. In this talk we examine a mechanism – the so-called hyperbolic instability – whereby unbalanced or 3-D motion can be generated from random straining by balanced or 2-D flow. Using numerical simulations of freely-decaying 2-D turbulence, it is shown that the growth can be described with a pressureless analysis wherein the horizontal pressure gradient is neglected: the perturbation grows where the pressureless approximation holds, and the growth rate of the perturbation can be estimated from the strain and vorticity of the base flow (i.e., variants of the well-known Weiss criterion). From the numerically-determined spectral eddy viscosity, it is also shown that the perturbation exerts an appreciable influence on the base flow, even for small aspect ratios. Applications to ocean modelling are discussed.

OS33B-02 1330h POSTER

Mesoscale Variability in the Black Sea: Satellite Observations

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The circulation in the Black Sea is characterized by a strong basin-wide cyclonic current along the shore known as the Rim Current, which exhibits important mesoscale transient features such as meanders, intense jets, eddies and filaments triggered by baroclinic instabilities. A new method is developed to infer the velocity field and its variability by analyzing series of subsequent satellite observations of the sea surface temperature made by NOAA AVHRR during 2000-2002 years. The analysis is based on the Maximum Cross Correlation (MCC) and Particle Image Velocimetry (PIV) methods. The application of these two techniques to the Black Sea reveals the large scale dynamic features of the circulation, as well as many details of mesoscale vortical activity. Analysis of the instantaneous velocity and vorticity fields further reveals a distinct seasonal variability of the circulation and provides the means to estimate important characteristics of the variability of the Black Sea such as basin-integrated kinetic energy, number of eddies, and fluctuation of the Rim Current width.

OS33B-03 1330h POSTER

Energy Transfer in Internal Waves Generated by Tidal Flow over Topography

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Internal wave induced mixing in the deep ocean is believed to play an important role in the meridional overturning circulation. Tide-topography interaction is the source of approximately half of the internal tide energy. This energy is injected at large scales so it is important to understand how energy is transfered to the small scales at which mixing occurs. In order to examine how the energy supplied by internal tides transfers to different scales and frequencies, several sets of numerical experiments have been conducted. A two dimensional finite-difference model solving the non-hydrostatic equations of motion is used. The simulations are run at low- and mid-latitudes. Topographies consisting of one and two localized hills are used to generate internal waves. Spectral analysis of the induced nonlinear interactions is carried out. In particular, the dynamics of the power spectrum in time is analyzed. The results are compared to those obtained by J.A. MacKinnon and K.B. Winters, who used a three dimensional spectral model to investigate the spectral evolution of an internal wave field. The major distinction between their simulations and ours lies in the way we model the bottom forcing. In their case, they use a flat bottomed ocean and generate internal waves with an upwardly propagating internal tide via a forcing term in the momentum equations, whereas in our simulations we explicitly consider the wave generation process by introducing topography.

OS33B-04 1330h POSTER

Ra-226 and Ra-226/Ba Signatures of Intermediate and Deep Water Masses of the Labrador Sea

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The Labrador sea plays an important role in the formation of intermediate North Atlantic water, (cf. Labrador Sea Water -LSW) and subsequently, in the general thermohaline circulation of the ocean. In addition, water masses originating from the Norwegian and Greenland seas are present below the LSW, in the deeper part of the basin. Investigations on the geochemistry of radium have been undertaken as a mean to document these deep and intermediate circulation processes. The vertical distribution of Ra-226 and Ba contents has been established for 8 stations located along 2 sections from 4844 N; 5258W to 5223 N 4517W and from 53.59N to 60.34N, 48.13W. Thermo-Ionization Mass Spectrometry coupled with a new radium extraction and purification technique permitted the measurement of Ra-226 using 200 ml samples (i.e., appr. 10 femtograms of Ra). In parallel, Ba contents were determined using M-C-ICP-MS in order to normalize Ra-226 concentrations, since Ba is often seen as a subrogate stable isotope of Ra, due to their almost similar geochemical behaviour. Large variations in Ra-226 concentrations are observed. They range from 51 fg/g in intermediate and deep water samples to 31 fg/g in surface waters. When normalised to a salinity of 35 or to the Ba contents large discrepancies are still observed. They suggest a specific Ra-signature for each of the major water masses present in the basin. Particular attention has been paid to Ra-226 contents in the LSW in relation to its production rate as well as to the influence of the Western Boundary Under Current (WBUC), which carries the North Atlantic Deep water masses into their gyre along the lower slopes of the Labrador sea. Based on the presently available data set, a peak in Ra-226 and Ba contents seems to characterise the high velocity axis of the WBUC. These data suggest moreover a lower Ra-226 content for the LSW than for the deeper water masses.

OS33B-05 1330h POSTER

Propagation of the low-modes internal waves through the ocean

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Low mode internal tides are an important part of the energy budget in the abyssal ocean. To zeroth order their generation is understood, but their subsequent propagation has not been addressed. We study the propagation of these waves through a climatological ocean in order to understand the direction and speed with which they propagate. We find that the speed is strongly influenced by the ocean depth, in particular the group velocity is significantly reduced over shallower topographic features such as the mid-Atlantic Ridge and East-Pacific Rise. The latitude also has a strong effect, gradually decreasing the group velocity as the waves move from the equator, eventually going to zero at the turning latitude. The change of buoyancy frequency at the subtropical front (30-35 degrees) is responsible for a sharp decrease of both group and phase velocity. These results are important for determining where the low-mode tidal energy eventually dissipates.

OS33B-06 1330h POSTER

Extreme Edge Waves Above a Cylindrical Shelf

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The analysis of recent in-situ measurements shows that nearshore longwave motions and velocity field are mainly determined by progressive edge waves, which have principal influence upon coastal zone, lead to forming of peculiar relief features, can impact on harbor installations and constructions. Edge waves moving in alongshore direction can excite strong natural oscillations (seiches) in adjacent bays or inlets. In the present work different effects resulting in edge wave amplification are considered. The dynamics of the edge waves above a cylindrical beach is studied in the framework of the linear and nonlinear shallow-water theory. Several forms of bottom geometry, such as linearly sloped shelf and concave exponential shelf, are considered as examples. The mechanism of the spatial-temporal focusing (dispersion enhancement) of multimodal edge waves in the shelf zone is investigated in the framework of linear theory both analytically and numerically. The structure and nonlinear dispersion relation up to second order in small parameter characterizing wave amplitude is found explicitly for weakly nonlinear edge waves. Coefficients of nonlinear correction in dispersion relation are calculated and the nonlinear Shrodinger equation is derived. Modulation instability can lead to forming of extreme edge waves over linearly sloped shelf.

OS33B-07 1330h POSTER

Tsunami Inundation Mapping of Coastal Alaska

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Seismic events that occur within the Alaska-Aleutian subduction zone have a high potential for generating both local and Pacific-wide tsunamis. To help mitigate the large risk these earthquakes and tsunamis pose to Alaskan coastal communities, the Alaska Tsunami Modeling Team addresses the problem of predicting runup of tsunami waves using a numerical modeling technique. The model solves nonlinear shallow-water equations with a finite-difference method. Embedded grids of different resolution are employed to increase spatial resolution in the shelf area. Numerical simulations yield runup heights, extent of maximum inundation for chosen tsunami scenarios, depths of inundation on dry land, and maximum velocity current distribution in inundation zones. The communities for inundation mapping are selected in coordination with the Alaska Division of Emergency Services with consideration to location, infrastructure, availability of bathymetric and topographic data, and community involvement.The communities of Homer and Seldovia are located in Kachemak Bay, which is one of the high-priority region for Alaska inundation mapping. We modeled two hypothetical earthquake scenarios as potential sources of tsunami waves that affect the Kachemak Bay communities. They represent both distant and local sources, and we model them using the multiple fault approach. Seward, a community in the Prince William Sound area, suffered an extensive damage and 12 fatalities during the 1964 tsunami. The most destructive waves in Seward were local slump-generated tsunamis. We consider several tsunami scenarios for Seward inundation mapping that include both tectonic and landslide sources.

OS33B-08 1330h POSTER

Tsunami Risk Estimations for Black Sea Coast Using Method of Synthetic Catalogue

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Tsunami problem for the Black Sea is discussed by comparing historical, instrumental and numerical data. There are 22 tsunami events documented in the Black sea since 1st century and eight of them have occurred in 20th century. The numerical simulation of tsunami propagation is performed by using the framework of the shallow-water theory for the 1966 and 1939 events. The directivity of tsunamis in the Black sea is studied. The distribution of maximum positive tsunami amplitudes along the north and south coasts are obtained for each event. The instrumental data of tide gauge records for these two tsunamis are presented. The computed arrival time and the tsunami amplitudes at the tidal gauge stations are compared with the instrumental data. The features of tsunami manifestation in the coastal zone for various source locations are discussed. It is shown, that the lognormal distribution in the best way describes tsunami wave height distribution along a coast. The most dangerous (in respect to distant tsunami waves) regions of the coast are marked out.

OS33B-09 1330h POSTER

Development of New Accurate, High Resolution DEMs and Merged Topographic-Bathymetric Grids for Inundation Mapping in Seward Alaska

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The Geophysical Institute of the University of Alaska Fairbanks and the Alaska Division of Geological and Geophysical Surveys continue to participate in the National Tsunami Hazard Mitigation Program by evaluating and mapping potential inundation of selected coastal communities in Alaska. Seward, the next Alaskan community to be mapped, has excellent bathymetric data but very poor topographic data available. Since one of the most significant sources of errors in tsunami inundation mapping is inaccuracy of topographic and bathymetric data, the Alaska Tsunami Modeling Team cooperated with the local USGS glaciology office to perform photogrammetry in the Seward area to produce a new DEM. Using ten air photos and the APEX photogrammetry and analysis software, along with several precisely located GPS points, we developed a new georeferenced and highly accurate DEM with a 5-meter grid spacing. A variety of techniques were used to remove the effects of buildings and trees to yield a bald earth model. Finally, we resampled the new DEM to match the finest resolution model grid, and combined it with all other data, using the most recent and accurate data in each region. The new dataset has contours that deviate by more than 100 meters in some places from the contours in the previous dataset, showing significant improvement in accuracy for the purpose of tsunami modeling.

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