waves the following mechanisms are considered: dispersion enhancement of transient wave groups, geometrical focusing in basins of variable depth, and wave-current interaction. Taking into account nonlinearity of the water waves, these mechanisms remain valid but should be modified. Also, the influence of the nonlinear modulational instability (Benjamin-Feir instability) on the rogue wave occurence is discussed. Specific numerical simulations were performed in the framework of classical nonlinear evolution equations: the nonlinear Schrödinger equation, the Davey - Stewartson system, the Korteweg - de Vries equation, the Kadomtsev - Petviashvili equation, the Zakharov equation, and the fully nonlinear potential equations. In particular, the experimental data recorded in the North and Black Seas are simulated to determine the lifetime of the freak waves.

OS23A CC: 524 C Tuesday 1330h

Coastal Region Dynamics I

Presiding: **K Lamb,** University of Waterloo**; A C Warn-Varnas,** Naval Research Laboratory, Stennis Space Center

OS23A-01 1330h INVITED

Propagation of Ocean Acoustic Fields Through Shallow-Water Internal Waves

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Under certain conditions when an ocean acoustic wave propagates through and interacts with shallow water internal waves, the acoustic wave can suffer an abrupt reduction in intensity that extends over a narrow band of acoustic frequencies. This “anomalous loss” in signal was measured by Zhou, et al. (1991), and attributed to a “resonance” effect caused by acoustic mode conversions that occurred when the acoustic fields interacted with the internal wave fields. Numerous subsequent field experiments and computer model simulations have verified this intensity loss, and the acoustic mode conversions hypothesis. We review the physical mechanisms and environmental conditions that are necessary for this loss in acoustic signal to occur, and present computer simulations with analysis that illustrate the “resonance” effect. The simulations indicate that for the anomalous signal loss to occur, a complex set of environmental conditions must first occur that involves a lengthy portion of the ocean volume and ocean bottom (rather than just a short range “snap shot” of the ocean volume). Since the solitary internal wave fields are slowly evolving, and the acoustic signals are near-instantaneous and often broad band in frequency, the opportunity for fulfilling the conditions needed to produce anomalous signal losses is quite prevalent. [Work supported by ONR/NRL.]

OS23A-02 1350h

Winter Primer4 Ocean-Acoustic Dynamics and Energy Structures.

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Solitary wave generation and propagation simulations are conducted with the Lamb(1994) nonhydrostatic model in conjunction with winter Primer4 data. The model simulation parameters are adjusted until the structures of the simulated wave packets compare favorably with the measured data, in period and amplitude. Acoustical field calculations are performed with a parabolic equation acoustical model along the path of solitary wave train propagation. Comparisons of time series spectra are undertaken between the thermistor chain data and the corresponding observation mooring post in the model. The variance spectra of the data and model moorings show the presence of semidiurnal tidal and internal solitary wave energies. In addition two other moorings are placed in the model domain, one 10km to the right and another 10km to the left. The mooring locations are in the vicinity of bores of depression, first appearance of solitary waves, and well developed solitary waves of elevation. The analysis of model variance spectra, at the three moorings, exhibits a conversion of energy from the semidiurnal tidal band to the internal solitary waves band as one moves up onto the shelf through the three moorings. The internal solitary wave energy increases and the semidiurnal tidal energy decreases. This indicates energy conversion from the barotropic tide to the baroclinic tide and into internal solitary waves. Calculation of acoustical intensity in conjunction with model predicted internal bore and solitary wave train structures on the shelf indicate significant fluctuations of acoustical intensity in the spatial and temporal bands. In some cases these fluctuations in acoustic intensity are similar to that observed by Zhou, et al., resulting in anomalous losses; however, in other cases these fluctuations can produce significant gains in acoustic intensity. Although such gains were not reported by Zhou, et al., we have observed them in our coupled ocean-acoustic model studies of winter Primer4 solitary waves. [Work supported by ONR/NRL.]

OS23A-03 1405h

Shoaling Internal Solitary Waves

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Shoaling large amplitude internal solitary waves (ISWs) are common in the coastal ocean environment. In this talk the properties of exact, fully nonlinear ISWs will be discussed and compared with the predictions of weakly nonlinear theory. Numerical simulations of their shoaling behaviour will be presented using a variety of stratifications which exhibit different shoaling behaviours

OS23A-04 1420h INVITED

Life-Time Of Internal Solitary Waves On Oceanic Shelves Based On Numerical Simulations

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Due to the horizontal variability of oceanic hydrology (density and current stratification) and the variable depth over the continental shelf, internal solitary waves transform as they propagate shorewards into the coastal zone. If the background variability is smooth enough, a solitary wave possesses a soliton-like form with varying amplitude and phase. This stage is studied in detail in the framework of the variable-coefficient extended Korteweg-de Vries equation where the variation of the solitary wave parameters can be described analytically through an asymptotic description of a slowly-varying solitary wave. Direct numerical simulation of the variable-coefficient extended Korteweg-de Vries equation is performed for several oceanic shelves (North-west Shelf of Australia, Malin Shelf Edge, Arctic Shelf) to demonstrate the applicability of the asymptotic theory. It is shown that the solitary wave may maintain its soliton-like form for large distances (up to 100 km), and this confirms why internal solitons are observed widely in the world's oceans. In some cases the background stratification contains critical points (when the coefficients of the nonlinear terms in the extended Korteweg-de Vries equation change sign), or does not vary sufficiently smoothly; in such cases the solitary wave deforms a group of secondary waves. This stage is studied numerically. These results are used to estimate the life-time of the internal solitons on oceanic shelves.

OS23A-05 1435h

Physical Oceanographic Conditions in Barkley and Clayoquot Sounds, British Columbia Canada - Late Summer 2000-2003

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The physical oceanographic conditions in the inlets and fjords of Barkley and Clayoquot Sounds along the outer coast of Vancouver Island have been explored for the past four years as part of a five-year multidisciplinary project that involves faculty and undergraduates from three institutions. Temperature, salinity, density, oxygen and chlorophyll sections from 2000 through 2003 will be presented and compared. Many of these fjords contain anoxic bottom waters with renewal times on the order of months to years. During 2000, the visited inlets were all anoxic, yet during the summer of 2001 many of the inlets turned over, resulting in large fish kills. A number of inlets were again anoxic in 2002 and 2003. Understanding the local and regional physical oceanographic conditions and mechanisms that lead to these fish kill events is an important factor in determining the future health and function of these estuaries.

OS23A-06 1450h

The New York Harbor Observation System (NYHOS): Preliminary Results on Real-Time Quality Control of Hourly Reported Data

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The New York Harbor Observation System is a regional integrated system dedicated to monitoring the New York Harbor area through model-directed observations and model forecast for security and surveillance purposes. Observations encompass a unique combination of sensors, both at fixed stations and upon dynamic platforms. Measurements include surface and bottom CTD (YSI) from numerous shore-side and buoy stations, moored ADCP (RDI) and bottom CTD (SeaBird) from a cross river transect, High Frequency radars (CODAR) as well as surface CTD (Seabird) from a series of ferries. The combined data allow an optimal fine coverage of the studied area of the order of $50km^2$, within a time window of 60 min. Transmission is performed hourly via wireless transmission (both UHF conventional radio and cellular), cable or regular telephone lines. In order to insure the quality of the newly collected data, we proceed in two steps. First, we test our data for quality control using the NDBC man-machine mix data control protocols. These protocols concern in particular data associated with physical processes, such as sea level, water temperature, conductivity and salinity. They focus on transmission errors, gross range and time-continuity checks and wind gust to wind speed checks, following D.B. Gilhousen (1998) specifications. We then test our data for quality control using protocols based on static as well as dynamic checks as proposed by Miller et al. (2003). We address in particular spatial and temporal data disparity resulting from the operational mode of the instrumented ferries using wavelets following Mallat, (1998). Assuming the physical data is temporally constant within a one hour time frame, the fine model grid, used by the system's nowcast and forecast model, is filled using simple data interpolation. The modified data persistence analysis can then be used as background for horizontal consistency checks. Results of the two approaches are compared in terms of detection percentage and false alarm percentage. Shore-based and moored CTD are used as reference values to test the ferry data when possible. Then, results on salinity and temperature disparities in the New York harbor as

functions of space and time scales are shown. Adapted algorithms, derived from these results, are discussed in details.

OS24A CC: 524 C Tuesday 1530h

Coastal Region Dynamics II

Presiding: **K Lamb,** University of Waterloo**; A C Warn-Varnas,** Naval Research Laboratory, Stennis Space Center

OS24A-01 1530h INVITED

Seasonal Variability of Internal Tides and Associated Nonlinear Internal Waves on the New Jersey Continental Shelf

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Internal tides and associated internal wave packets generated by tidal flow over bathymetry variability have been observed on the New Jersey Shelf during the summer, fall and winter seasons. In mid summer the mixed layer was thin and the seasonal thermocline was near the ocean surface. The internal wave packets were mode 1 nonlinear waves of depression. In the early fall the mixed layer thickness was nearly half the water column depth. Depending on their location within the internal tide the internal wave packets were composed of either depression or elevation waves. In addition, interfacial mode 2 internal waves were observed. In the winter the mixed layer was often more than 3/4 of the water column depth in thickness. The mixed layer often lay on an intruding slope water front. Internal tides and internal waves of elevation, some of large amplitude, were observed during this time period. This work was supported by The Office of Naval Research.

OS24A-02 1550h INVITED

Internal Tides in the Northern South China Sea

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Internal tides have been observed by the PI's of the ASIAEX acoustics/physical oceanography experiment at the continental shelf break south of China. The bathymetry favors generation of diurnal internal tides at this site because of near-critical bathymetry. The bathymetric slope is subcritical for semidiurnal internal tides. The diurnal internal tidal waves are seen to propagate upward as they move shoreward (phase velocity downward). They also steepen to form bores with associated packets of nonlinear high-frequency internal waves as they move into shallow water. The tide may be interacting with a surface reflection of itself at this point. The steepening occurs in a fraction of a wave period. The ratio of particle velocity to phase velocity is of order 0.2 for these waves. The energy flux of the diurnal waves has an average value of about 1000 W/m, and a peak value at spring tide of over 2000 W/m. This energy flux happens to be close to that of large high-frequency internal waves moving into the area from the Luzon Strait area to the east. The detailed observations of waves present an opportunity to compare internal tide generation and nonlinear internal wave generation theories and simulations to detailed field data. The spatially broad internal tides have first-order effects on the acoustic wave guide and thus influence signal propagation, whereas the short nonlinear waves produce sound-speed perturbations that produce high-frequency signal fluctuations.

OS24A-03 1605h

On the Formation and Cirulation of the Intermediate Waters of the Gulf of St. Lawrence

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The Gulf of St. Lawrence is a seasonally ice covered northern shelf sea that exhibits strong interannual variability in its water mass characteristics and circulation. In summer, the vertical water column in the Gulf is comprised of three layers: a warm and fresh surface layer, a deep saline layer of Atlantic slope waters, and a cold intermediate layer (CIL) which was formed during the previous winter. It is unclear, however, where and how the CIL is formed, how it circulates through the GSL, and to what extent inflowing waters from the Labrador Sea through the Strait of Belle Isle contribute to its formation. The results of a winter observation campaign that shed new information on these processes will be presented. The renewal of the CIL found in summer in the St. Lawrence Estuary is due to its advection into the region at the end of winter, rather than in situ formation. Deep mixing in the Estuary is prevented by strong winter surface stability, which remains high throughout winter. The observations also suggest an intensified bottom layer circulation during winter, with the intrusion of warm Atlantic waters, usually found deeper than 150 m, at depths near 30 m. A hindcast simulation of the winter 2002/3 was performed using a three-dimensional numerical ice-ocean model. The model reproduces the observed strong spring renewal event of the CIL into the Estuary, and helps to explain the role of local dynamics, including the stability of the Gaspé Current and the coupled circulation in the northwestern GSL, in controlling the exchange processes at depth. The model results suggest the existence of a stable offshore Gaspé Current, that is maintained by the combined effects of downwelling along the Gaspé coast and upwelling along the south coast of Anticosti Island. The results demonstrate that lateral and vertical structures of the estuarine circulation in the GSL undergo a strong and well-defined seasonal cycle.

OS24A-04 1620h

Intercomparison of Third Generation Wave Models in Shallow Water

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For coastal engineering studies, as well as offshore oil platforms and related marine activities, wave information is required in shallow water areas where wind growth, bottom dissipation and wave-current interactions may be important. In this study the performances of three widely-used third generation numerical wave models, SWAN, WAM and WaveWatch-III (hereafter WW3) are evaluated through comparisons for accuracy, with *in situ* measurements, and with their computational efficiency. These models were adapted to the Northwest Atlantic in a set of four composite model systems: (a) the nesting of WAM in WAM, (b) WW3 in WW3, (c) SWAN in WAM and (d) SWAN in WW3. The models were driven with wind fields from two severe winter storms: the Superbomb of January 2000 and the Bomb of January 2002. On one hand, observations of peak waves from these storms are used to inter-compare the capabilities the wave models to simulate extreme waves. On the other hand, the capabilities of different instruments to measure those waves in shallow waters are discussed. Directional wave measurements were made using a conventional directional wave rider (DWR), and also by an acoustic Doppler current profiler (ADCP) co-located in shallow water. Additional deep-water measurements are available from non-directional wave riders (WR). Although all models provide skillful hindcasts for significant wave height (H_s) and for peak period (T_p), under-estimation of H_s at the peak of both storms, compared to observations, is evident. Moreover, we also present comparisons between models and 2-dimensional wave spectra. The recently released upgrade to the WW3 model shows some advantages over the other models, in these comparisons with measurements.

OS24A-05 1635h

Results of 3-D Travel Time Tomography Studies of the Gas Hydrate Bearing Sediments in Cascadia Region Offshore Vancouver Island

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The COAMS'99 experiment was one of a series of seismic and other surveys designed to study the gas hydrate field offshore Vancouver Island near the ODP 889/890 drill site. The presence of the gas hydrate was proven by the occurrence of the Bottom Simulating Reflector (BSR) on the seismic sections as well as by physical recovery of the gas hydrate samples. The experiment included multichannel COAMS streamer, single channel Teledyne streamer, and 5 Ocean Bottom Seismographs (OBS). The survey was targeted on a hydrocarbon vent site and the associated with it "blank zones" - zones of decreased seismic signal strength visible on seismic recordings. The nature of the blank zones at the site is quite speculative, since very little is yet known about the physical properties of the sediment environment. The paper reports results for a 3-D tomographic inversion that images the structure of the velocity field above the BSR around the most prominent blank zone. The seismic dataset used for picking of travel times consisted of 22 main grid parallel profiles and 3 cross lines recorded by the OBS's placed in proximity of the blank zone, and 15 lines of normal-incidence seismic data recorded by the Teledyne streamer. A 40 in. single airgun was used as controlled seismic source. The arrival time of seismic waves reflected from 4 interfaces (the deepest interface corresponds to the BSR) were inverted using a linearized travel time inversion code (JIVE3D by James Hobro). The resulting model with horizontal dimensions of 2.3 x 2.6 km and a volume cell size of 50(X)x50(Y)x20(Z) m reveals a positive velocity anomaly that spatially corresponds to the blank zone.

OS24A-06 1650h

A Controlled Source Electromagnetic Experiment for Gas Hydrate Assessment: First Results from the Chilean Margin

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Gas hydrates in seafloor sediments are recognized as an important future energy resource, a powerful greenhouse gas and the potential cause of submarine landslides. Gas hydrates are ice-like solids consisting of a mixture of water and gas molecules, mainly methane, and are stable at low temperatures and high pressures. They have been found worldwide on continental margins and in permafrost areas. In general, a gas hydrate deposit can be identified on a seismic section by a so-called Bottom Simulating Reflector (BSR) which is associated with trapped free gas below the base of the hydrate stability zone (BHSZ), or the depth where the geothermal gradient intersects the hydrate stability curve. However, the area above the BSR is often invisible on seismic sections, which therefore, generally provide no information about hydrate concentration that is essential to resource assessment and hazard evaluation. Measurements of the electrical conductivity of seafloor sediments can be the key to the estimation of gas hydrate concentrations. The relation between conductivity and porosity is given by Archie's law. In the hydrate layer, insulating hydrate forms in pore spaces and replaces conductive pore fluid and subsequently increases the bulk resistivity. Exact conductivity measurements therefore allow estimation of hydrate concentration. A controlled source electromagnetic (CSEM) method has been developed at the University of Toronto and has been tested on the Cascadia Margin. In March 2003 the group was invited to take part in a Chilean project to explore the gas hydrate deposits along the Chilean Margin. Data have been collected in 3 different areas. The data show little variation within the respective areas and are comparable to those obtained in the Cascadia Margin. At this stage of the data analysis, there is no observed correlation between conductivities and preliminary BSR locations from seismic data. Two scenarios could be the cause for this disagreement: a) Hydrate is everywhere, and therefore we see no anomalies, the conductivities are uniform. The BSRs are patchy since free gas is not throughout available. b) The hydrate concentration is not high enough to make any anomaly, even if there is a BSR.

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