MASTER OF SCIENCE
IN
METEOROLOGY AND PHYSICAL OCEANOGRAPHY

OCEANOGRAPHY OBSERVED DIRECTIONAL SPECTRA OF SHOALING AND BREAKING WAVES

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The evolution of the frequency-directional wave spectrum, E(f, 0), across the inner continental shelf and beach was examined with measurements collected at the U.S. Army Corps of Engineer's Field Research Facility during the recent SandyDuck experiment. Arrays of bottom pressure sensors were deployed on the shelf in 20 m depth and on the beach in depths ranging from 2 - *5* m. These arrays were complemented by a directional wave buoy in 20 m depth and an array of pressure sensors in 8 m depth maintained by the U.S. Army Corps of Engineers. A preliminary analysis of these data is presented here focused on four case studies that illustrate the observed wave shoaling evolution in both non-breaking and breaking conditions. Estimates of E(f,0) extracted from array cross-spectra at six cross-shore locations are compared to predictions of linear refraction theory. The present observations support conclusions from previous studies that the cross-shore evolution of dominant wave propagation direction is well described by linear refraction theory. Observations of harmonic peak development at directions aligned with the dominant waves are consistent with theoretical wave-wave interaction rules and previous observations. In both non-breaking and breaking conditions, the observed E(f, 0) are directionally broader than predicted. In contrast to previous observations on a barred beach, the present observations on a planar beach do not show a dramatic broadening of directional wave spectra in the surf zone.

DoD KEY TECHNOLOGY AREA: Other (Environmental Prediction)

KEYWORDS: Ocean Surface Gravity Waves, Directional Wave Spectra, Surf Zone, Wave Shoaling, Beach

COMPARISON OF LIDAR AND MINI-RAWINSONDE PROFILES

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Current Light Detection and Ranging (LIDAR) technology allows for remotely sensed, real-time measurement of most atmospheric properties including structure, dynamics and primary chemical constituents. The LIDAR Atmospheric Profile Sensor (LAPS) instrument, completed in April 1996 at the Applied Research Laboratory/Pennsylvania State University (ARL/PSU), was developed as a prototype sensor for continuous, automated atmospheric soundings aboard aircraft carriers, advanced-radar combatants and shore stations. These data can then be used to calculate the atmospheric refractivity profiles for electromagnetic propagation prediction and as input to system performance assessments.

This report shows the advantages and disadvantages of LAPS atmospheric data as compared to the MRS sounders currently in use. LAPS can provide an accurate, continuous on-demand real-time data, is able to characterize variations in the marine boundary layer, and does not require cumbersome logistic support (e.g., helium bottles and balloons). The

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present weaknesses of LAPS are its relatively coarse vertical resolution, degraded daytime data due to scattering, sometimes erratic temperature measurements, and ship's gas absorption.

DoD KEY TECHNOLOGY AREA: Sensors

KEYWORDS: Lidar, Laps, Mini-rawinsonde, USNS Sumner (T-AGS 61)

STRUCTURE AND VARIABILITY OF THE MESOSCALE CIRCULATION IN THE CARIBBEAN SEA AS DEDUCED FROM SATELLITE ALTIMETRY

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Four years of Topex/Poseidon (TIP) and European Remote Sensing Satellite (ERS) altimetry data in the Caribbean Sea are used to describe the structure and variability of the mesoscale circulation in this area. These results are compared with satellite-derived sea surface temperature (SST) and drifter trajectories for the same period of time. Contour maps of sea surface height anomalies made for each 10-day period (TIP data) reveal the formation and evolution of anticyclonic and cyclonic mesoscale features in the central part of the Caribbean Sea during the entire period studied. These features move westward at average speeds between 10 and 15 cmls, growing in amplitude up to 25 cm. Also, a quasi-permanent gyre is detected in the Golfo de los Mosquitos (coast of Panama and Colombia). The sense of rotation of this gyre is shown to be modulated seasonally. Enhanced relative clockwise and counterclockwise rotation are observed during the rainy season (June-October) and the dry/windy season (January-April), respectively. No strong mesoscale anomalies are detected in the eastern part of the Caribbean Sea where they are expected. A seasonal cycle is found in the sea level anomaly (SLA) derived from TIP and ERS-1 data due to steric effects. Upwelling is observed near the coast of Venezuela during the dry season. A comparison of SLA with SST is made and good correlation is observed at some locations. Drifter trajectories contemporaneous with SLA data agree well with the sense of rotation of strong features, but the drifter speeds are twice the absolute geostrophic currents calculated from SLA.

DoD KEY TECHNOLOGY AREAS: Environmental Quality, Sensors

KEYWORDS: Caribbean Sea, Topex/Poseidon (TIP), ERS-l, Mesoscale Variability, Eddies, Sea Level Anomal (SLA), Satellite Altimetry

IDENTIFICATION OF ACOUSTICALLY ACTIVE ARCTIC PRESSURE RIDGES THROUGH THE USE OF RADARSAT GEOPHYSICAL PROCESSOR SYSTEM (RGPS) SEA ICE PRODUCTS

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The identification of acoustically active pressure ridges in the Arctic Ocean represents an important step in the development of a physics-based, operational Polar ambient noise model. One method to accomplish this goal is through the use of satellite-based remote sensors, specifically synthetic aperture radar (SAR).

A proof-of-concept study was conducted that determined that the RADARSAT Geophysical Processor System (RGPS), currently being developed at NASA JPL, Pasadena, CA, produces SAR-derived sea ice products capable of quantifying large-scale ice deformation that may produce significant levels of low frequency ambient noise.

This research also identifies the meteorological forcing that causes the sequence of divergent and convergent events in the ice cover, which results in the creation of open water leads and subsequent generation of noisy pressure ridges. Offshore followed by onshore winds near coasts and land-fast ice and atmospheric lows/troughs followed by atmospheric highs/ridges or velocity shear in straight isobaric flow result in significant pressure ridge formation.

The RGPS ridging algorithm shows that more ridges exist in RGPS cells exhibiting large cell area changes than in those with small area changes, assuming relatively constant sail heights in all cells.

The feasibility of using ice divergence fields generated by Fleet Numerical Meteorology and Oceanography Center's (FNMOC's) Polar Ice Prediction System (PIPS) was evaluated. NIPS modeled ice divergence patterns reasonably well, although divergence values in the high Arctic ice cover were underestimated.

DoD KEY TECHNOLOGY AREA: Other (Remote Sensing, Arctic Ocean)

KEYWORDS: Polar Oceanography, Pressure Ridges, Open Water Leads, Ice Deformation, Synthetic Aperture Radar, RADARSAT, Geophysical Processor System, Polar Ice Prediction System, Low Frequency Ambient Noise, Arctic Submarine Operations, Remote Sensing

THE ROLE OF SALINITY IN EQUATORIAL MIXED LAYERS

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The purpose of this study was to understand the role of surface salinity flux in changing heat exchange between the ocean and the atmosphere by means of its effect on mixed layer dynamics. This was accomplished by a series of thirty-day mixed layer experiments using the one-dimensional Naval Postgraduate School (NPS) mixed layer model. Results from the NIPS mixed layer model, forced with both idealized and in situ data from the western equatorial Pacific Ocean, demonstrated that salinity can play a significant role in potentially changing the surface heat flux, with its effect on the mixed layer depth and mixed layer temperature. Precipitation stabilized the mixed layer by creating a barrier layer, which slowed entrainment. The net accumulation of rain was found to be an important source of buoyancy that reduces entrainment by subsequent wind mixing events.

DoD KEY TECHNOLOGY AREA: Battlespace Environments

KEYWORDS: Oceanic Mixed Layer, Salinity, Ocean Models