MASTER OF SCIENCE
IN
PHYSICAL OCEANOGRAPHY

OBSERVED KINEMATICS OF WAVES IN THE SURF ZONE
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The observed kinematics of waves in the surf zone is examined with extensive measurements from the DUCK94 experiment. Field data used in the study were obtained from vertical stacks of bi-directional current meters and a pressure sensor mounted on a rigid frame at 3 locations along a cross-shore transect in depths of 2, 4, and 8m. Observed pressure and velocity spectra are compared to transfer functions based on linear finite depth theory and a simple nonlinear model that accounts for harmonic generation in shallow water. At high frequencies, the observed vertical attenuation of horizontal velocity spectra in 8 and 4m depth is much weaker than predicted by linear theory, and generally in good agreement with the nonlinear model predictions. In 2m depth, differences between the linear and nonlinear transfer function are small and both predictions are in reasonable agreement with the observed weak vertical decay. At infragravity frequencies in shallow water depths, observed velocity spectra often show significant vertical decay that is not predicted by either model. Velocity and pressure spectra measured in 4m depth are in good agreement with the nonlinear transfer function. Pressure spectra levels at high frequencies are shown to be significantly reduced by the nonlinear Bernoulli term in the second order pressure field. Analysis of the slopes of the high-frequency tails of the observed velocity spectra shows considerable scatter with a general tendency for spectra to flatten as waves propagate through the surf zone.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Nearshore Processes, Surf Zone, Waves

MAPPING COASTAL SURFACE WINDS IN MONTEREY BAY USING HIGH FREQUENCY RADAR
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Over-water wind directions derived from high frequency (HF) radar - the new Multi-frequency Coastal Radar (MCR) - are compared to in-situ observations to determine the skill of the radar measurements. Conventional beam processing of data collected from two MCR sites located around Monterey Bay during summer 1997 is used to create wind directions based on the relative strength of the positive and negative Bragg-resonant peaks, which correspond to the wind-driven waves approaching and receding from the radar, respectively. Based on a selected functional relationship that converts the radar signal to wind direction, radar-derived wind directions are created using a new wind-retrieval algorithm and are compared to mooring observations under a variety of wind conditions. Analysis indicates that the signal not only follows wind direction, but also strongly correlates to the wind speed measured at the mooring. Results show that many of the Bragg peaks are close to the noise level, and consequently, low signal-to-noise ratios restrict the statistical confidence of the measurements. Nonetheless, maps of radar-derived wind directions show good agreement with in-situ observations, especially when the wind speed is relatively strong and is sustained for long duration.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Sensors

KEYWORDS: HF Radar, Diurnal Winds, HF Surface Current Radar, Mesoscale Circulations, Monterey Bay Circulation, Wind Direction, Sea Breeze, Surface Winds, Multi-Frequency Radar, Wind Maps

A MODELING STUDY OF THE COASTAL EASTERN BOUNDARY CURRENT SYSTEM OFF IBERIA AND MOROCCO

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To investigate the northern Canary Current system (NCCS), results from four numerical experiments of increasing complexity are examined. Experiment one, which uses seasonal wind forcing only, shows that, as expected, wind forcing is the key generative mechanism for the current, upwelling, meander, eddy, and filament structures. Experiments two and three have the addition of an irregular coastline. These two experiments show that capes are areas for enhanced upwelling, extensive filaments, maximum current velocities, and enhanced growth of cyclonic meanders and eddies. Also, an embayment like the Gulf of Cadiz is a primary region for anticyclonic meander and eddy development. A fourth experiment has the additional effects of thermohaline gradients and Mediterranean Outflow. This complex regime has features similar to NCCS observations, including the generation of Eddies.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Canary Current, Eastern Boundary Currents, Meanders, Eddies, Filaments, Mediterranean Outflow

PROPAGATION SPEEDS OF OCEAN SURFACE WAVES IN SHALLOW WATER

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Nonlinear effects on the dispersion relation of waves in shallow water are examined with measurements collected on a mild sloping sandy beach during the recent Sandy Duck experiment. Four arrays of bottom pressure sensors were deployed in depths ranging from 3–6m during August-November 1997. For each of these arrays, a root-mean-square average wavenumber was estimated as a function of frequency from the cross-spectra of one-hour-long pressure records. The observed wavenumbers are compared to linear finite depth theory predictions and to predictions based on a stochastic formulation of weakly nonlinear Boussinesq equations that incorporate both frequency and amplitude dispersion effects. The observed wavenumbers are generally in agreement with the nonlinear theory predictions and deviate significantly (maximum errors averaged over the spectrum of about 25%) from the linear theory predictions. In high energy conditions with breaking or nearly breaking waves, the effects of amplitude and frequency dispersion tend to cancel, and all components of the wave spectrum travel with approximately the shallow water wave speed. These results are consistent with previous studies.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Nearshore Processes, Surf Zone, Waves

ADRIATIC SEA SURFACE TEMPERATURE: SATELLITE AND DRIFTER OBSERVATIONS, MAY TO OCTOBER, 1995

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The Adriatic Sea is the northernmost semi-enclosed basin of the Mediterranean Sea and has been the subject of various oceanographic studies since the 19th century. Substantial changes in water properties (such as temperature) and in circulation, both spatially and temporally (seasonal) occur as a result of extreme forcing by the local winds and by the freshwater discharge by rivers. In recent years, extensive measurements have been made, primarily through remote sensing techniques. In particular, satellite infrared data were used to study the surface thermal features and associated circulation.

In order to improve upon previous results, this study focuses on a period of 6 months (May to October 1995) in which the full resolution (1.25x1.25 km) satellite images are used to describe and study the variability of the sea surface temperature (SST) and circulation from meso- (days) to seasonal (months) scales. The satellite infrared temperatures are compared to simultaneous and collocated in-situ drifter temperature measurements. They are corrected by removing biases obtained by regression analysis. The corrected images are used to produce maps representing daily, three-day, weekly and monthly Adriatic SSTs. Selected SST composites augmented with drifter overlays disclose important quantitative features of the Adriatic surface waters. The spatial structure and temporal variability of the surface fields are presented and discussed.

DoD KEY TECHNOLOGY AREA: Environmental Quality

KEYWORDS: Adriatic, Sea Surface Temperature, Drifters