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ENVIRONMENTAL DESCRIPTORS FOR OCEAN BUBBLES AND ACOUSTIC SURFACE BACKSCATTER

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LONG-TERM GOALS

This work will contribute to the development of a global, physics-based model with readily observable air-sea inputs (i.e., via satellite) for the prediction of acoustic surface scatter in littoral and open-ocean environments.

SCIENTIFIC OBJECTIVES

The primary objectives of this study were to (1) describe the influence of bubble-related physical and biological factors on surface scattering strength (SSS), and (2) advance the development of surface wave descriptors for near-surface bubbles and acoustic backscatter.

APPROACH

A diverse set of observations made during the Critical Sea Test (CST) field program was employed to empirically relate deviations from Ogden-Nicholas-Erskine (ONE) SSS model predictions to various physical and biological factors related to the supply, mixing, and removal of upper ocean bubbles. Furthermore, new surface wave descriptors were calculated from observed directional wave spectra using a wave spectral partitioning approach to isolate wind seas, and an extension of Phillips' (1985) Equilibrium Theory was used to estimate the total rate of wave dissipation by breaking. The dependence of wave dissipation rate on ocean surface whitecap coverage was described empirically.

WORK COMPLETED

A preliminary assessment of the physical and biological factors most important for SSS site-to-site differences has been accomplished. In addition, a fully automated method for surface wave spectral partitioning, swell tracking, and storm source identification using MATLAB programming tools has been developed. These tools were used to successfully generate surface wave descriptors for air-sea processes models.

RESULTS

1. Biological productivity significantly increases SSS in the open ocean. This is likely due to increased dissolved gas levels and the presence of biochemical surfactants.
2. SSS is higher in warm water. This is probably a result of increased bubble supply and extended bubble lifetimes due to viscosity, surface tension, and gas solubility effects.
3. SSS increases in higher-energy environments. It is likely that elevated turbulence levels result in more entrained bubbles.
4. Wave spectral partitioning can be employed to extract wave descriptors for bubble related processes in the ocean.
5. Wave dissipation rate improves the standard power-law model for the prediction of ocean whitecaps.

IMPACT/APPLICATIONS

Physical and biological factors will amplify SSS variability in shallow water. These results demonstrate that a model could be developed for estimating SSS statistics in coastal areas using readily available (by satellite and operational models) inputs. The wave partitioning technique has several important applications, including the reduction and validation of global wave data sets, storm wave forecasting, and air-sea process modeling.

TRANSITIONS

The wave spectral partitioning approach is being used to examine acoustic surface interactions in the Forward Barrier program (J. M. Griffin /Code N875D).

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