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SUBJECT: Final Technical Report
ONR Award No. N00014-97-1-0621
PI: Robert Guza

Enclosed for your records is the final technical report for the above referenced grant.

Very truly yours,

UCSD/Scripps Institution of Oceanography

Ann F. Dunbar
Contract & Grant Specialist

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This ASSERT award supported PhD dissertation research concerning breaking-wave driven circulation in the surf zone.

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AASERT Student in Nearshore Fluid Dynamics
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Robert T. Guza

This ASSERT award was used to support PhD students Falk Feddersen and T. James Noyes. Their thesis studies concern ocean surface gravity waves and the gravity-wave driven circulation in shallow water. Intense wave breaking within the surf zone dissipates large amounts of energy and drives strong quasi-steady flows (e.g. alongshore currents greater than 100 cm/sec are not unusual) that transport sediment and are important to Navy missions. The strong nonlinearity and dissipation within the surf zone results in complex dynamics that are not amenable to straightforward theoretical approaches and many important conceptual advances have been substantially guided by field observations. The analysis and interpretation of data from experiments on natural beaches are the central element of the ongoing ONR supported parent program. The overall, long-term objective of the parent grant is to observe and model the coupling between complex and changing topography, waves, and nearshore circulation. The specific goals of the parent grant during the Assert award period were to observe and model (as part of the SandyDuck nearshore experiment) the wave-driven circulation on a natural beach.

Dr Falk Feddersen successfully completed his PhD while supported by this grant. As described in the publications and abstracts listed below, Feddersen investigated the alongshore momentum balances that control the dynamics of the mean alongshore current in the surf zone and the accuracy of various bottom stress parameterizations.

T. James Noyes is studying shear waves, the instabilities of the mean wave-driven alongshore currents. The dependence of shear wave energy and mixing on the mean alongshore current, the bathymetry, and the offshore wave conditions is not well understood. Weakly unstable mean currents could give rise to low energy shear waves with a negligible effect on the mean flow. Such shear waves might consist of small (but finite amplitude) unstable modes predicted by linear stability theory. In contrast, fully nonlinear numerical models suggest that strongly unstable currents produce instabilities that roll up into eddies that are tens of meters in diameter. In this regime, the instabilities have a major impact on the cross-shore flux of mean alongshore momentum and therefore significantly alter the mean flow.

Shear waves typically have wavelengths of a few hundred meters and periods of a few hundred seconds. Infragravity waves with similar periods have longer wavelengths. Frequency-alongshore wavenumber spectra estimated from alongshore array data have previously been used to estimate the fraction of the total velocity variance contributed by shear waves. However, data were available from only a single alongshore array, so the cross-shore structure of shear waves was not investigated. Noyes' study uses data collected with five 200-m long alongshore arrays of current meters deployed between about 1- and 5-m water depth near Duck, NC. When the mean alongshore current was strong, shear wave velocity variance decayed rapidly seawards of its maximum near the sand bar crest and the maximum of the mean current. A shear wave climatology was constructed from the approximately 270 hours of observations when the mean alongshore current was strong enough to produce detectable shear waves. For a wide range of conditions, the cross-shore structure of shear wave cross-shore and alongshore velocity variance are being related to properties of the mean flow (maximum alongshore speed, maximum cross-shore shear), the bathymetry, and the incident wave field. In addition, numerical simulations of selected cases are being compared with the observations.

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