Final Technical Report for the Project:

NEARSHORE WAVE PROCESSES, N00014-94-1-1185

1997

Long Term Goal

The long term goal of this project was to obtain accurate, detailed predictions of wave properties in the nearshore given the incident wave conditions and local bathymetry, and thus allow for confident simulation of the forcing mechanisms in models that couple wave-driven flows, sediment transport, and changing bathymetry. For the last three years efforts have been focussed on analyzing wave observations made in the Duck94 field experiment and obtaining new observations during the SandyDuck field experiment.

Analysis of Duck94 Observations

One-dimensional Boussinesq shoaling wave models have been compared with observations made on the cross-shore transect of the Duck94 pilot experiment (Elgar et al. 1997, Chen et al. 1997, Norheim et al. 1997). The momentum balance described by the shallow water equations was verified by comparison with mean longshore currents observed along the Duck94 transect (Fedderson et al. 1997). A 1D morphological evolution model was shown to predict the offshore sandbar migration observed in Duck94 (Gallagher et al. 1997).

SandyDuck Field Experiment

The evolution of waves, currents, and bathymetry on a natural beach is being observed during the SandyDuck field experiment on the North Carolina coast. Pressure gages, current meters, and sonar altimeters were deployed in July 1997 on a two-dimensional grid extending 370 m from near the shoreline to about 5 m water depth and spanning 200 m along the coast. The grid is large enough to sample significant bathymetric inhomogeneities and their effects on wave evolution and circulation. Data have been acquired nearly continuously for more than 3 months (Aug – Nov 1997) and data return is greater than 97%. Significant processing is performed in near-real time, and maps of nearshore wave heights and directions, bathymetry, mean flows, and setup every 3 hours for 120 days have been produced. The spatially extensive instrument arrays will allow quantitative investigations of sea and swell, edge waves, shear waves, alongshore inhomogeneous circulation, and changing morphology.

A Boussinesq model for the nonlinear evolution of nonbreaking, directionally spread waves will be tested by comparison with the array observations. The model will be initialized with wave directional spectra estimated from pressure sensor array data acquired in 8-m water depth, and model predictions will be compared with wave observations at shallower depths.

A cross-shore transect of buried (to avoid flow-induced pressures) Paros pressure gages provides estimates of the wave-breaking induced setup. The observations will be compared with models for setup and with the corresponding offshore directed near-bottom flows (undertow).

References

Chen, Y., R. Guza, and S. Elgar, 1997 Modeling breaking surface waves in shallow water, J. Geophys. Res., in press.

Elgar, S., R. Guza, B. Raubenheimer, T. Herbers, and E. Gallagher, 1997 Spectral evolution of shoaling and breaking waves on a barred beach, J. Geophys. Res. **102**, 15,797–15,805.

Fedderson, F., R. Guza, S. Elgar, and T. Herbers, 1997 Longshore momentum balances in the nearshore, J. Geophys. Res., sub judice.

Gallagher, E., S. Elgar, and R. Guza, 1997 Observations of sand bar evolution on a natural beach, J. Geophys. Res., in press.

Norheim, C., T. Herbers, and S. Elgar, 1997 Nonlinear evolution of surface wave spectra on a beach, J. Phys. Ocean., in press.

ONR-Sponsored Refereed Publications

Herbers, T.H.C., Steve Elgar, R.T. Guza, and W.C. O'Reilly, 1995 "Infragravity-frequency (0.005-0.05 Hz) motions on the shelf, Part II: Free Waves," J. Physical Oceanography 25, 1063-1079.

Elgar, Steve, T.H.C. Herbers, V. Chandran, and R.T. Guza, 1995 "Higher-order spectral analysis of nonlinear ocean surface gravity waves," Journal of Geophysical Research 100, 4977-4983.

Herbers, T.H.C., Steve Elgar, and R.T. Guza, 1995 "Generation and propagation of infragravity waves, J. Geophysical Research 100, 24,863–24,872.

Gallagher, Edith, B. Boyd, Steve Elgar, R.T. Guza, B.T. Woodward, 1996 Performance of a sonar altimeter in the nearshore, Marine Geology 133, 241–248.

Raubenheimer, B., R.T. Guza, and Steve Elgar, 1996 Wave transformation in the inner surf zone, J. Geophysical Research 101, 25,589–25,597.

Vanhoff, B., Steve Elgar, and R.T. Guza, 1997 Numerically simulating nonGaussian sea surfaces, ASCE J. Waterway, Port, Coastal, and Ocean Engineering 123, 68–72.

Elgar, Steve, R.T. Guza, B. Raubenheimer, T.H.C. Herbers, Edith Gallagher, 1997 Spectral Evolution of Shoaling and Breaking Waves on a Barred Beach, J. Geophysical Research 102, 15,797–15,805.

Vanhoff, B and Steve Elgar, Simulating quadratically nonlinear random processes, International J. Bifurcation and Chaos, in press.

Chen, Yongze, R.T. Guza, and Steve Elgar, Modeling breaking surface waves in shallow water, J. Geophysical Research, in press.

Gallagher, Edith, Steve Elgar, and R.T. Guza, Observations of Sand Bar Evolution on a Natural Beach, J. Geophysical Research, in press.

Raubenheimer, B., Steve Elgar, and R.T. Guza, Estimating wave heights from pressure measured in a sand bed, ASCE J. Waterway, Port, Coastal, and Ocean Engineering, in press.

Norheim, C., T.H.C. Herbers, and Steve Elgar, Nonlinear Evolution of Surface Wave Spectra on a Beach, J. Physical Oceanography, in press.

Feddersen, Falk, R.T. Guza, Steve Elgar, and T.H.C. Herbers, Longshore momentum balances in the nearshore, J. Geophysical Research, sub judice.

Elgar, Steve, T.H.C. Herbers, and R.T. Guza, 1997 Nearshore Observations of Nonlinear Ocean Surface Gravity Waves, Naval Research Reviews 48, 41–52 (INVITED).

ONR-Sponsored Proceedings and Conference Presentations

Vanhoff, B., S. Elgar, and R. T. Guza, Numerically simulating nonGaussian sea surfaces, Eos Trans. AGU 77, 394, 1996.

Raubenheimer, B., S. Elgar, and R. T. Guza, Wave attenuation in a sand bed, Eos Trans. AGU 77, 403, 1996.

Chen, Y., R.T. Guza, and S. Elgar, Modeling breaking surface gravity waves in shallow water, Eos Trans. AGU 77, 393, 1996.

Herbers, T.H.C., S. Elgar, and R.T. Guza, Directional spreading of shoaling and breaking waves, Eos Trans. AGU 77, 400, 1996.

Norheim, C., T.H.C. Herbers, and S. Elgar, A stochastic model for shoaling waves, Eos Trans. AGU 77, 400, 1996.

Feddersen, F., R.T. Guza, and S. Elgar, 1997 Investigating nearshore circulation using inverse methods, Proc. of Coastal Dynamics '97 Plymouth, ASCE, in press.

Feddersen, F., R.T. Guza, S. Elgar, and T.H.C. 1997 Cross-shore structure of longshore currents during Duck94, Proc. 25th Int'l Conf. Coastal Eng., ASCE, New York, in press.

Statistics

14 Papers published/in press, refereed journals
7 Proceedings/conference presentations
1 Undergraduate students supported
2 Graduate students supported
1 Post-docs supported
0 Other professional personnel supported

EEO/Minority Support

1 Female undergrad student
1 Female grad student
0 Minority grad students
0 Asian grad students
0 Female post-docs
0 Minority post-docs
0 Asian post-doc