Abstract View

Volume 18, Issue 11 (November 1988)

Journal of Physical Oceanography
Article: pp. 1465–1483 | Abstract | PDF (1.21M)

A Finite-Depth Wind-Wave Model. Part I: Model Description

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(Manuscript received October 16, 1987, in final form February 3, 1988)

DOI: 10.1175/1520-0485(1988)018<1465:AFDWWM>2.0.CO;2

ABSTRACT

A parametric windsea model for arbitrary water depths is presented. The model is derived from a conservation of energy flux formulation and includes shoaling, refraction, dissipation by bottom friction, as well as finite-depth modifications of the atmospheric input and nonlinear wave–wave interaction source terms. The importance of dissipation due to a rough ocean floor on the migration of the spectral peak frequency is discussed and compared with that caused by nonlinear energy transfer. Numerical simulations are used to systematically examine wave growth and the development of the spectral peak in a depth-limited ocean.

Two idealized situations of wave growth and propagation are considered to further understand the influence of bottom friction on the spectral dynamics. The first case studies the characteristics of fetch-limited wave growth in a steady, uniform wind as function of depth and bottom roughness. The second case examines the role of bottom dissipation on a fully developed deep-water spectrum propagating up a constant slope under a steady onshore blowing wind. For case 1 the growth curves and peak frequency development are plotted as a function of fetch, and wave spectra for infinite fetch and duration are shown for all depths and wave friction factors. For case 2 the evolution of total energy and peak frequency along the shelf slope are presented for stationary conditions as well as the stationary inshore energy spectra.

This numerical study reveals the following: (i) bottom friction is a finite-depth mechanism as important as the nonlinear energy transfer in controlling the spectral shape in shallow water, (ii) under the influence of bottom dissipation the positive energy transfer from wave–wave interactions to lower frequencies is reduced and causes the spectral peak to wander towards higher frequencies; (iii) equilibrium energy spectra in finite depth depend on depth and bottom roughness and occur when the nonlinear energy transfer and bottom friction source terms approximately balance each other.

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