Abstract View

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Shelf Wave Scattering due to Longshore Jump in Topography

John F. Middleton and Daniel G. Wright

Physical and Chemical Science, Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada

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ABSTRACT

The scattering of barotropic shelf waves by an abrupt jump in longshore topography is examined for unbounded and bounded exponential shelves by matching modal representations for longshore transport and sea level. Estimates of the ratio of transmitted to incident energy flux, F_T/F_I, are obtained for a bounded shelf (i.e., with coastal and offshore walls) using an asymptotically exact first-order differential equation for streamfunction that is derived from the matching conditions at low frequencies. The equation is shown to represent the production of relative vorticity, manifest as backscattering waves, due to vortex stretching induced by flow over the jump. At low frequencies, low mode waves exhibit a strong tendency to propagate along f/h contours even as the jump is crossed and scattered energy is found to reside mainly in the gravest reflected and transmitted modes. Results agree with corresponding low frequency solutions derived using a direct mode-matching procedure. At higher frequencies the solutions determined using the mode matching procedure fail to conserve energy: possible explanations are discussed. For unbounded shelves a simple analytical expression for the ratio of transmitted to incident energy flux, F_T/F_I, is derived and used to show that (i) transmission decreases with increasing jump size, (ii) a topographic jump acts to pass (retard) incident modes which have cross-shelf scales that are larger (smaller) than that of the topography, (iii) F_T/F_I is a maximum and essentially constant at frequencies much less than that of the zero in incident wave group speed, σ_I, and (iv) that F_T/F_I monotonically decreases to zero as frequency approaches σ_I. These results also summarize the qualitative nature of the approximate solutions for a bounded shelf determined using the mode matching technique. The analysis suggests that results may be applicable to scattering by smooth jumps provided the longshore topographic scale is less than half the shelf width.

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Headquarters: 45 Beacon Street Boston, MA 02108-3693
DC Office: 1120 G Street, NW, Suite 800 Washington DC, 20005-3826
amsinfo@ametsoc.org Phone: 617-227-2425 Fax: 617-742-8718
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