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Resonant coupling of mode-1 and mode-2 internal waves by topography

Zihua Liu, Roger Grimshaw, and Edward Johnson
University College London, FACULTY OF MATHEMATICAL AND PHYSICAL SCIENCES, Department of Mathematics, London, United Kingdom of Great Britain and Northern Ireland (zihua.liu.15@ucl.ac.uk)

We consider the resonant coupling of mode-1 and mode-2 internal waves by topography. The mode-2 wave is generated by a mode-1 internal solitary wave encountering variable topography in the framework of a pair of coupled Korteweg-de Vries (KdV) equations. Three cases (A) weak resonant coupling, (B) moderate resonant coupling, (C) strong resonant coupling, are examined using a three-layer fluid system with fixed total depth but different layer thicknesses, and each case has two different topographic slopes, gentle and steep, respectively. The criterion for the strength of the resonant coupling is the ratio of the linear phase speeds c_2 for mode-2 and c_1 for mode-1 waves. This ratio c_2/c_1 varies from 0.42-0.48 (A), 0.58-0.72 (B), to 0.44-0.92 (C). The simulations using the coupled KdV model are compared with a KdV model for the evolution of a mode-1 wave alone. In case (A) a convex mode-2 wave of small amplitude is generated by a depression incident mode-1 wave and the feedback on mode-1 wave is negligible. In case (B) a concave mode-2 wave of comparable amplitude to the incident mode-1 wave is formed from a depression incident mode-1 wave; strong feedback enhances the polarity change process of the mode-1 wave. In (C) a concave mode-2 wave of large wave amplitude with wave fission is produced by an elevation incident mode-1 wave; strong feedback from the mode-2 wave suppresses the fission of the mode-1 wave. In all cases, the amplitudes of the generated mode-2 waves are proportional to the topographic slope.

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