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The evolution of second mode internal solitary waves over variable topography

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A study of the propagation of a mode-2 internal solitary wave over a slope-shelf topography is presented. The methodology is based on a variable-coefficient Korteweg-de Vries (vKdV) equation, using both analysis and numerical simulations, and simulations using the MIT general circulation model (MITgcm). Two configurations are considered. One is a mode-2 internal solitary wave propagating up the slope, from one three-layer system to another three-layer system. Depending on the height of the shelf, which determines the variation of the nonlinear coefficient of the vKdV equation, this can be classified into two cases. First, the case of a polarity change, in which the coefficient of the quadratic nonlinear term changes sign at a certain critical point on the slope, and second, the case with no such polarity change. In both these cases there is a small transfer of energy from the mode-2 wave to mode-1 waves. The other configuration is when the lower layer in the three-layer system goes to zero at a transition point on the slope, and beyond that point, there is a two-layer fluid system. A mode-2 internal solitary wave propagating up the slope cannot exist past this transition point. Instead it is extinguished and replaced by a mode-1 bore and trailing wave packet which moves onto the shelf.