Abstract View

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Explosive Instability of Vorticity Waves

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ABSTRACT

The weakly nonlinear dynamics of “vorticity waves” (VW), specific wavelike motions occurring nearshore in the presence of an alongshore shear current is examined. By means of a standard asymptotic technique starting with the shallow-water equations, the authors derive the equations governing field evolution due to resonant interactions for the arbitrary current and bottom profiles and show that the VW interactions occur in the lowest order. Among them there are always explosive interactions; that is, the resonant triplets where all interacting waves growing synchronously tend to infinity in a finite time. The explosive instability is studied as a potential mechanism for VW generation, their main implications being the following: 1) The range of explosively excited scales appears to be much wider than the domain of linear instability, with the low-frequency cutoff absent; 2) the explosive instability occurs even when all linear perturbations are damped due to bottom friction, provided the initial amplitudes of disturbances exceed a certain threshold; and 3) the weakly nonlinear evolution most likely results in the emergence of strongly nonlinear motions. The dependence of the explosive processes on the background parameters is analyzed for the simplest model of alongshore current and topography.