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Head-on collision of large amplitude internal solitary waves of the first mode

Kateryna Terletska (1), Vladimir Maderich (1), Igor Brovchenko (1), Kyung Tae Jung (2), and Tatiana Talipova (3)

(1) Institute of Mathematical Machines and System Problems NASU, Marine and River Systems Modelling Department, Kiev, Ukraine (kterletska@gmail.com), (2) Korea Institute of Ocean Science and Technology, Ansan , South Korea, (3) Department of Nonlinear Geophysical Processes, Institute of Applied Physics, Nizhny Novgorod, Russia

The dynamics and energetics of a frontal collision of internal solitary waves of depression and elevation of moderate and large amplitudes propagating in a two-layer stratified fluid are studied numerically in frame of the Navier-Stokes equations. It was considered symmetric and asymmetric head-on collisions. We propose the dimensionless characteristic of the wave collision ξ that is the ratio of the wave steepnesses. Wave runup normalized on the amplitude of incoming wave as function of the waves steepness is proposed. Interval $0<\xi<1$ corresponds to the smaller wave in the case of asymmetric collision, $\xi=1$ correspond to the symmetric collision and $\xi>1$ corresponds to the larger wave in the case of asymmetric collision. Results of modeling were compared with the results of laboratory experiments [1]. It was shown that the frontal collision of internal solitary waves of moderate amplitude leads to a small phase shift and to the generation of dispersive wavetrain trailing behind transmitted solitary wave. The phase shift grows with increasing amplitudes of the interacting waves and approaches the limiting value when amplitudes of the waves are equal to the upper/lower layer for waves of depression/elevation. The deviation of the maximum wave height during collision from the twice the amplitude are maximal when wave amplitudes are equal to the upper/lower layer for waves of depression/elevation, then it decays with growth of amplitudes of interacting waves. It was found that the interaction of waves of large amplitude leads to the shear instability and the formation of Kelvin—Helmholtz vortices in the interface layer, however, subsequently waves again become stable.

References

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