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Current structure of strongly nonlinear interfacial solitary waves

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The characteristics of highly nonlinear solitary internal waves (solitons) in two-layer flow are computed within the fully nonlinear Navier-Stokes equations with use of numerical model of the Massachusetts Institute of Technology (MITgcm). The verification and adaptation of the model is based on the data from laboratory experiments [Carr & Davies, 2006]. The present paper also compares the results of our calculations with the computations performed in the framework of the fully nonlinear Bergen Ocean Model [Thiem et al, 2011]. The comparison of the computed soliton parameters with the predictions of the weakly nonlinear theory based on the Gardner equation is given. The occurrence of reverse flow in the bottom layer directly behind the soliton is confirmed in numerical simulations. The trajectories of Lagrangian particles in the internal soliton on the surface, on the interface and near the bottom are computed. The results demonstrated completely different trajectories at different depths of the model area. Thus, in the surface layer is observed the largest displacement of Lagrangian particles, which can be more than two and a half times larger than the characteristic width of the soliton. Located at the initial moment along the middle pycnocline fluid particles move along the elongated vertical loop at a distance of not more than one third of the width of the solitary wave. In the bottom layer of the fluid moves in the opposite direction of propagation of the internal wave, but under the influence of the reverse flow, when the bulk of the velocity field of the soliton ceases to influence the trajectory, it moves in the opposite direction. The magnitude of displacement of fluid particles in the bottom layer is not more than the half-width of the solitary wave.

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