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Modeling short-period internal waves in the Baltic Sea

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The Baltic Sea is a shallow offshore sea with prevailing depths of 40 to 100 m and is practically non-tidal. However, even in such seas there are mechanisms for generating intense internal waves. For example, they can be generated during the course of active dynamic processes associated with the emergence and relaxation of coastal upwelling and downwelling, vortices of various scales, surging phenomena, oscillations of hydrological fronts, and so on. Confirming this, packages of internal waves in the Baltic Sea are clearly visible on satellite photographs.

The active use of wind power plants, oil platforms and pipelines running along the seabed in the Baltic Sea forces us to take a fresh look at the problem of redistribution of sediments and the dynamics of erosion near subsea parts of hydraulic structures. Internal waves in the greater scale determine this dynamics, which can lead to the formation of unstable states of hydraulic structures and, as a consequence, to an increase in the risk of man-made disasters in the coastal zone. Therefore, the development of methods for modeling and analyzing internal wave regimes and their corresponding velocity and pressure fields for developing recommendations for assessing safety and improving hydraulic structures becomes particularly relevant.

In order to calculate the transformation of internal solitons along the vertical section in the Baltic Sea, we have used the model that has already become generally accepted, based on the Gardner equation with variable coefficients. The hydrological data for the calculations are taken from the GDEM V 3.0 atlas for July.

Numerical results of modeling the evolution of an internal solitary wave along different transects in the Baltic Sea make it possible to observe the complex behavior of internal waves, including adiabatic rearrangement and adjustment, wave amplification, the transformation of a wide solitary wave into a sequence narrow soliton-like disturbances, a change in their polarity, the appearance of multiple breather-like perturbations, and the radiation of oscillating dispersion trains of small amplitudes. All these non-stationary and nonlinear effects arising from the inhomogeneity of the medium lead to the formation of a complex field of currents induced by internal waves that can be easily reconstructed and additionally used as input data for bottom boundary layer models, as well as for advection-diffusion models of pollution dynamics.

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