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Internal waves in shelf zones: from generation till dissipation

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Huge energy of tides and inertial motions is dissipated in near-shore waters, but in stably stratified seas the initial stage of the dissipation is generation of internal waves (IW) with wide spatial-temporal spectrum over the continental slope and shelf break. It is evident that all energy of IW is dissipated before they reach shores, but it is hardly known, where the dissipation occurs, and what is the energy distribution between turbulence, work against buoyancy, mean currents, and bottom sediments transport.
Numeric modeling of IW generation and transformation was executed using nonlinear equations of shallow water for typical density distribution (seasonal thermocline at the depths from 15-20 till 30-40 m) and bottom profile in the shelf zone of the Sea of Japan. It was shown that hydraulic jumps can be formed on fronts of internal tides, but full IW destruction happens mainly in high-frequency short waves that are generated due to the jumps instabilities. The corresponding horizontal and vertical mixing is patchy in space and time and can not explain observed distributions of physical and biological parameters in shelf zones. Nonlinear transformations of IW, leading to changes in mean density structure, can frequently go on without IW breaking till the zones, where thermocline begins to feel bottom. But the model used can not describe processes in a shoaling thermocline, so experimental investigations were carried out in the Vitiaz Bay (southern part of Peter the Great Bay, Sea of Japan) on the hydrophysical polygon “Cape Shulz” of the V.I.Il’ichev Pacific Oceanological Institute FEB RAS.
Measurements of temperature were performed at 20 levels with separation 0.5 m in the 10-meter thick near-bottom layer at two buoy stations in the bay Vitiaz and at two stations in the open sea. Measurements of current velocity profile with the help of SBE19+ and pressure fluctuations with the help of SBE26 were made close to the garlands with thermistors. In addition, characteristics of microdeformations and strains in the upper layers of the Earth crust were measured with the help of a laser strainmeter on the shore about 500 m from the fixed sea and bay stations. Analysis of the data obtained makes it possible to formulate the following statements: 1) Internal waves in the near-bottom thermocline bring to transport of cold (denser) waters in form of boluses rather far from the thermocline upper boundary contact with bottom. 2) The boluses destruction occurs in course of their shortening and amplitude fast grow. 3) Changes of temperature fluctuations spectral structure in the near-bottom layer lead to the conclusion that different kinds of turbulence are generated: small-scale three-dimensional and horizontal with time-space scales of incoming IW. 4) Vertical and horizontal current velocities, as well as corresponding flows of momentum and heat sharply increase in the 2-3-meter thick bottom layer. These processes lead to bottom deposits movement and effective transport of nutrients. 5) In zones of IW and boluses steepening and destruction distinct fluctuations of pressure arise, which are the possible cause of the Earth crust microdeformations registered by the shore-based strainmeter in the range of IW frequencies.