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Internal waves in the systems of stratified currents

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The system of stratified currents is a composition of flows (circulating, near-bottom, intermediate) developed at different depths and interacting to each other. Internal waves that usually present at such currents substantially influence both on dynamics of single flows (due to the action on their trajectories and thicknesses) and on the processes of interaction between currents in the systems. Such systems quite often include currents, directly caused by internal seiches. The investigations of systems of stratified currents with internal waves are inseparably linked with hydroecological and other problems of a great practical importance. The presented results are obtained during the investigations of the systems of stratified currents in Lakes Teletskoye (Gorny Altai, Russia) and Onega (Karelia, Russia) in 2006-2008. There are analyzed the following systems: 1) density current – jet – flow current at Teletskoye Lake and 2) circulating current – jet – near-bottom current at Lake Onega.
The purposes of this work include: the revelation of mechanisms of the evolution of systems of stratified currents with internal waves, as well as of regularities of currents influence on the transfer of suspended sediments and dissolved salts.
At Teletskoye Lake there were revealed mechanisms of jet-type stratified currents with topographical disturbances. Such currents were registered while overflow of higher density waters through the under-water sill and further over the entire area of their propagation above the complex bottom relief. The current under investigation was caused by water entrance from the deepwater part of the lake (with depth up to 325 m) into the shallow part and further to river Biya outflow. Problems of this current theoretical description are stipulated by its complex nature. It is formed while transition of the intermediate jet, sinking along the prominent isopicnical surface before the sill into the stratified current above the sill. The prominent isopicnical surface oscillates under the action of internal waves of seiche type. Structure and dynamics of this current after the sill are exposed to the action of internal waves and topographical disturbances. The investigations of such currents are of great interest not only with reference to this poorly studied lake that is one of the main sources of great river Ob, but because they have analogs in other conditions (for example, at the shelves and see straits).
As a result of evaluation of parameters of internal waves and stratified currents it is possible to make a conclusion that the generation of the waves after the under-water sill is stipulated by two mechanisms, acting simultaneously. Firstly, this generation is provided by the current velocity disturbances causing these waves appear under the action of intermediate jet velocity fluctuations before the sill. This jet is locally accelerated or slowed down descending over the oscillating slope of isopicnical surfaces. Secondly, generation of the waves is provided by the action of bottom relief elevations on the intermediate current. Theoretical distribution of jet-current velocity, including quasistationary, topographical and wave components is in agreement with data of natural experiments. The analysis of this distribution shows that topographical and wave disturbances may cause blocking of the jet.
Effects of internal waves influence on the systems with circulating current, intermediate jet and density current were discovered at Lake Onega in August 2008. On the bases of current velocity fluctuation spectra there were determined main periods of internal waves. It was shown that these periods correspond to the general internal seiches of Petrozavodsk Bay and Lake Onega. There was discovered the increase of main mode period at the current velocity fluctuation spectra with height above the bottom in hypolimnion and opposite process in epilimnion.
The mechanism of direct and stepped transfer of pulse induced by internal wave from near-bottom current to intermediate jet was revealed.
In the current velocity field there were registered clearly defined accelerations of the jet simultaneously with wave upsurges of the near-bottom current height under the action of internal waves of seiche nature. The amplitudes of wave disturbances of jet velocity are proportional to the near-bottom current velocity. The probability of such

pulse transfer induced by internal wave grows simultaneously with increase of wave height and with decrease of stability of stratification. The semiempirical expression of intermediate jet current velocity reflecting these dependences of stratified currents and internal wave parameters was obtained. This expression is good for the evaluation of the jet velocity taking into account the influence of internal waves on the interaction of the flows entering into the system of stratified currents.

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