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Field and numerical studies of flow structure in Lake Shira (Khakassia) in summer

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Investigations of Lake Shira are conducted within a multidisciplinary approach that includes the study of biodiversity, biochemistry, geology of lake sediments, as well as its hydrophysics. Our report focuses on field measurements in the lake during the 2009 – 2013 and numerical modeling of flow structure.
The flow velocity, temperature and salinity distribution and fluctuations of the thermocline (density) were measured in summer.
An analysis of spatial and temporal variability of the major hydrophysical characteristics leads us to conclusion that certain meteorological conditions may cause internal waves in this lake.
Digital terrain model is constructed from measurements of Lake bathymetry allowing us to carry out numerical simulation.
Three-dimensional primitive equation numerical model GETM is applied to simulate hydrophysical processes in Lake Shira. The model is hydrostatic and Boussinesq. An algorithm of high order approximation is opted for calculating the equations of heat and salt transfer.
Temperature and salinity distributions resulting from field observations are taken as initial data for numerical simulations. Model calculations as well as calculations with appropriate real wind pattern being observed on Lake Shira have been carried out. In the model calculations we follow (1).
Significant differences are observed between model calculations with constant wind and calculations with real wind pattern. Unsteady wind pattern leads to the appearance of horizontal vortexes and a significant increase of vertical fluctuations in temperature (density, impurities). It causes lifting of the sediments to the upper layers at the areas where the thermocline contacts the bottom. It is important for understanding the overall picture of the processes occurring in the lake in summer.
Comparison of the results of numerical experiments with the field data shows the possibility of such a phenomena in Lake Shira.
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