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Process-based simulation of greenhouse gases in an artificial reservoir

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The one-dimensional model LAKE is applied to simulate greenhouse gases (CH_4 and CO_2) in Mozhaiskoe hydropower reservoir located in Moscow region.

LAKE is an extended one-dimensional model of thermodynamic, hydrodynamic and biogeochemical processes in the water basin and the bottom sediments (Stepanenko et al. 2016). The equations of the model are formulated in terms of quantities averaged over the horizontal section a water body, which leads to an explicit account of the exchange of momentum, heat, and dissolved gases between water and the inclined bottom. The equations of motion take into account the barotropic and baroclinic pressure gradients (Stepanenko, 2018). Besides basic physical processes, the model also describes vertical diffusion of dissolved gases (CO_2, CH_4, O_2), as well as their bubble transfer, methane oxidation, photosynthesis and processes of oxygen consumption. The aerobic transformations of organic carbon forms are simulated by vertically distributed version of model presented in (Hanson et al. 2004). For a reservoir with significant throughflow contribution of tributaries and dam outflow into momentum, heat and dissolved gases budgets are included. The pressure gradient parameterization is modified so as to include the mass input and output by tributaries and effluent.

The standard meteorological variables from nearby station and discharges of tributaries are involved as input for the model. Temperature, oxygen, CH_4 and CO_2 vertical profiles measured at the stationary mast and during whole-lake surveys at the reservoir are used to validate and calibrate the model. Based in model results, the terms of greenhouse gases budgets in the reservoir are assessed.

References

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