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Towards a lake greenhouse gases parameterization for the Earth System models

V.M. Stepanenko (1,4), V.Yu. Bogomolov (2,1), E.M. Volodin (3), S.P. Guseva (4), I. Mammarella (5), T. Vesala (5,6)

(1) Moscow State University, Research Computing Center, Laboratory of supercomputer modelling of climate system processes, Moscow, Russia (stepanen@srcc.msu.ru), (2) Institute of Monitoring of Climatic and Ecological Systems, SB RAS, Tomsk, Russia, (3) Institute of Numerical Mathematics, RAS, Moscow, Russia, (4) Moscow State University, Faculty of Geography, Department of Meteorology and Climatology, Moscow, Russia, (5) Department of Physics, University of Helsinki, Helsinki, Finland, (6) Department of Forest Sciences, University of Helsinki, Helsinki, Finland

A new version of the biogeochemical module is implemented in the one-dimensional lake model LAKE2.0 (Stepanenko et al., 2016). It solves a system of 6 diffusion equations with sources and sinks for 6 unknowns: concentration of methane, oxygen, dissolved inorganic carbon (DIC), density of dissolved organic carbon, density of living organisms (POCL – particulate organic carbon living), density of dead organisms (POCD – particulate organic carbon dead). Vertical turbulent diffusion is taken into account for all substances with the same diffusion coefficient, while for dead organisms, the settling velocity for the turbulent flow is also taken into account. The exchange of mass between the forms of organic carbon, as well as their transformation into DIC, are described by empirical relationships. In addition, the inflow and outflow of substances are introduced into the model, stream discharges being the external parameters of the model (as well as the stream concentrations of substances).

The new version of the LAKE model is tested and calibrated involving measurements of thermodynamic and biogeochemical characteristics collected on the Lake Kuivajärvi (Finland) by the University of Helsinki during the last few years (including freeze-up periods). Previously, the model has been verified in terms of methane fluxes for Shuchi Lake (North-Eastern Siberia) and Seida Lake (North of European Russia).

The lake model is implemented into the land surface scheme of the INM RAS Earth System model (ESM) (Volodin et al., 2013). In order to reduce the computational complexity of the lake code, the $k - \epsilon$ turbulent closure is substituted by Henderson-Sellers diffusivity. The global areal coverage of lakes and their depth distribution is borrowed from the Global Lake Database, version 2 (GLDBv2, Choulga et al., 2014). The model is tested in its ability to reproduce the mean surface temperature of largest world lakes, when coupled to INM RAS ESM. The model-based regional estimates of methane and CO_2 lake fluxes are performed and compared to lake emission inventories available so far.

References

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