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The model for methane emissions from lakes in the permafrost zone

Victor Stepanenko (1), Ekaterina Machulskaya (1,2), Mikhail Glagolev (3,4)

(1) Moscow State University, Moscow, Russian Federation (vstepanenkomeister@gmail.com), (2) German Weather Service, Offenbach am Main, Germany, (3) Moscow State University, Soil Science Faculty, Moscow, Russia, (4) Yugra State University, Khanty-Mansiysk, Russia

The permafrost zone in the Northern hemisphere is nowadays widely recognized as an important source of methane due to emissions from bogs and lakes, expected to increase while the climate is warming. Numerous experimental and modelling efforts have been performed to assess the current magnitude of methane emissions from bogs and their potential positive feedback in the future climate change. However, much less attention has been paid to lakes that occupy a significant fraction of permafrost area. Particularly, thermokarst lakes which abundance is up to 40% in some Siberian regions are worth mentioning when considering the methane fluxes. Recent observations by Walter and colleagues indicate thermokarst lakes as an important methane source likely to provide a positive feedback to climate warming since thermokarst lakes' area tends to expand when permafrost thaws. Hence, a modelling tool is needed to assess this feedback in future.

We present a one-dimensional model of a lake, that includes processes of production, transport and sink of methane in the bottom ground and water column. Among other physical processes, the model takes into account the processes of heat and moisture transport in permafrost explicitly. The model thermodynamics and hydrodynamics are briefly described. More attention is paid on the methane model, discussing the main assumptions used to derive the equation set, its capabilities and expected limitations. The model is verified using the available data on measured methane fluxes over the thermokarst lake in North-Eastern Siberia, that are kindly provided by Katey Walter, University of Fairbanks.