Geophysical Research Abstracts
Vol. 21, EGU2019-10562, 2019
EGU General Assembly 2019

Shallow meromictic lakes as a source of methane emissions to the atmosphere

Irina Repina (1,2), Victor Stepanenko (2), Arseniy Artamonov (1), and Sofya Guseva (3)

(1) A.M. Obukhov Institute of Atmospheric Physics RAS, Moscow, Russian Federation (repina@ifaran.ru), (2) Lomonosov Moscow State University, Moscow, Russian Federation, (3) Institute for Environmental Sciences, University of Koblenz-Landau, Landau, Germany

Meromixic lakes are lakes that do not annually mix completely. In these lakes the water column typically consists of at least three major layers: the upper layer where the mixing occurs, the bottom layer where mixing is almost completely inhibited and the transition layer. Such lakes reveal complex biogeochemical interactions that contribute to the maintenance of meromixis. Many of these lakes are saline and sulfate-containing sea water is present in the bottom layers. Organic carbon is also concentrated in the bottom layer, and strong stratification prevents its from release to the surface.

Our studies were carried out in winter time on the shore of Kandalaksha Bay (the White Sea, Russia) and focused on several shallow lakes that had separated from the sea in the past. Despite shallowness, they exhibit completely developed water column stratification with high-density microbial chemocline community (bacterial plate) and high rates of biogeochemical processes.

The phenomenon of the salty water with temperatures above zero in the winter period was registered in the lakes at a depth of only 1 m below the water's surface.

Water samples for methane concentrations were collected along a vertical profile. Three years of wintertime measurements demonstrated excessive concentrations of methane in the bottom layer in all studied lakes. The greatest concentrations (1000-1600 μmol/l) were observed on the Trekhtzvetnoe Lake (average depth 3.5 m). There, increased concentrations (20-50 μmol/l) were observed in the upper layer, directly below the ice surface, which can lead to high methane emissions from the lake at the ice-off.

Summer measurements on a similar lake were carried out on Kamchatka peninsula. The Bolshoi Viluyi is the shallow estuarine lake with strong stratification in density and temperature. The depth of mixed layer is 2.5 m. The presence of hydrogen sulphide indicating anoxic conditions and numerous bubbles on the surface suggest the existence of methane emission from lake. Analysis of water samples also showed significant concentrations of methane in the lake bottom layer.

An eddy covariance system including an open-path methane analyzer (LI-7700) was used to measure methane flux (FCH4) from the lake surface and partial pressure of methane in the atmosphere (pCH4a). These measurements show a diurnal cycle in both FCH4 and pCH4a with high values during nighttime.

Estimations of waterside buoyancy flux showed that the high methane fluxes coincided with convective periods. Waterside convection might enhance the transfer velocity and consequently enhance the diffusive flux. The linear fit to the data shows no strong effects of wind speed and pressure changes. Conversely, there seems to be a weak increase in CH4 flux with increasing water temperature.

This work was supported by a grant from the RSF 17-17-01210.