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Features of methane emission in wetland during permafrost thawing

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The specificity of the continental part of the Arctic latitudes is large areas covered by wetlands. Huge masses of slightly decomposed organic substance (peat) are conserved in permafrost. The modern climatic changes and development of northern territories lead to intensifying of cryolithozone degradation process. The thawing of permafrost is accompanied by the thermokarst lakes formation and the withdrawal of ancient organic carbon from frozen soils in the form of carbon dioxide and methane, which is one of the most serious environmental threats in the global climate change scenario. Tundra landscape complexes have an important climate-regulating function at the biosphere level, but it is still not properly taken into account when drawing up global models of climate changes and carbon balance. Quantifying methane emissions from discontinuous permafrost is an important task.
This paper presents the first results of a dissolved methane concentrations study in water of 54 thermokarst water bodies of Bolshezemelskaya tundra (BZT) at different stages of formation. Direct measurements of methane flux from the surface of 8 lakes using a floating chamber were carried out, and a diffusion flux of methane from the lakes surface was calculated on the basis of water surface methane concentration, wind speed and gas transfer coefficient.
The research results have shown that all the studied water bodies were oversaturated with CH4. Concentrations of CH4 in lakes varied from 0.081 to 106.1 μmol l – 1. The highest CH4 concentrations were observed in subsidence, different from lakes with high concentrations of DOC, mineralization, and microelement composition. The diffusion methane flux from the subsidence and depression 11-30 times exceeded that from the thermokarst lakes surface. Measured with the floating chamber, methane fluxes from the surface water bodies were 1-2 orders of magnitude higher than those calculated. Significant and abrupt increase of methane flux in air samples from the chamber on a number of lakes indicates registering by the chamber of a bubble stream from the bottom of a lake. Methane emissions by means of bubble transfer ranged from 19 to 99%.
Thus, depressions, subsidence, as well as small reservoirs (<100m2), are characterized by the highest concentrations of CH4, DOC. They are not represented on existing maps and databases of world lakes, and contain 3-70 times higher methane compared to large lakes. Methane emissions from small water bodies should be included in the methane flux assessment system from the Arctic tundra territory. All the more so as their contribution to total surface coverage of BZT area will increase, both as a result of climate warming and with an increase of anthropogenic load.
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