Geophysical Research Abstracts
Vol. 16, EGU2014-10610, 2014
EGU General Assembly 2014

Zero methane-emitting peatlands: biogeochemical features and forecasting response to environmental change

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Peatlands are one of the main sources of atmospheric CH_4, a greenhouse gas responsible for a large part of current climate forcing. Existing estimates of methane flux from peatlands on a country, continental and global scale do not cover all variety of extremely diverse natural peatland ecosystems, their spatial uncertainties, and related to human impacts modifications. During last 2-3 decades numerous CH_4flux measurements were conducted in northern peatlands, but many peatland types were not elaborated being suggested as unessential or even "zero" source of methane to the atmosphere. Among them are widespread forested dwarf-shrub sphagnum peatbogs, frozen flat palsa mires, etc., as well as considered "dry" peatlands drained and utilized for peat extraction, agriculture and forestry.

Methane fluxes were measured at key peatland taiga test-plots of Central part of European Russia and taiga and tundra-forest zones of West Siberia purposely to examine periods of different level of humidity. The water level (WL) position switching from methane emission to uptake was elucidated for pine-dwarf-shrub-sphagnum ecotopes: at 50 cm WL near-zero or negative methane fluxes were registered at 86% of measurements, at 40 cm WL – emission at 89%. Observations in Central European Russia cover different natural and drained peatland types. Drainage and management usually decreased CH_4 emissions relative to pristine peatlands through drying of surface peats and simultaneous decrease the size of anoxic horizons, but the rise of WL switches to CH_4 fluxes. Relation between methane flux and peat wetness was additionally tested by series of lab mesocosm experiments.

Processes resulting in similar final zero methane emissions under conditions of drained and intact peatland could be different. Microbial communities, involved in methane cycle, have been significantly changed in drained peatlands. Methanogens in natural peatlands were almost exclusively composed of hydrogenotrophs, whereas both hydrogenotrophs and acetotrophs were almost equivalent in the drained peats. The study revealed also striking difference between aerobic methane oxidizing communities. Sequence analysis of markers, *pmoA* and the 16S rRNA genes, suggested that methanotrophic *Alphaproteobacteria,* with *Methylocystis* as most close relative, dominate in natural peatlands. In the drained peats *Methylobacter* is an important group actively involved in CH_4 oxidation.

We expect that our studies and data obtained will provide an empirical basis for understanding the potential contributions of commonly treated as "zero" methane-emitting peatlands to local and regional greenhouse gas budgets.

The study was partially supported by RFBR research project # 12-05-01029_a