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Effects of hydrological versus temperature changes on methane emissions from arctic tundra lowlands in north-eastern Siberia

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Global warming is expected to have a strong effect on arctic regions. Not only are the Polar Regions warming at a faster rate than other parts of the world, the hydrological cycle is also expected to be influenced significantly in these regions, leading to changes in precipitation, evaporation and river discharge. Methane emissions are controlled both by water table and temperature and are therefore expected to change as a result.

It has been shown that currently tundra mires are a small emitter of methane while river plain backswamps are methane emission hotspots. Emissions from these backswamps are strongly influenced by river discharge and changes in floodplain hydrology may therefore have a relatively strong influence on regional methane emissions, compared to the effects of temperature rise.

To determine the influence of these factors on tundra methane emissions, we have analysed a 4-year data set of methane flux measurements in arctic tundra in the Indigirka lowlands of north-eastern Siberia (Kytalyk nature reserve). Emissions of floodplain backswamps are compared to the emissions of largely ombrotrophic tundra mires, and sensitivity to temperature and water table has been determined by statistical analysis.

By extrapolating the statistical relations and by modelling methane fluxes using a process-based model we quantify the relative change in the regional methane emissions of arctic tundra lowlands for several future scenarios, based on likely changes in surface temperature, precipitation and river discharge. These changes in methane emissions are then combined with known changes in carbon dioxide fluxes for the same scenarios to provide a qualitative measure of the future change in the greenhouse gas sink function of this region.