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Microbial Methane Driving Processes in Siberian Arctic and Sub-Arctic Cryosols

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Despite an increasing number of studies on microbial processes and communities in permafrost environments (WAGNER 2008), their function, population structure, and reaction to environmental changes is largely unknown. As a result, important part of the process knowledge of methane fluxes in permafrost ecosystems is far from completely understood. This hampers predicting the effects of climate warming on arctic methane fluxes, in particular when these predictions are based on models that do not take into account the specific nature of microbial populations in permafrost soils and sediments. Therefore, understanding these microbial populations is highly important for analysing the global climatic effects of a warming Arctic.

The Arctic plays a key role in the Earth's climate system. Global warming is predicted to have the most pronounced effects at high latitudes, and one third of the global carbon pool is stored in the ecosystems of the northern latitudes. The degradation of permafrost and the associated release of climate-relevant trace gases from intensified microbial turnover of organic carbon and from destabilized gas hydrates represent a potential environmental hazard.

Study sites are located on Samoylov island, an island in the central part of the Lena River delta (N 72°, E 126°), a permafrost-affected tundra ecosystem; and at the nearby Evenkian forest research station Tura, located along the Tunguska river connected to the Yenisei (N 64°, E 100°), a permafrost-affected forest ecosystem.

1. Permafrost-Affected Tundra Ecosystem

The mean flux rate from polygon depressions was 53.2 ± 8.7 mg CH_4 m^{-2} d^{-1}, whereas the mean flux rate of the drier rim part of the polygon was 4.7 ± 2.5 CH_4 m^{-2} d^{-1}. The CH_4 production in the upper soil horizon of the polygon depression was about 10-times higher (38.9 ± 2.9 nmol CH_4 m^{-2} d^{-1}) in July than in August (4.7 ± 1.3 nmol CH_4 m^{-2} d^{-1}). The CH_4 oxidation behaved exactly in reverse: The oxidation rate of the upper soil horizon was low in July (1.9 ± 0.3 nmol CH_4 m^{-2} d^{-1}) compared to the activity in August (max. 7.0 ± 1.3 nmol CH_4 m^{-2} d^{-1}). The findings demonstrate the close relationship between apparent methane fluxes

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and the modes and intensities of microbiological processes of methane production and oxidation in the polygonal tundra soils.

2. Permafrost-Affected Forest Ecosystem

The mid-vegetation season mean flux rate from the south-exposition slope was 7.5 ± 2.6 mg CH_4 m^{-2} d^{-1}, and the mean flux rate from the north-exposition slope was 7.8 ± 2.8 mg CH_4 m^{-2} d^{-1}. The CH_4 production in the upper soil horizons of both slopes was very low (0.20 ± 0.06 nmol CH_4 m^{-2} d^{-1} for the south-exposition slope; and 0.31 ± 0.13 nmol CH_4 m^{-2} d^{-1} for the north-exposition slope). The CH_4 oxidation rate of the upper soil horizon of the south-exposition slope was 0.14 ± 0.06 nmol CH_4 m^{-2} d^{-1}; and of the north-exposition slope was 0.13 ± 0.07 nmol CH_4 m^{-2} d^{-1}. The data obtained shows that there is no difference between soil methane-driving microbiocenosises of contrast slopes despite sufficient disparity in their active layer thickness, soil moisture, and temperature.

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Reference

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