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Methane Emission from Siberian arctic polygonal Tundra: Eddy Covariance Measurements and Modeling

C. Wille (1,2), L. Kutzbach (1,2), T. Sachs (1), D. Wagner (1), E.-M. Pfeiffer (3)

(1) Alfred-Wegener-Institute Foundation for Polar and Marine Research, Research Unit Potsdam, Germany, (2) Now at the Institute of Botany and Landscape Ecology, University of Greifswald, Germany, (3) Institute of Soil Science, University of Hamburg, Germany (kutzbach@uni-greifswald.de / Fax: +49-3834-864114 / Phone: +49-3834-864185)

Eddy covariance measurements of methane flux were carried out in an arctic tundra landscape in the central Lena River Delta at 72 ˚N. The measurements covered the seasonal course of mid-summer to early winter in 2003 and early spring to mid-summer in 2004, including the periods of spring thaw and autumnal freeze back. The study site is characterized by very cold and deep permafrost and a continental climate with a mean annual air temperature of -14.7 ˚C. The surface is characterized by wet polygonal tundra, with a pronounced micro-relief consisting of raised moderately dry sites, depressed wet sites, polygonal ponds, and lakes. We found relatively low fluxes of typically 30 mg CH_4 m^{-2} d^{-1} during mid-summer and identified soil temperature and near-surface turbulence as the driving parameters of methane emission. A model based on these two variables explained variations of methane flux corresponding to the continuous processes of microbial generation of methane and its transport to the atmosphere through soil, plants, and water. Transitory processes related to spring thaw and turbulence- and pressure-induced ebullition were estimated to contribute about 10 % to the measured flux. The relationship found between methane flux and soil temperature was extrapolated to estimate the methane emission during the winter. Based on this estimate, the annual methane flux was 3 g CH_4 m^{-2}. This is low compared to values reported for similar ecosystems. Reason for this were thought to be (a) the very low permafrost temperature in the study region, (b) the sandy soil texture and low bioavailability of nutrients in the soils, and (c) the high surface coverage of moist to dry micro-sites. The methane emission accounted for about 13 % of the annual ecosystem

carbon balance. Considering the global warming potential of methane, the methane emission turned the tundra into an effective source of greenhouse gases.