Geophysical Research Abstracts
Vol. 14, EGU2012-1158, 2012
EGU General Assembly 2012

Carbon mineralisation and trace gas production in Holocene and Late Pleistocene permafrost deposits and surface soils of northeast Siberia

C. Knoblauch (1), A. Sosnin (2), D. Wagner (3), and E.-M. Pfeiffer (1)

(1) Institute of Soil Science, University of Hamburg, Hamburg, Germany (Christian.Knoblauch@uni-hamburg.de), (2) Faculty of Geography and Geoecology, University of St. Petersburg, St. Petersburg, Russia, (3) Alfred Wegener Institute for Polar and Marine Research, Research Unit Potsdam, Potsdam, Germany

The permafrost in northern latitudes contains up to 1672 Pg organic carbon representing almost 50% of the global belowground organic carbon pool. The currently observed warming of the Arctic will increase permafrost degradation followed by microbial mineralisation of organic carbon to CO_2 and methane. Despite increasing awareness of permafrost vulnerability the degradability of organic matter in thawing permafrost remains unclear. To quantify the potential formation of CO_2 and methane from permafrost organic matter, permafrost samples (n=29) from Holocene and Late Pleistocene deposits in the Lena Delta, Northeast Siberia, were incubated for 2.7 years at 4°C. Additionally, carbon mineralization was quantified in surface soils overlying the sampled permafrost. The highest CO_2 production was measured in the uppermost 2 m of the Holocene surface permafrost (14C age 2.6-3.8 ky) with 213 μmol g-1 (aerobic) and 38 μmol g-1 (anaerobic) and in 16 m deep Pleistocene permafrost (14C age 34 ky, 190 μmol C g-1 aerobically and 53 μmol C g-1 anaerobically). Anoxic conditions strongly reduced carbon mineralization since only 26 % (± 10%, n=28) of aerobically mineralized carbon was released as CO_2 and methane in the absence of oxygen. Methane production was low or absent in the Pleistocene permafrost and always started after a significant lag phase of up to 1.7 years. In Holocene deposits, the maximum methane production rates reached values of up to 86 nmol CH4 g-1 d-1, which is considerably lower than CO_2 production rates in the same sample (223 nmol CO_2 g-1 d-1). Aerobic and anaerobic CO_2 formation was highly significantly correlated with the content of organic carbon ($p < 0.001$, r2 = 0.72) but not with age, indicating that organic matter degradation does not continue substantially when surface carbon becomes trapped in the permafrost. The content of organic carbon was the main predictor for carbon mineralization rates in the overlaying surface soils as well. However, surface carbon mineralization rates were up to 18 fold higher than maximum rates in the underlying permafrost. Furthermore, increasing organic matter contents caused a significantly stronger increase of carbon mineralization rates in the surface soil, demonstrating the lower degradability of permafrost carbon. The obtained data indicate that on a 100 year time scale on average 24% (± 11%, n=29) of initial permafrost carbon can be released as CO_2 under aerobic conditions while under anaerobic conditions only 5.8% (± 4.7%, n=28) of permafrost carbon is transferred to CO_2 and methane.