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Land-atmosphere fluxes of methane and carbon dioxide at Siberian polygonal tundra - new data from 2009 in comparison to data from 2003/04 and 2006.

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The fluxes of carbon dioxide (CO_2) and methane (CH_4) between wet arctic polygonal tundra and the atmosphere were investigated by the eddy covariance method and empirical modeling. The study site is situated in the Lena River Delta in Northern Siberia (72˚22' N, 126˚30' E) and is characterized by a polar and distinctly continental climate, very cold and ice-rich permafrost, and its position at the interface between the Eurasian continent and the Arctic Ocean. The soils at the site are characterized by high organic matter content, low nutrient availability and pronounced water logging. The vegetation is dominated by sedges and mosses. Flux measurements were performed during one "synthetic" growing season consisting of the periods July - October 2003 and May - July 2004, one full growing season in 2006 (June - September), and during July - August in 2009. The main carbon exchange processes - gross photosynthesis, ecosystem respiration, and CH_4 emissions - were generally found to be of low intensity. Over the 2004/2003 growing season (June - September), these gas fluxes accumulated to -0.43 kg m^{-2}, +0.33 kg m^{-2}, and +2 g m^{-2}, respectively. CH_4 emissions from June - September 2006 were 1.96 g m^{-2} with highest emissions in July (+0.57 g m^{-2}) and August (+0.64 g m^{-2}). Day-to-day variations of photosynthesis were mainly controlled by radiation and hence by the synoptic weather conditions. Variations of ecosystem respiration were best explained by an exponential function of surface temperature, which indicates that plant respiration plays a major role within the tundra carbon balance. The factors controlling CH_4 emissions were found to be soil temperature and near-surface atmospheric turbulence. The influence of atmospheric turbulence was attributed to the high coverage of open water surfaces in the tundra. For the 2003- 2004 period, winter fluxes were modeled based on functional relationships found in the measured data. On an annual basis, CH_4 emissions accounted for 14 % of the annual ecosystem carbon balance. Considering the global warming potential of CH_4, the tundra was an effective greenhouse gas source. Comparison of data from 2003-2004 and 2006 showed a difference of only a few percent between the CH_4 fluxes measured. In this work, we present new analyses of CO_2 and CH_4 flux data from 2009 in order to assess interannual variability in the greenhouse gas balance of the polygonal tundra.