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Environmental controls on plot-scale CH4 emission from polygonal tundra in the Lena River Delta, Siberia

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The carbon budgets of the atmosphere and terrestrial ecosystems are closely coupled by vertical exchange fluxes of carbon dioxide and methane. Arctic tundra ecosystems have been major carbon sinks throughout the Holocene, resulting in a globally significant but highly sensitive carbon reservoir. Large uncertainties about the current and future contribution of these environments to the global carbon cycle remain especially with regard to the processes controlling methane fluxes as well as their temporal and spatial variability. In order to address this uncertainty and analyze the complex network of coupled processes and interconnected controls of tundra carbon exchange, we combined intensive field studies on two spatial scales with process-based and statistical model approaches. Methane fluxes on both ecosystem-scale and plot-scale were measured in northern Siberia covering the entire snow-free period from end of May until end of September 2006 by the eddy covariance method, and from July through September 2006 by closed chambers, respectively. Our study site was located in the southern part of the Lena River Delta, which is characterized by arctic continental climate and cold continuous permafrost, and adds results from an area that is seriously underrepresented in current efforts to quantify carbon emissions from high latitude ecosystems. Closed chamber measurements of methane fluxes were conducted daily on 15 plots in four differently developed polygon centers and on a polygon rim. Controls on methane emission were identified by applying models of differing complexity ranging from more deterministic to more empirical approaches. In contrast to the rela-

tively low ecosystem-fluxes, which were mainly controlled by near-surface turbulence and to a lesser extend by atmospheric pressure and soil temperature, fluxes on the plot-scale were almost an order of magnitude higher and varied strongly even within the same polygon. The only statistically significant control on chamber-based fluxes was surface temperature and results from the eddy covariance measurements hint at the importance of open water surfaces and potential problems of chamber-methods in wet polygonal tundra environments.