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Variability of methane fluxes over high latitude permafrost wetlands

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Atmospheric methane plays an important role in the global climate system. Due to significant amounts of organic material stored in the upper layers of high latitude permafrost wetlands and a strong Arctic warming trend, there is concern about potentially large methane emissions from Arctic and sub-Arctic areas. The quantification of methane fluxes and their variability from these regions therefore plays an important role in understanding the Arctic carbon cycle and changes in atmospheric methane concentrations. However, direct measurements of methane fluxes in permafrost regions are sparse, very localized, inhomogeneously distributed in space, and thus difficult to use for accurate model representation of regional to global methane contributions from the Arctic.

We aim to contribute to reducing uncertainty and improve spatial coverage and spatial representativeness of flux estimates by using airborne eddy covariance measurements across large areas. The research aircraft POLAR 5 was equipped with a turbulence nose boom and a fast response methane analyzer and served as the platform for measurements of methane emissions. The measuring campaign was carried out from 28 June to 10 July 2012 across the entire North Slope of Alaska and the Mackenzie Delta in Canada.

The supplemented simulations from the Weather Research and Forecasting (WRF) model exploring the dynamics of the atmospheric boundary layer were used to analyze high methane concentrations occasionally observed within the boundary layer with a distinct drop to background level above. Strong regional differences were detected over both investigated areas showing the non-uniform distribution of methane sources. In order to cover the whole turbulent spectrum and at the same time to resolve methane fluxes on a regional scale, different integration paths were analyzed and validated through spectral analysis. Methane emissions measured over the Mackenzie Delta were higher and generally more variable in space, especially in the outer Delta with known geogenic methane seepage. On the North Slope, methane fluxes were larger in the western part than in the central and eastern parts.

The obtained results are essential for the advanced, scale dependent quantification of methane emissions. Our contribution will present an overview of the experiment as well as preliminary results from more than 52 flight hours over high latitude permafrost wetlands.