The Airborne Measurements of Methane Fluxes (AIRMETH) Arctic Campaign *(Invited)*

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Abstract

One of the most pressing questions with regard to climate feedback processes in a warming Arctic is the regional-scale methane release from Arctic permafrost areas. The Airborne Measurements of Methane Fluxes (AIRMETH) campaign is designed to quantitatively and spatially explicitly address this question. Ground-based eddy covariance (EC) measurements provide continuous in-situ observations of the surface-atmosphere exchange of methane. However, these observations are rare in the Arctic permafrost zone and site selection is bound by logistical constraints among others. Consequently, these observations cover only small areas that are not

necessarily representative of the region of interest. Airborne measurements can overcome this limitation by covering distances of hundreds of kilometers over time periods of a few hours. Here, we present the potential of environmental response functions (ERFs) for quantitatively linking methane flux observations in the atmospheric surface layer to meteorological and biophysical drivers in the flux footprints. For this purpose thousands of kilometers of AIRMETH data across the Alaskan North Slope are utilized, with the aim to extrapolate the airborne EC methane flux observations to the entire North Slope. The data were collected aboard the research aircraft POLAR 5, using its turbulence nose boom and fast response methane and meteorological sensors. After thorough data pre-processing, Reynolds averaging is used to derive spatially integrated fluxes. To increase spatial resolution and to derive ERFs, we then use wavelet transforms of the original high-frequency data. This enables much improved spatial discretization of the flux observations, and the quantification of continuous and biophysically relevant land cover properties in the flux footprint of each observation. A machine learning technique is then employed to extract and quantify the functional relationships between the methane flux observations and the meteorological and biophysical drivers in the flux footprints. Lastly, the resulting ERFs are used to extrapolate the methane release over spatio-temporally explicit grids of the Alaskan North Slope. Metzger et al. (2013) have demonstrated the efficacy of this technique for regionalizing airborne EC heat flux observations to within an accuracy of ≤18% and a precision of ≤5%. Here, we show for the first time results from applying the ERF procedure to airborne methane EC measurements, and report its potential for spatio-temporally explicit inventories of the regional-scale methane exchange.
References: Metzger, S., Junkermann, W., Mauder, M., Butterbach-Bahl, K., Trancón y Widemann, B., Neidl, F., Schäfer, K., Wieneke, S., Zheng, X. H., Schmid, H. P., and Foken, T.: Spatially explicit regionalization of airborne flux measurements using environmental response functions, Biogeosciences, 10, 2193-2217, doi:10.5194/bg-10-2193-2013, 2013.

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