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Variability of surface energy fluxes over high latitude permafrost wetlands

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Arctic ecosystems are undergoing a very rapid change due to global warming and their response to climate change has important implications for the global energy budget. Therefore, it is crucial to understand how energy fluxes in the Arctic will respond to any changes in climate related parameters. However, attribution of these responses is challenging because measured fluxes are the sum of multiple processes that respond differently to environmental factors.

Ground-based measurements of surface fluxes provide continuous in-situ observations of the surface-atmosphere exchange. But these observations may be non-representative, because of spatial and temporal heterogeneity, indicating that local observations cannot easily be extrapolated to represent global scales. Airborne eddy covariance measurements across large areas can reduce uncertainty and improve spatial coverage and spatial representativeness of flux estimates. Here, we present the potential of environmental response functions for quantitatively linking energy flux observations over high latitude permafrost wetlands to environmental drivers in the flux footprints. We used the research aircraft POLAR 5 equipped with a turbulence probe, fast temperature and humidity sensors to measure turbulent energy fluxes across the Alaskan North Slope.

We used wavelet transforms of the original high-frequency data, which enable much improved spatial discretization of the flux observations, and determine biophysically relevant land cover properties in the flux footprint. A boosted regression trees technique is then employed to extract and quantify the functional relationships between energy fluxes and environmental drivers. Using extracted environmental response functions and supplemented simulations from the Weather Research and Forecasting (WRF) model the surface energy fluxes were then projected beyond measurement footprints across North Slope of Alaska.