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Spatial and Temporal Variation of Arctic CH_4 and net CO_2 Fluxes Using Nested Chamber, Tower, Aircraft, Remote Sensing, and Modeling Approaches for Regional Flux Identification and Estimation

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The hydrological, cryogenic, topographic, environmental, biotic, and metabolic heterogeneity of terrestrial ecosystems and landscapes can be large even despite a seemingly homogeneous landscape. The error of estimating and simulating fluxes due to the existing heterogeneity is commonly overlooked in regional and global estimates. Here we evaluate the pattern and controls on spatial heterogeneity on CH_4 and CO_2 fluxes over varying spatial scales. Data from the north slope of Alaska from chambers, up to a 16 year CO_2 flux record from up to 7 permanent towers, over 20 portable tower locations, eddy covariance CH_4 fluxes over several years and sites, new year-around CO_2 and CH_4 flux installations, hundreds of hours of aircraft concentration and fluxes, and terrestrial biosphere data driven models and flux inverse modeling, are used to evaluate the spatial variability of fluxes and to better estimate regional fluxes. Significant heterogeneity of fluxes is identified at varying scales from sub-meter scale to >100km.

A careful consideration of the effect that heterogeneity has on estimating ecosystem fluxes is critical to reliable regional and global estimates. The combination of eddy covariance tower flux, aircraft, remote sensing, and modeling can be used to provide reliable, accurate, regional assessments of CH_4 and CO_2 fluxes from large areas of heterogeneous landscape.