(10-240326-B) **A Dual Comb Spectrometer for Arctic Methane Flux Quantification**

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As global temperatures continue to rise, the thawing of permafrost poses significant climate risks, notably from the release of methane—a potent greenhouse gas. Current methane flux measurement methods, using either ground-based measurements or remote sensing inversions, show significant divergence in Arctic methane estimates. This discrepancy highlights a crucial gap in available flux quantification understanding. Further, emissions from permafrost landscapes exhibit spatially heterogenous emissions characterized by diffusive fluxes, ebullition in lakes, and terrestrial hotspots. To address this challenging flux quantification environment, we have deployed a long-distance open-path Dual Comb Spectrometer (DCS) capable of continuous, landscape-scale methane flux observation through spatially-averaged measurements with large (10s km^2) flux footprints. We have deployed this instrument overlooking the Goldstream Valley near Fairbanks Alaska. Our preliminary review of the first year of methane concentration data is promising. Initial analysis includes validation with a nearby eddy-covariance flux tower and analysis comparing our measurements to forward modeling of emission “hotpsot” locations. Our development of atmospheric inversion models aims to refine these concentration measurements into continuous flux estimates over our measurement duration. We are also upgrading the DCS transceiver to reduce noise in the concentration measurements for year 2. These results will further not only understanding of permafrost methane dynamics but also generalized flux quantification of heterogenous sources using open-path lasers.

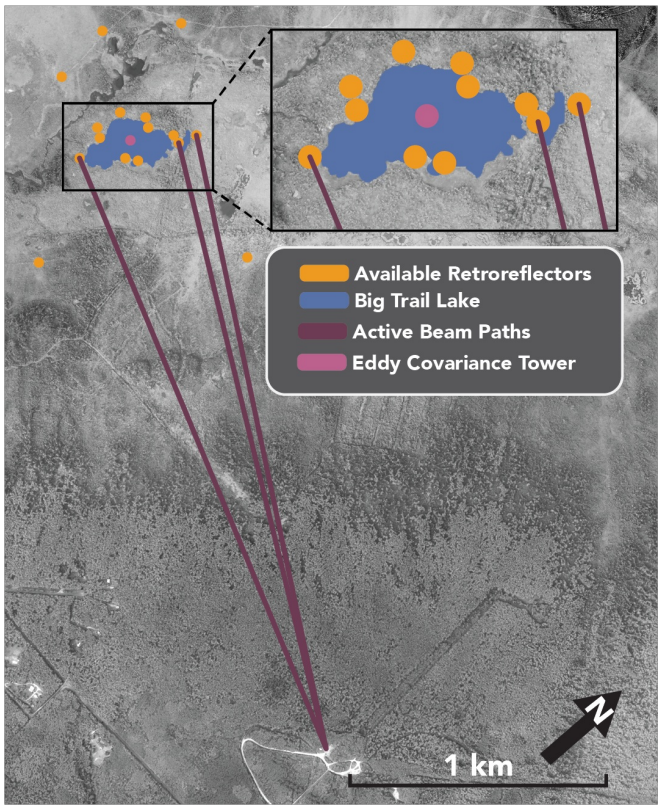

Figure 1. Site configuration for DCS flux quantification in the Goldstream Valley near Fairbanks Alaska (64.9194, -147.822). Multiple retroreflector locations allow measurement across the region with spatial specificity.

Figure 2. Tower crew installs DCS laser transceivers overlooking Goldstream Valley.