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Broad spatial comparison of methane emission patterns in the Mackenzie Delta, NWT using complimentary airborne eddy covariance and hyperspectral visible/infrared imaging spectroscopy

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Arctic CH4 emissions could more than double by mid-century as the region adapts to rapid sea-ice decline and amplified warming1,2. Yet despite decades of research, the high spatial and temporal heterogeneity of CH4 emissions and the inaccessibility of Arctic regions has complicated efforts to reconcile top-down and extrapolated bottom-up CH4 emission budgets. As a result, these approaches rarely converge, scaling of site-level observations across landscapes or regions suffers large uncertainties, and forecasts of CH4 emissions from high latitudes span two orders of magnitude through year 2300 (ref. 2). Here, we leverage two novel approaches: the GFZ/AWI AirMeth airborne eddy covariance observation and NASA's Airborne Visible/Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) in the Mackenzie Delta, NWT, Canada to directly observe Arctic CH4 emission patterns at unprecedented spatial scales. The AirMeth survey, conducted in summer of 2012 and 2013, derives a regional scale (10,000 km2) CH4 flux map at 100 x 100 m spatial resolution using airborne eddy covariance and multiple flight transects3. Alternatively, the AVIRIS-NG observes excess CH4 absorption in the atmospheric column between the aircraft and the surface (CH4 enhancement), and is sensitive enough to detect CH4 hotspots at 5 x 5 m spatial resolution4. In summer of 2017, the AVIRIS-NG imaged over 2.0 x 108 pixels in a 5,000 km2 mosaic designed to overlap with the prior AirMeth survey in the Mackenzie Delta.

We exploit spatial and temporal differences in each survey, and the fact that AVIRIS-NG is only sensitive to CH4 emission hotspots on land, to differentiate temporal variability in CH4 emissions as well as dispersed vs. concentrated hotspot emission patterns across the Delta landscape. AVIRIS-NG pixels were aggregated to the AirMeth pixel grid and the median CH4 enhancement was compared to the AirMeth-derived fluxes. Preliminary results indicate that there is no correlation between the two observations. This suggests that either dispersed, uniformly elevated emissions (below the AVIRIS-NG detection limit), or emissions over water (undetectable by AVIRIS-NG), are the primary CH4 emission modes in the Delta -as opposed to concentrated hotspots on land. In instances where the independent observations were consistent (< 10% of study area), emissions are thus temporally persistent between the observation periods and are predominantly CH4 hotspots. This suggests that CH4 emissions in these regions are likely dominated by geologic seeps, which are relatively insensitive to the interannual environmental variability that regulates ecological-type CH4 emissions. Ongoing work further investigates the relationship between the two observation techniques and aims to coordinate AirMeth and AVIRIS-NG surveys in time and space in the summer of 2019. This research has the ability to bridge scale gaps in existing CH4 observation systems and reshape our understanding of CH4 emission patters across regional scales.

References:

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