EGU2019-13081

Broad spatial comparison of CH_4 emission patterns in the Mackenzie Delta, NWT using airborne eddy covariance and hyperspectral visible/infrared imaging spectroscopy

Jet Propulsion Laboratory
California Institute of Technology

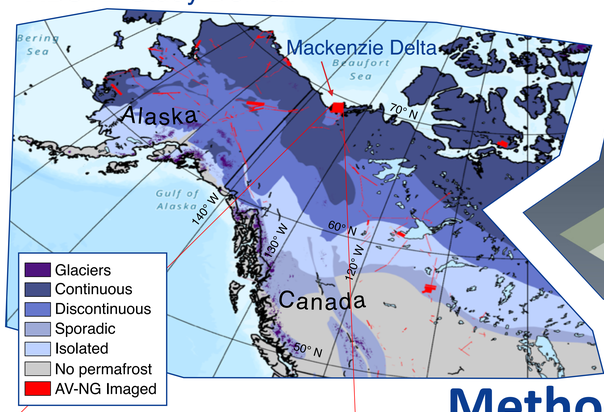
Clayton D. Elder[1], Katrin Kohnert[2], Andrei Serafimovich[3], Andrew K. Thorpe[1], David R. Thompson[1], Torsten Sachs[3], Charles E. Miller[1]

[1]Jet Propulsion Laboratory, California Institute of Technology, [2]Leibniz Institute for Freshwater Ecology and Inland Fisheries, [3]GFZ Hemholtz Centre Potsdam

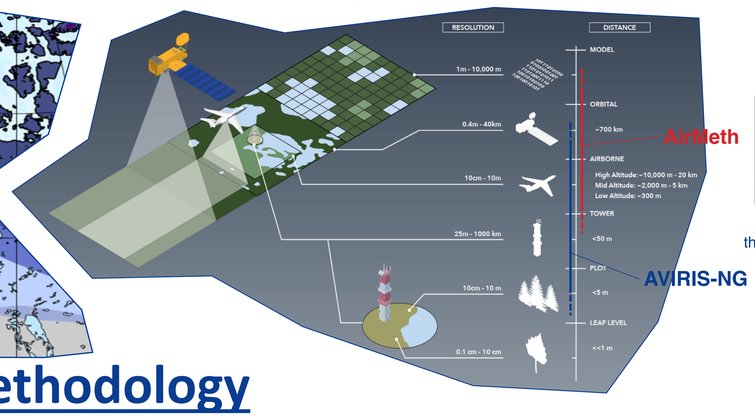
Motivation

Arctic regions are warming faster than any other region, accelerating permafrost thaw. Natural CH_4 emissions are likely to increase as consequence, constituting a positive feedback to further thaw. Despite ongoing efforts, considerable uncertainties remain in our ability to forecast arctic CH_4 emissions into the warmer future with emissions estimates varying by two orders of magnitude by 2100[1]. Here we compare two complimentary advances for **observing Arctic CH_4 on unprecedented scales**: NASA JPL's Next Generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG) and the AWI/GFZ AirMeth. Leveraging fine-scale **AVIRIS-NG hotspot detection** against the **broad spatial fluxes observed by AirMeth** we elucidate CH_4 emission patterns from process-level to landscape scales.

ABoVE Study Domain



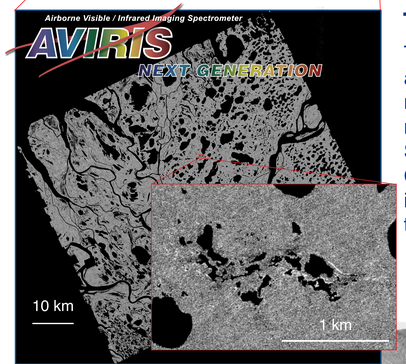
ABoVE Scaling Diagram

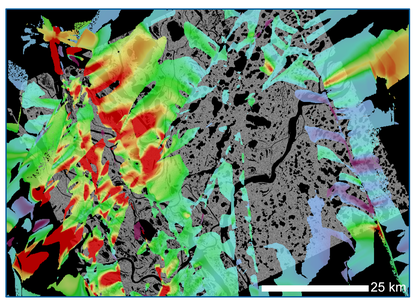


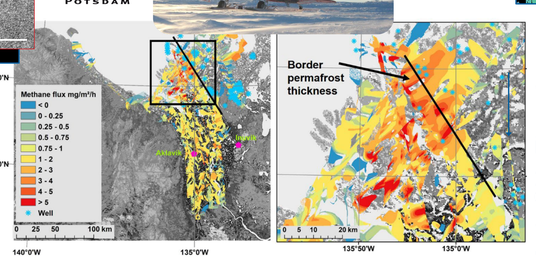
Methodology

1) AirMeth Airborne Eddy Covariance

The AirMeth system observes **CH_4 flux** via airborne eddy covariance. Low altitude flights and repeat passes allow for flux calculation at a resolution of 100m across several 1000km². Surveys conducted in **2012 and 2013** mapped CH_4 fluxes in the M. Delta and revealed the influence of strong **geologic seeps** in the region's total emissions[2].





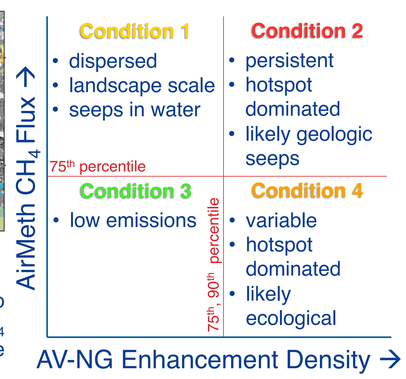


2) AVIRIS-NG Column CH_4

AVIRIS-NG detects absorption of reflected solar SWIR radiation by CH_4 in the atmospheric column and determines the **excess CH_4 concentration** above background levels[3]. Images of enhanced CH_4 are produced at **5m resolution**. In July 2017, the Mackenzie Delta was mapped, producing a **5,000 km²** mosaic of > 320,000,000 individual CH_4 observations.

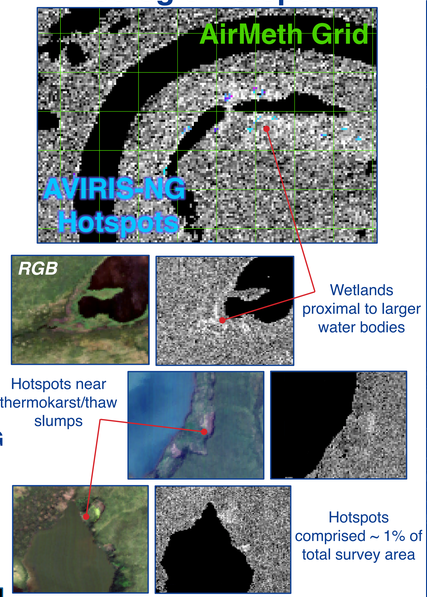
3) Spatial characterization

Leveraging the space & time differences in the two observation strategies, we characterize and map CH_4 emission modes into **4 distinct conditions** based on the relationship between AV-NG & AirMeth observations.

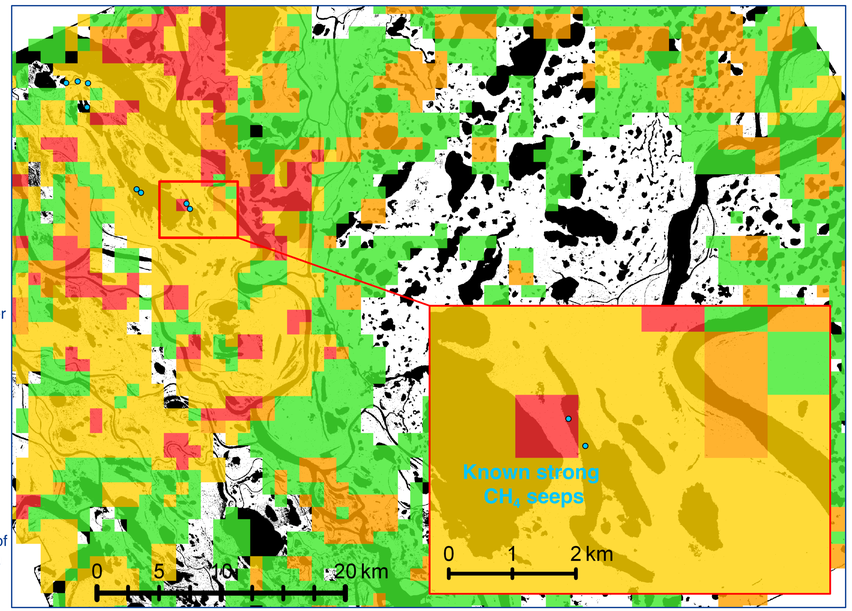


Results

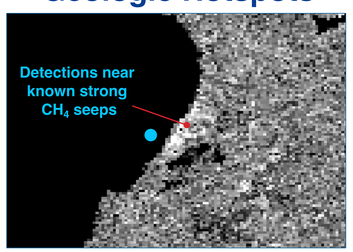
AVIRIS-NG Ecologic Hotspots



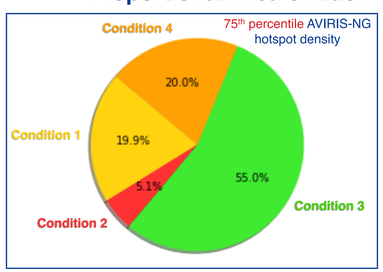
Scaling Challenge: AV-NG & AirMeth aggregated to 1km²

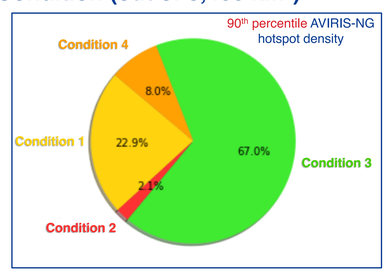


AVIRIS-NG Geologic Hotspots



Proportional Area of Each Condition (out of 3,400 km²)





Conclusions and Future Work

- 1000s of CH_4 enhancements observed via AVIRIS-NG (~1% of survey area)
- CH_4 enhancements related to typical delta wetlands, thermokarst features, and regions of known fossil fuel exploration and CH_4 seepage
- Conceptual framework accurately represented areas of known geologic CH_4 seepage
- Temporal synchronization of AVIRIS-NG and AirMeth in 2019 and 2020
- Apportionment of geologic vs. ecologic CH_4 fluxes
- Relate CH_4 emissions to permafrost conditions and vegetation.
- Scale fluxes across ecological domains and to the broader Arctic

References and Acknowledgements

[1]Schneider Von Deimling et al. *Biogeosciences* (2015). [2]Kohnert et al. *Scientific Reports* (2017). Thompson et al. *Atmos. Meas. Tech.* (2015). We thank Winston Olson Duvall and the AVIRIS team for assistance with data processing.