Methane retrieval over anthropogenic point sources using Hyperspectral Remote Sensing

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The atmospheric methane burden is increasing rapidly, contrary to pathways compatible with the goals of the 2015 United Nations Framework Convention on Climate Change Paris Agreement.

Urgent action is required to bring methane back to a pathway more in line with the Paris goals.

Emission reduction from “tractable” (easier to mitigate) anthropogenic sources such as the fossil fuel industries and landfills is being much facilitated by technical advances in the past decade, which have radically improved our ability to locate, identify, quantify, and reduce emissions.

Nisbet et al., 2020
https://doi.org/10.1029/2019RG000675
The issues with Inventories

…we find that methane emissions from natural gas, oil and coal production and their usage are 20 to 60 per cent greater than inventories.

Schwietzke et al., 2016

For example, of the 270 surveyed landfills, only 30 were observed to emit large plumes of methane. However, those 30 were responsible for 40% of the total point-source emissions detected during the survey.

Riley et al., 2019
My project objectives

Developing a CH$_4$ retrieval for point sources

Requires very high spatial resolution; localised observations from aircraft hyperspectral

Analysing CH$_4$ at a local scale worldwide

Requires global data from satellites, eg. Sentinel 5 Precursor.

Comparing CH$_4$ fluxes to emission inventories

Combining methods, eg. high resolution transport models, to evaluate emissions
CH$_4$ targets

for AisaFENIX campaign, UK, May 2018

Novel application for this instrument

First UK CH$_4$ point source campaign using remote sensing
Using SVD for spectral analysis

The goal is to identify large CH$_4$ enhancements over the background CH$_4$ with a statistical approach:
It’s faster and no instrument knowledge is required
Can we find the plume?

How well does the retrieved agree with the simulation?

Challenges
- Stripeing pattern in the image
- Reflective surfaces (albedo bias)
FENIX landfill preliminary results
Next steps

Run simulations on other scene
Check how reflective surfaces (buildings, etc.) affect the retrieval

Run our retrieval on all sites for FENIX
Isolate plumes and calculate fluxes

Use Sentinel 5P CH₄ for super-emitters globally
Evaluate emission inventories through atmospheric modelling
SUMMARY

- Developed our own retrieval method tested on AVIRIS-NG.
- Results compare very well to simulated plumes.
- Promising for confidence in retrievals from FENIX data.

Thank you
Genetic algorithm for singular vector selection

Allows an automated background CH$_4$ characterisation of the spectral data for our retrieval