Detecting and quantifying methane point sources from space-based system

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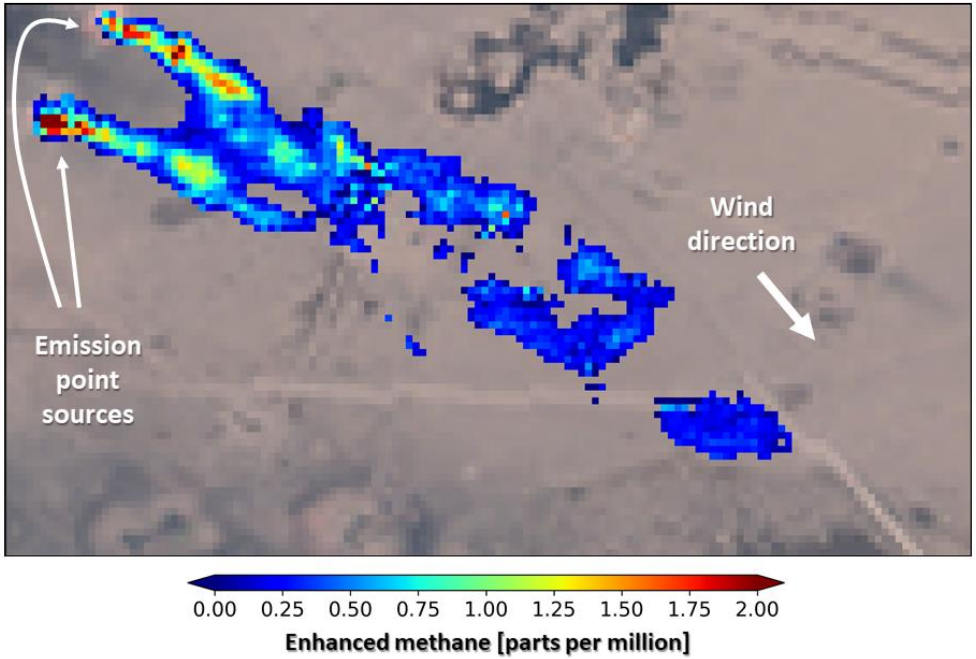


- Localised methane emitters are important contributors to regional methane budgets.
- New hyperspectral sensors offer a great opportunity to detect and maps emission plumes.
- Here, we demonstrate the use of WorldView-3 to observe emission plumes from an oil and gas facility with very high spatial resolution (4 metres).

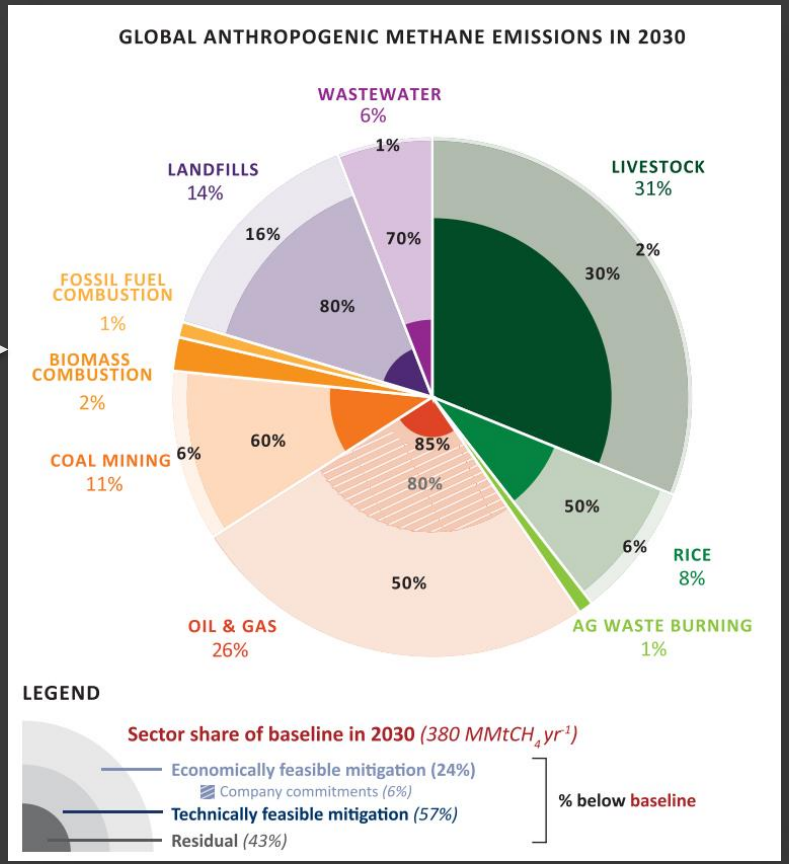
Why measure methane…

- Methane has 84 times the GWP of CO_2 over a 20-year period but a shorter lifetime of 12 years.
- 60-70% of methane is anthropogenic.
- There is great potential for climate change mitigation at short timescales.

…from space?

- Satellite observations allow detection and quantification of methane even in areas where monitoring would be difficult or costly.
- There are many current and upcoming satellite instruments with a wide range of capabilities that can be used in synergy.

Particularly point sources from the oil and gas industry



Ocko et al. (2021)

METHODS

Multispectral:
WorldView-3
(WV-3) 4 x 4 m^2
8 broad SWIR bands (30-70 nm)
Focus of this work

Similar satellites:
- Hyperspectral: **PRISMA**
- Multispectral: **Sentinel-2**

Spectral PCA-based retrieval

- Small number of singular vectors from the spectral PCA describe background.
- Spectral CH_4 Jacobian describes radiance changes corresponding to methane enhancements.

Background

Methane (KCH_4)

$$F(W,J) = \sum_{k=1}^{c} J_k \cdot W_k + J_{c+1} \cdot W_{c+1}$$

1. Forward model

$$\|y - F(J,W)\|^2 = 0$$

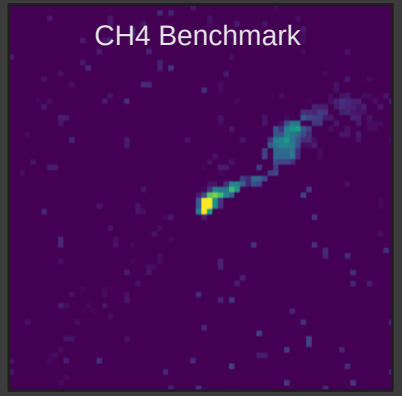
2. Least-squares fit

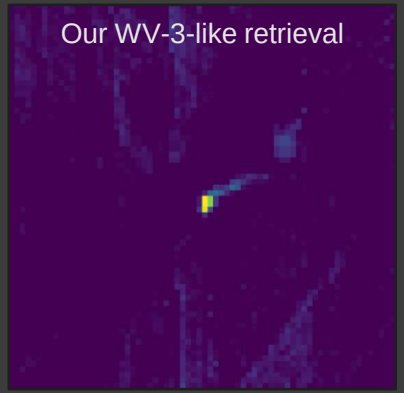
Based on Thorpe et al. (2014)

IME flux inversion

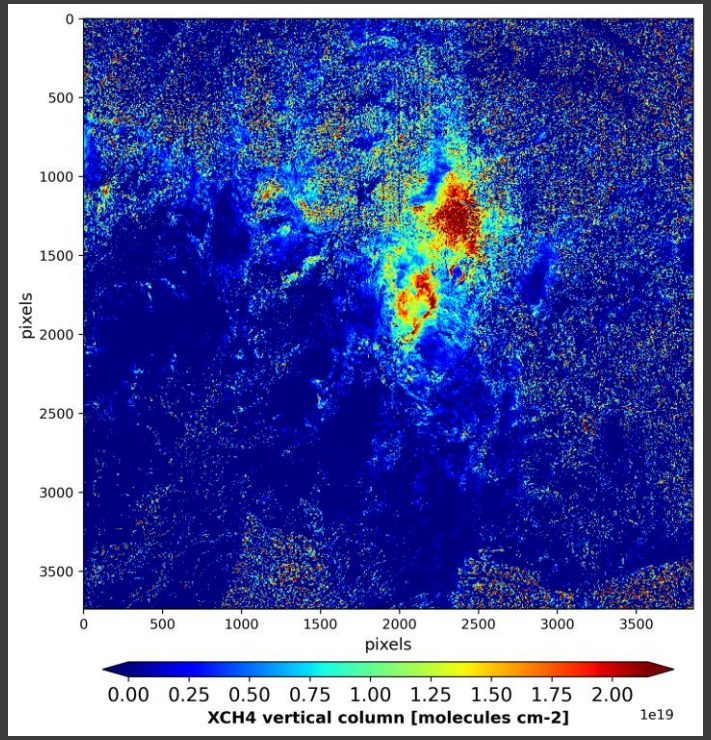
- Source rate estimated from total plume mass, wind speed, and plume length.

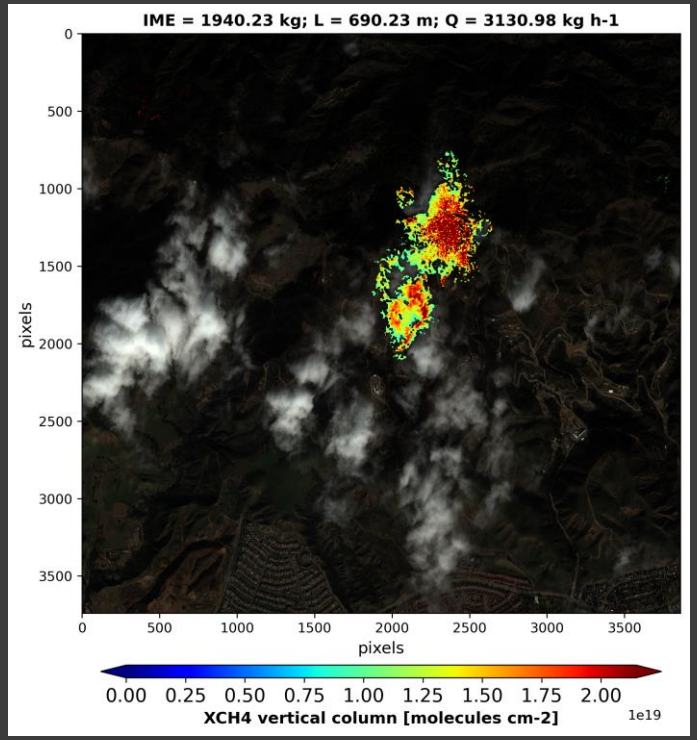
Synthetic WV-3 retrievals from AVIRIS-NG (ang20170616t212046)





CASE STUDY: ALISO CANYON

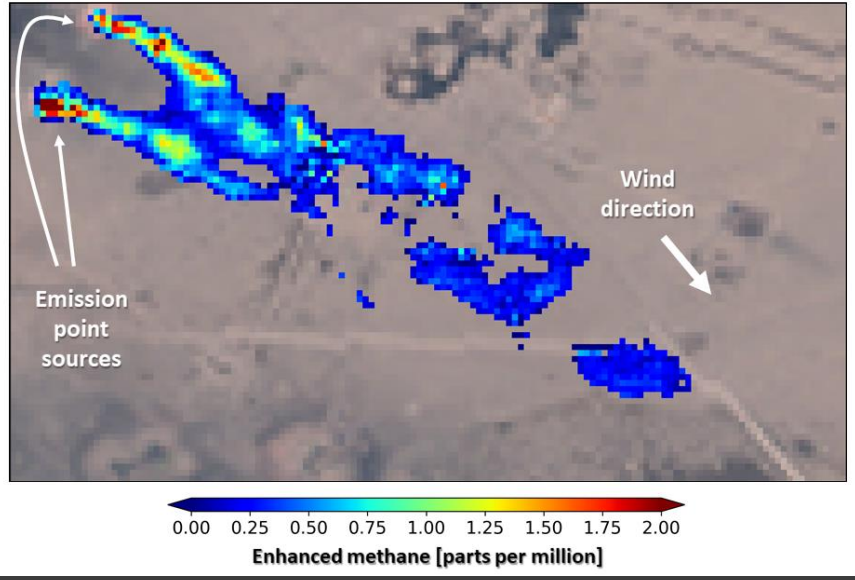




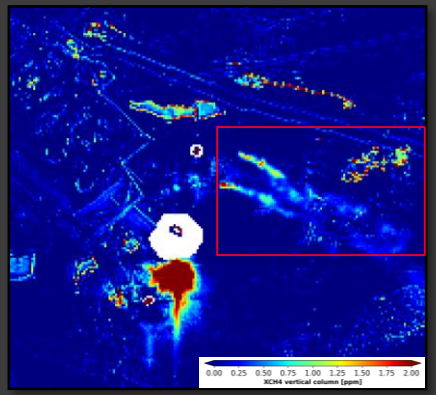
- Successful detection of large plume from Aliso Canyon blowout on 20th January 2016.
- Estimated emission rate is 3,130.98 kg/h.

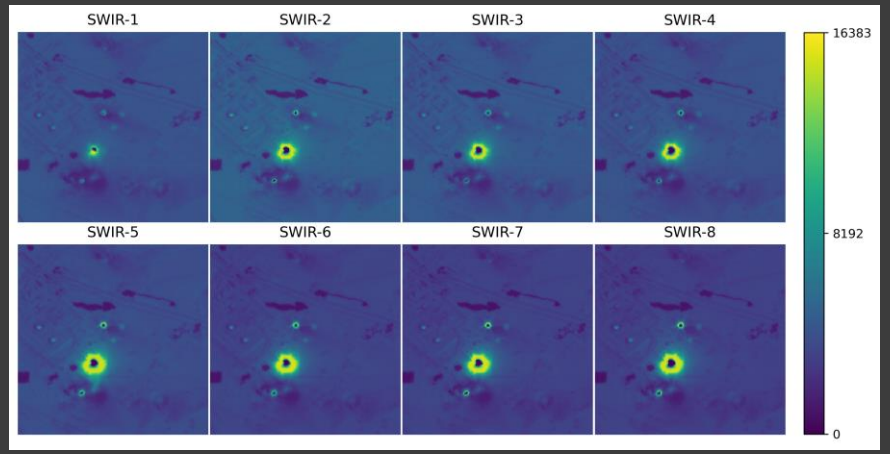
CASE STUDY: MIDDLE EAST OIL AND GAS FACILITY

Emission rate ~ **3,500 kg/h**



Detector saturation during hot flaring





Summary and outlook

- We have demonstrated the use of WorldView-3 (WV-3) to detect and quantify methane plumes from oil/gas facilities.
- A limitation of WV-3 is presence of hot flaring (due to detector saturation), or complex surfaces.
- In coming years, more missions to detect and quantify methane point sources will become available that will provide an important resource to support methane mitigation measures

Wide variety of instruments available and many more coming up soon

Trade-offs: spatial/temporal/spectral resolution, SNR, etc.