Quantifying extreme methane releases from oil and gas with the GOES Advanced Baseline Imager (ABI)

Algorithm and case studies

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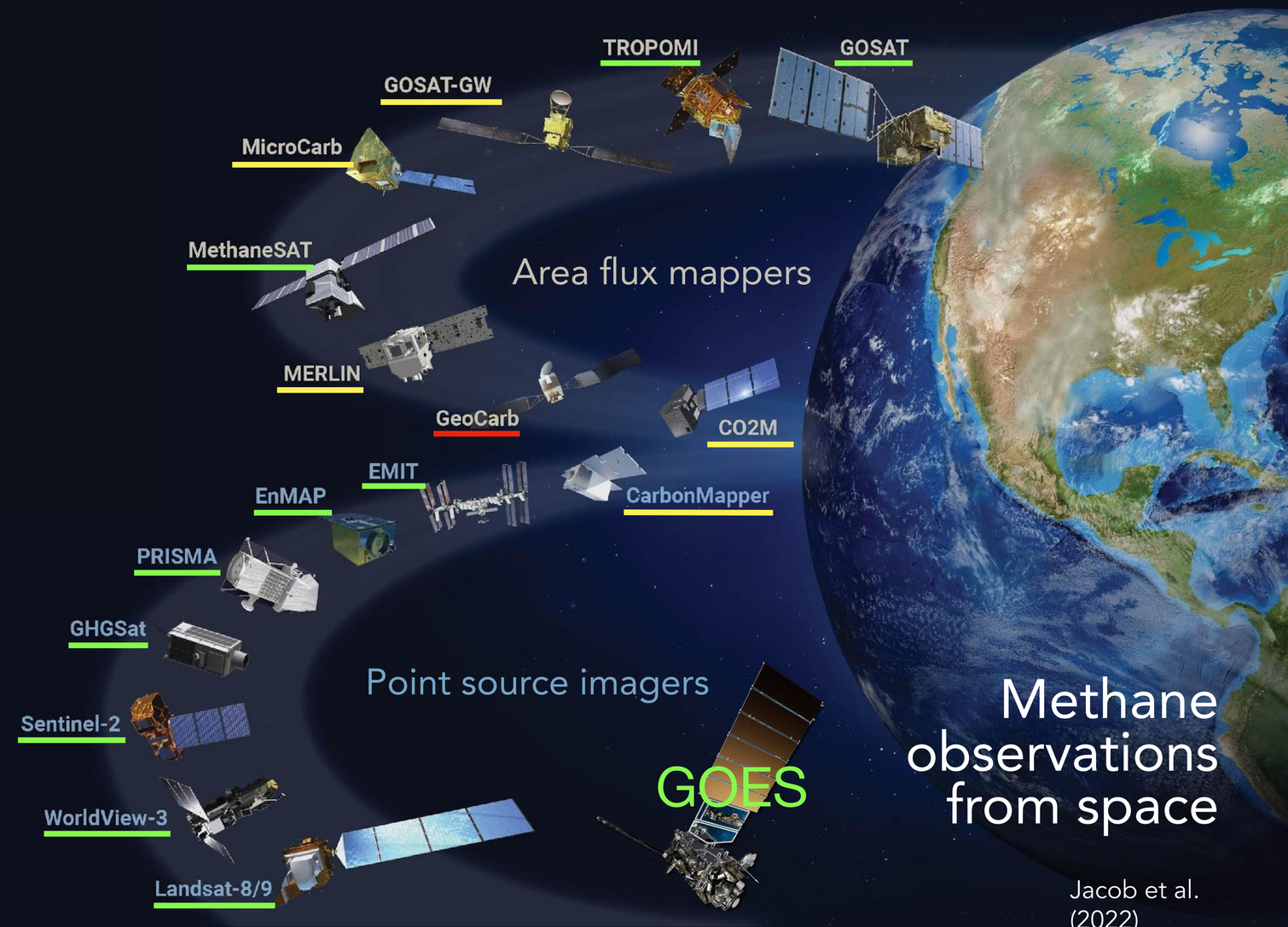
NOAA GeoXO ACX Science Team meeting | May 9

Current and planned satellite observing system for methane

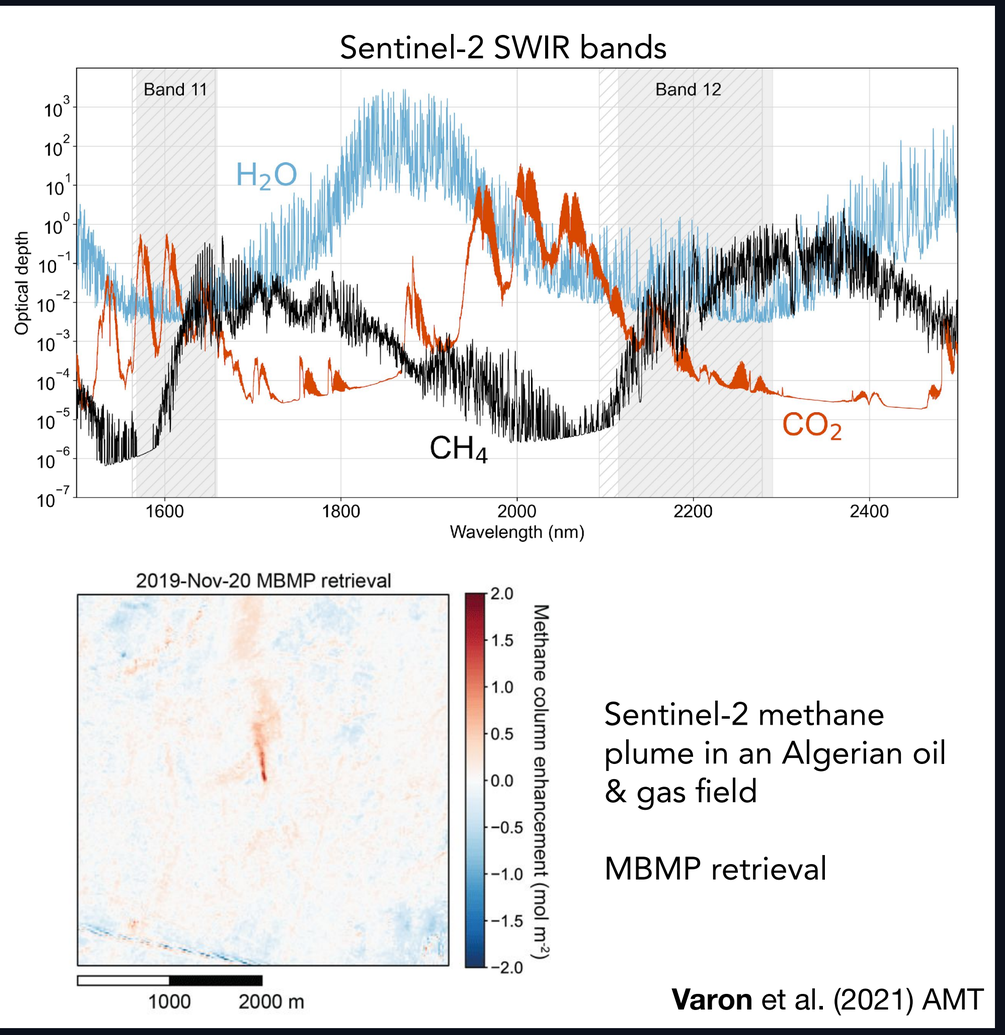
Launched
Planned
Canceled

- All instruments are in LEO (GeoCarb canceled)
- Revisit times are at best 1 day (usually >1 week)
- Observations at 10 am or 1 pm
- **Cannot quantify the total duration and impact of methane point sources**



Jacob et al. (2022)

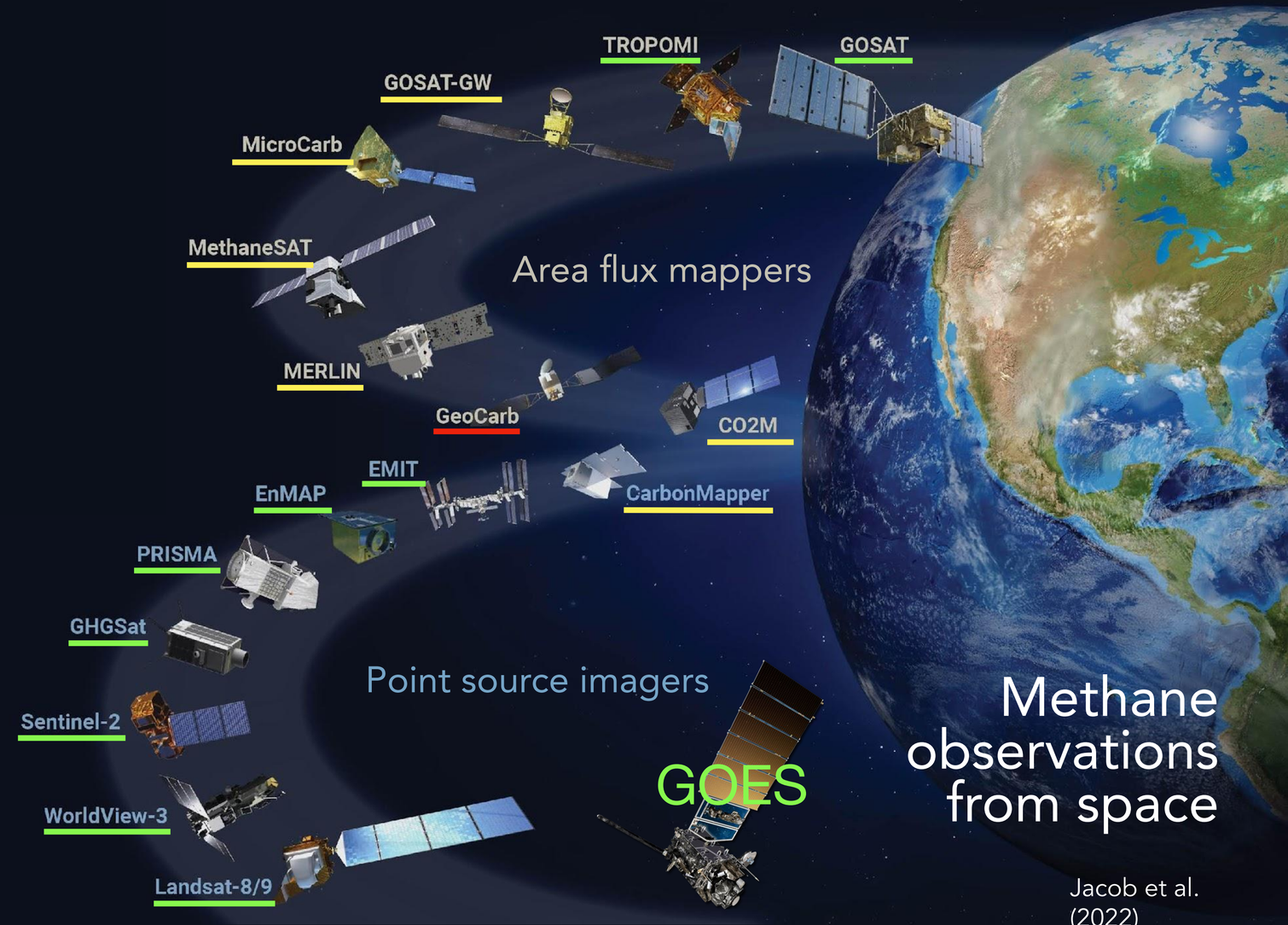
Current and planned satellite observing system for methane



Sentinel-2 methane plume in an Algerian oil & gas field

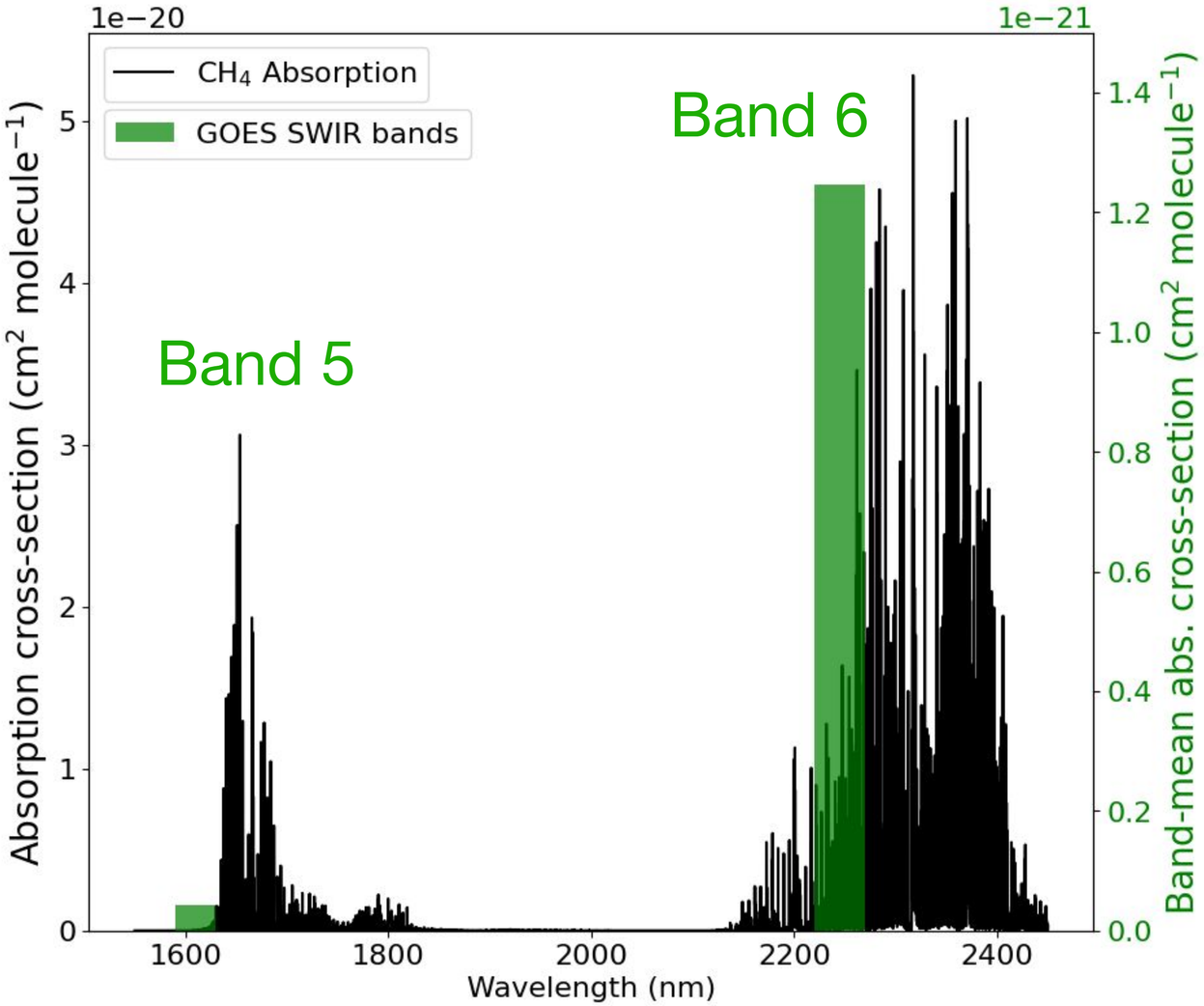
MBMP retrieval

Varon et al. (2021) AMT



Jacob et al. (2022)

GOES ABI has similar SWIR bands to Sentinel-2, Landsat, etc.



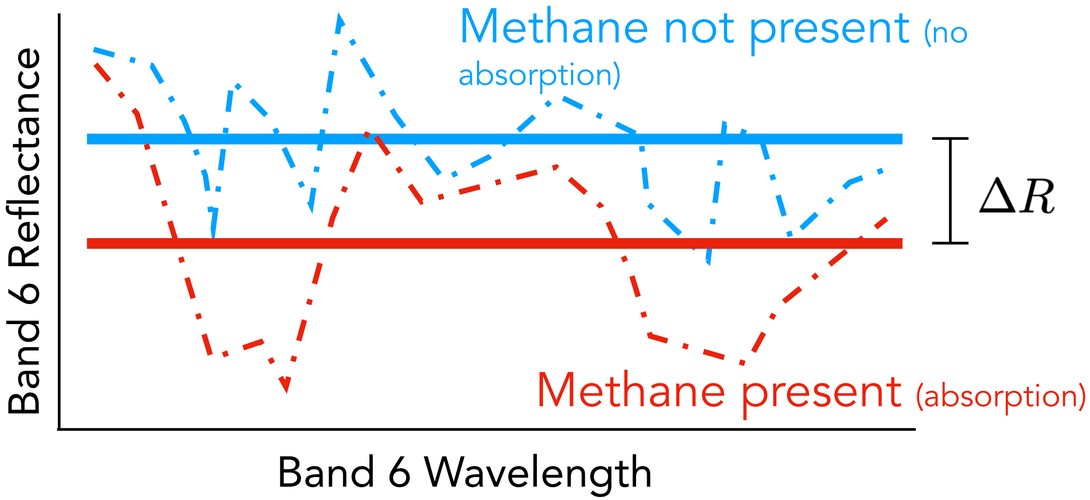
Band 6 (SWIR):

- Samples strong methane absorption lines
- Widening or shifting the band to the right would improve methane sensitivity
- Can perform MBMP retrievals every 5-10 minutes
- 2 km pixels → 1 km with GXI

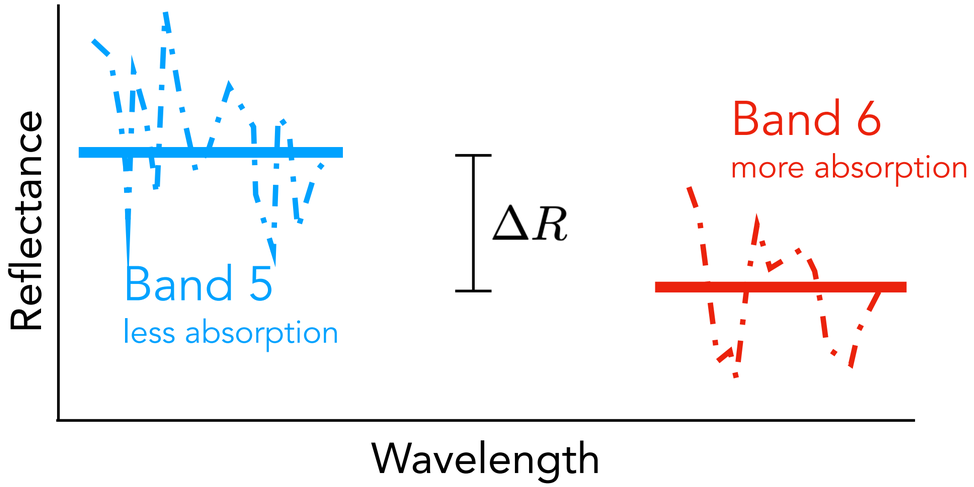
Watine-Guiu and Varon et al. (2023)

Methods to retrieve methane concentrations from multispectral satellite data

1. Single-band/multi-pass (SBMP) method



2. Multi-band/single-pass (MBSP) method

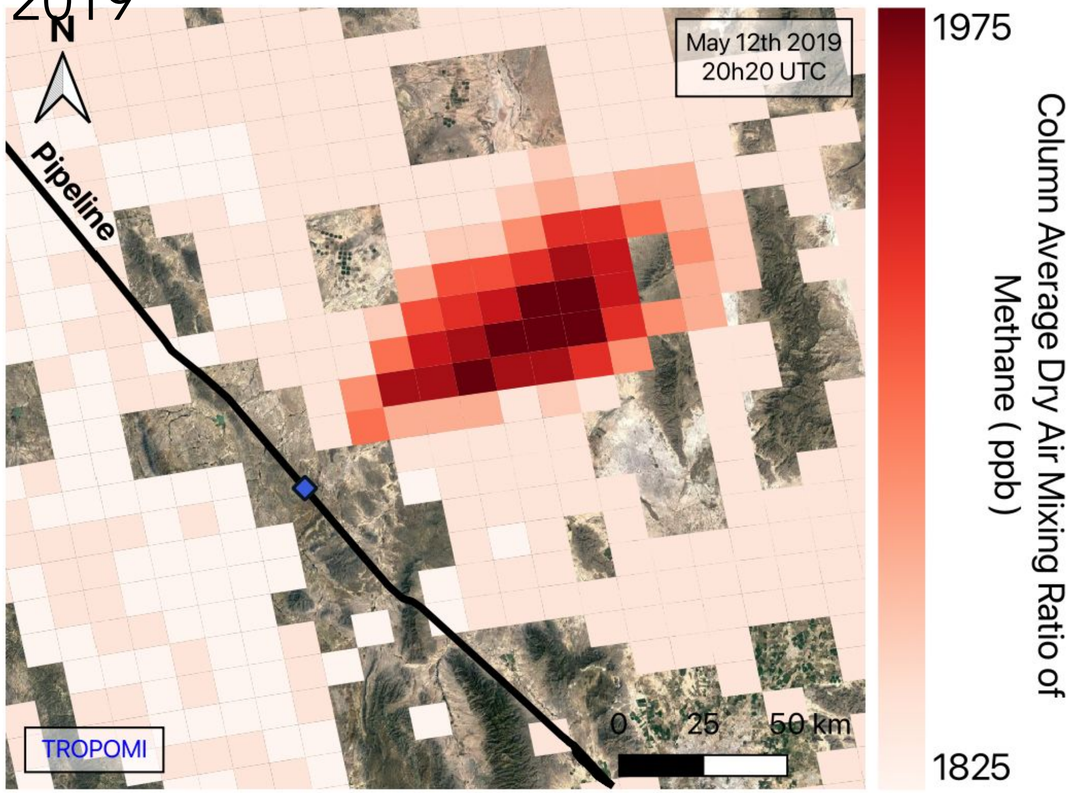


Infer methane from ΔR from Beer-Lambert law

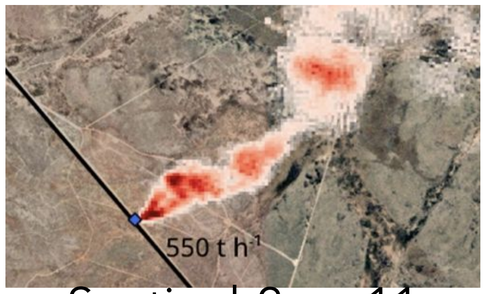
3. Multi-band/multi-pass (MBMP) method
   = Difference between MBSP results on different passes (with/without plume)

Demonstration: GOES ABI detects large release observed by TROPOMI over Mexico

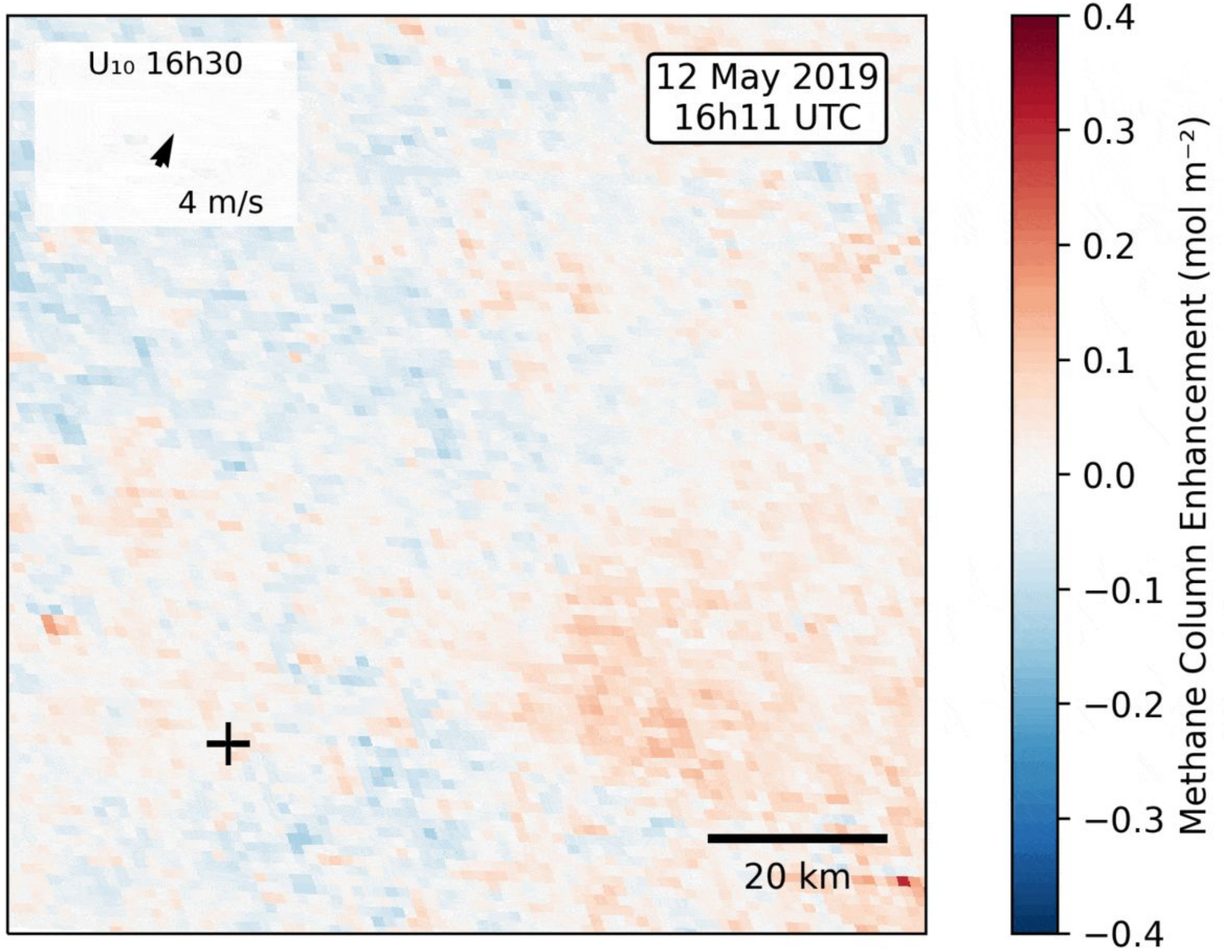
TROPOMI Detection 12 May 2019



Pipeline block station



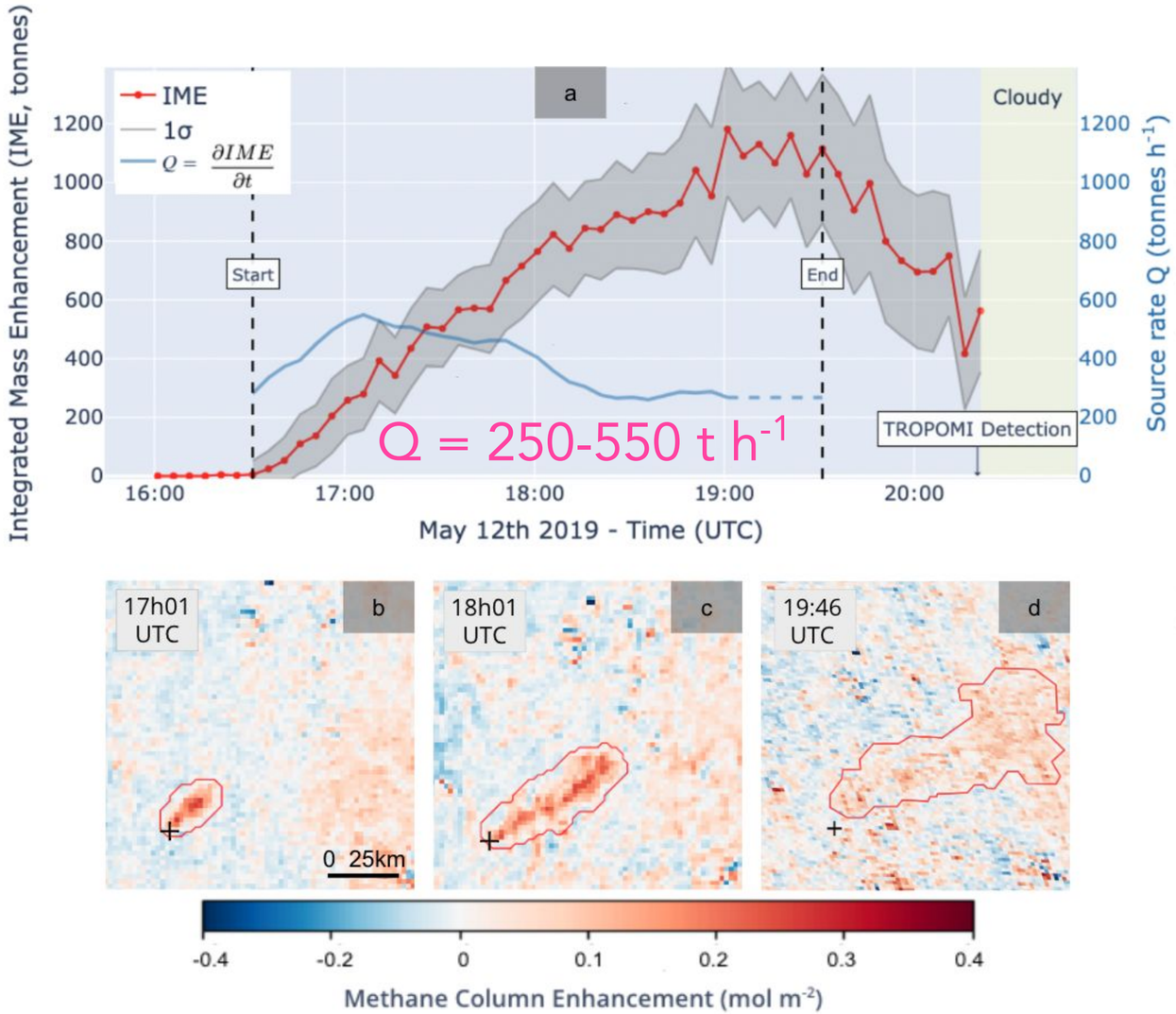
Sentinel-2 on 11 May



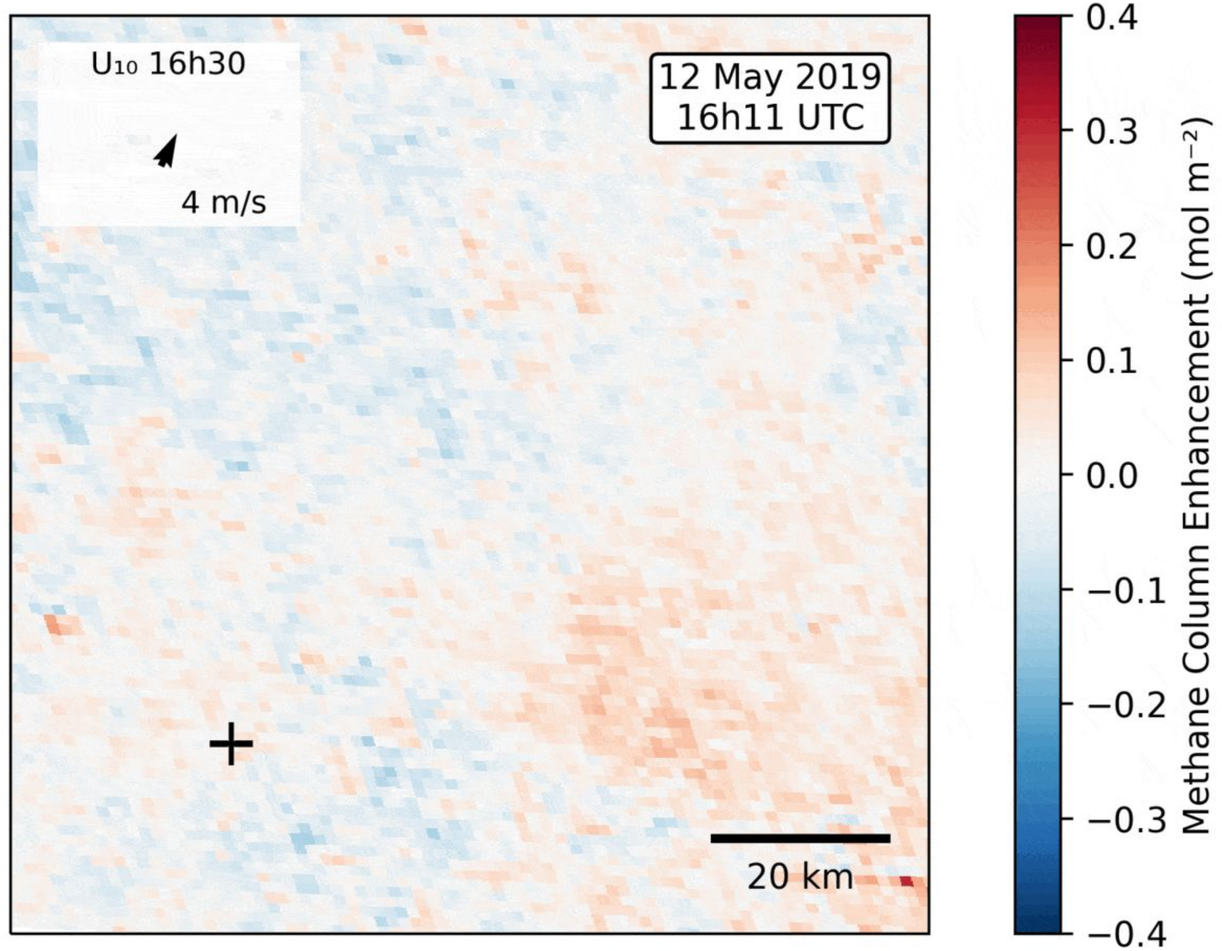
El Encino — La Laguna (EELL) pipeline in Durango
Transports Permian gas to Mexican markets

Watine-Guiu and Varon et al. (2023)

Demonstration: GOES ABI detects large release observed by TROPOMI over Mexico



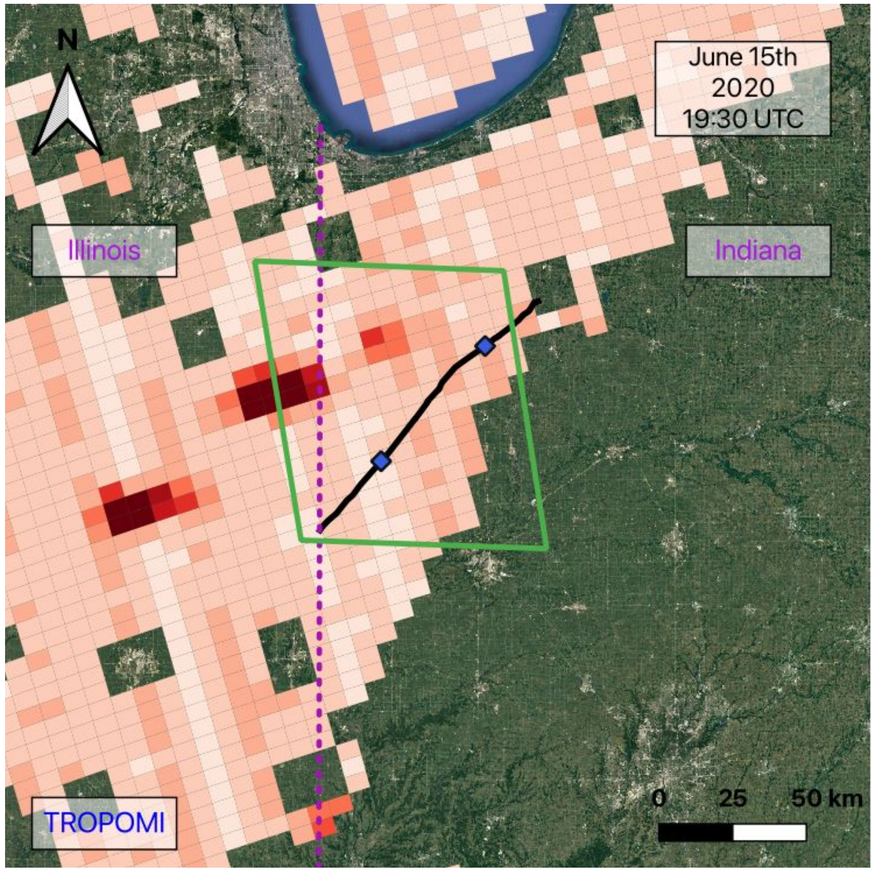
1100-1400 t released over 3 hours

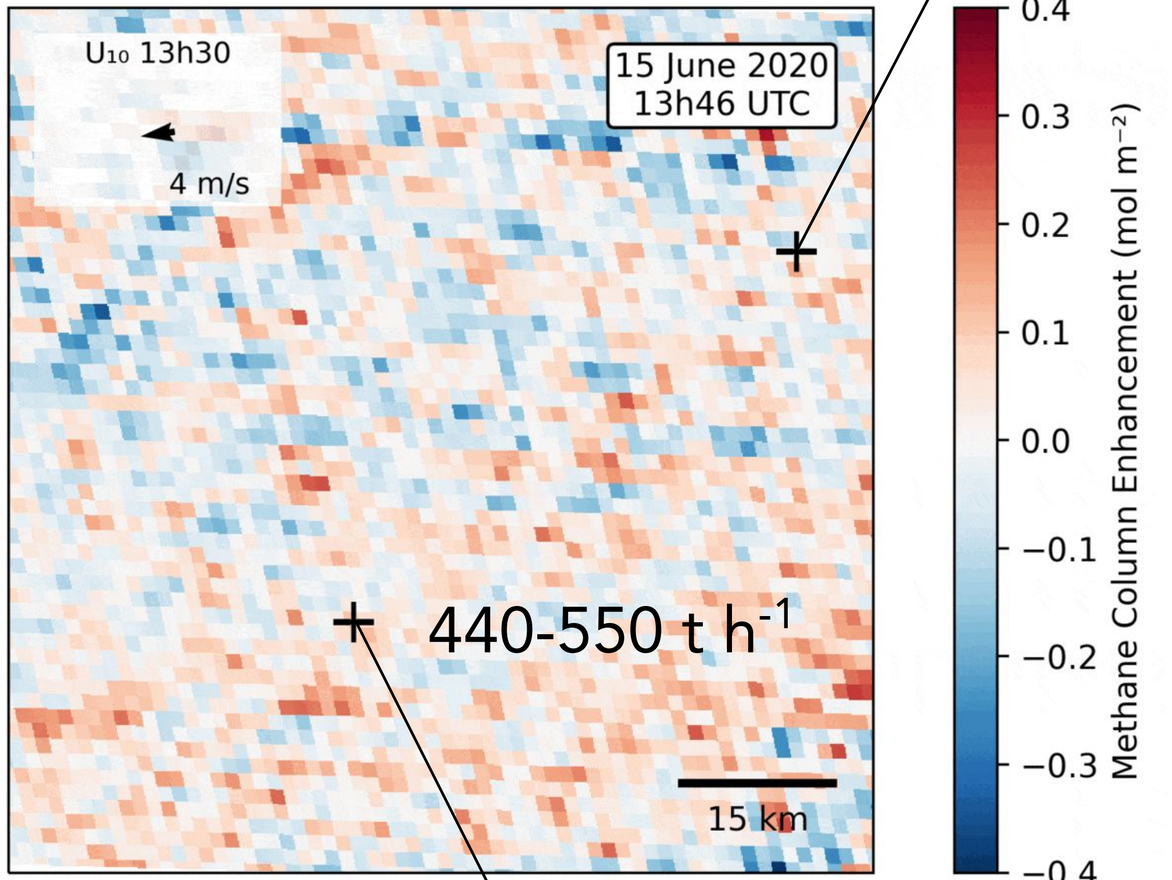


GOES ABI can quantify variable source rate and total release duration/mass

Watine-Guiu and Varon et al. (2023)

GOES ABI solves TROPOMI mystery over Indiana/Illinois





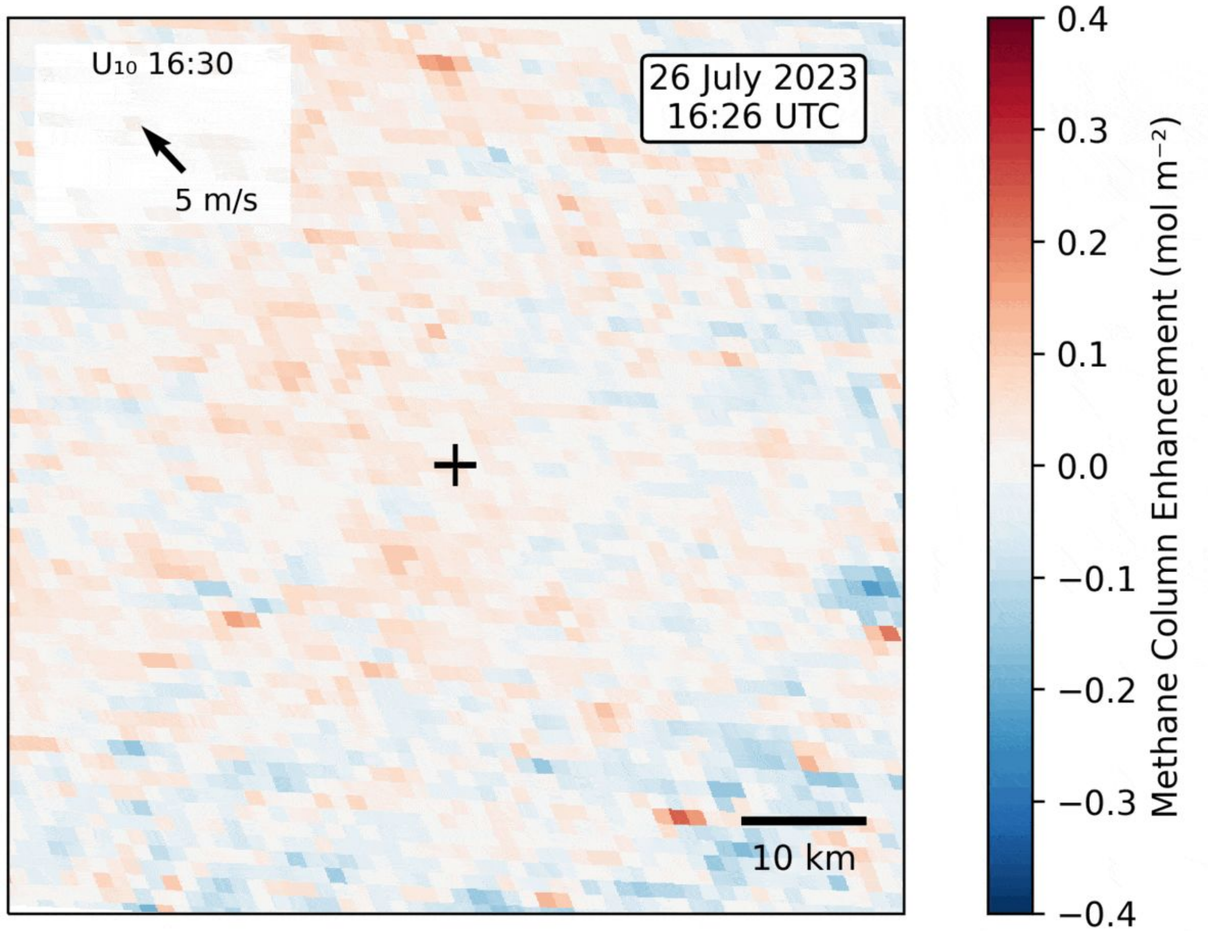
Block valve station

Block valve station

GOES ABI enables better source localization and monitoring of large transient releases

Watine-Guiu and Varon et al. (2023)

Independent methane plume detection with GOES — Infer detection limit



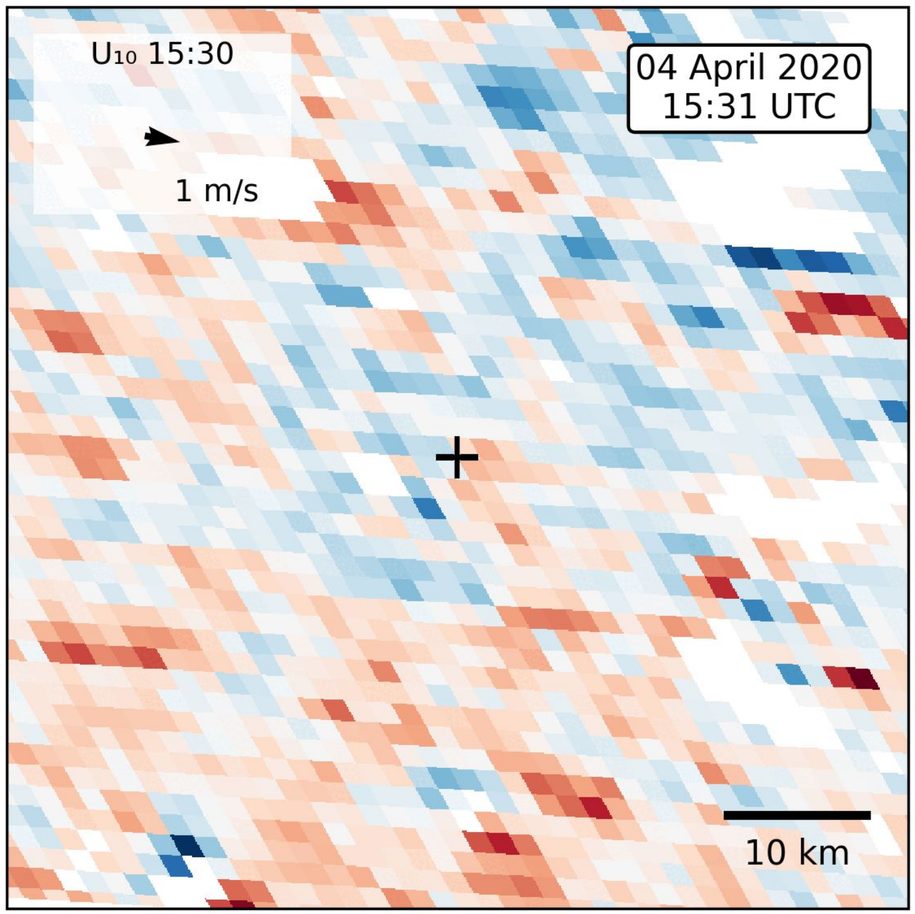
<u>GOES plume detected in the Permian</u>

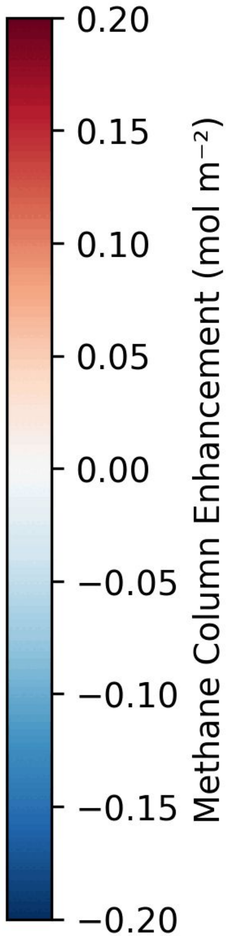
- ~60 t over 20 min (~170 t h^{-1})
- SNR (in vs. out of plume) ~ 5
- 10-m wind = 5 m s^{-1} (moderate)
- Moderately complex scene (Permian)
- Infer detection limit < 100 t h^{-1}

GOES ABI can independently detect large point sources

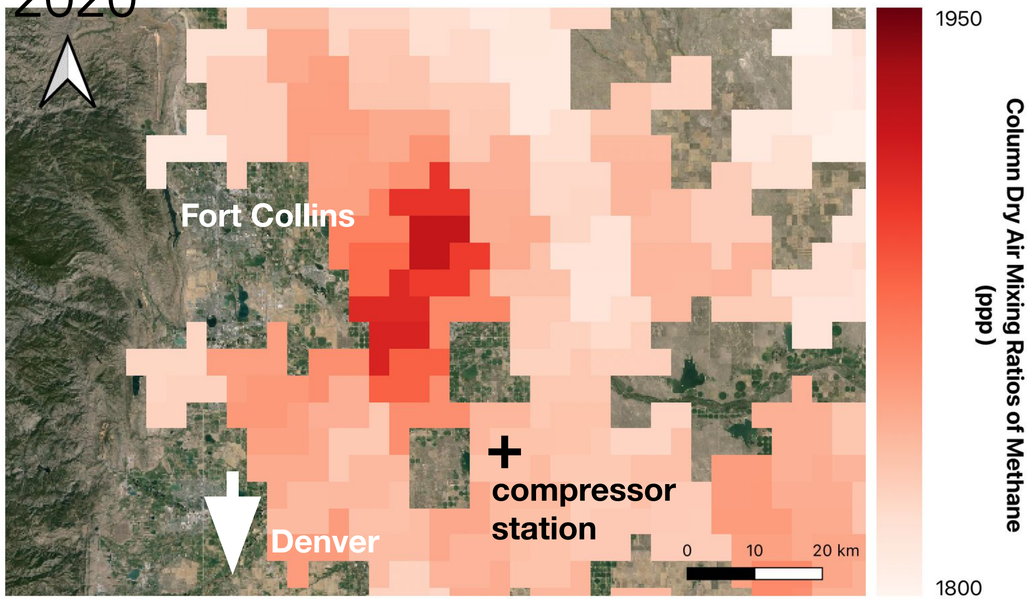
Watine-Guiu and Varon et al. (2023)

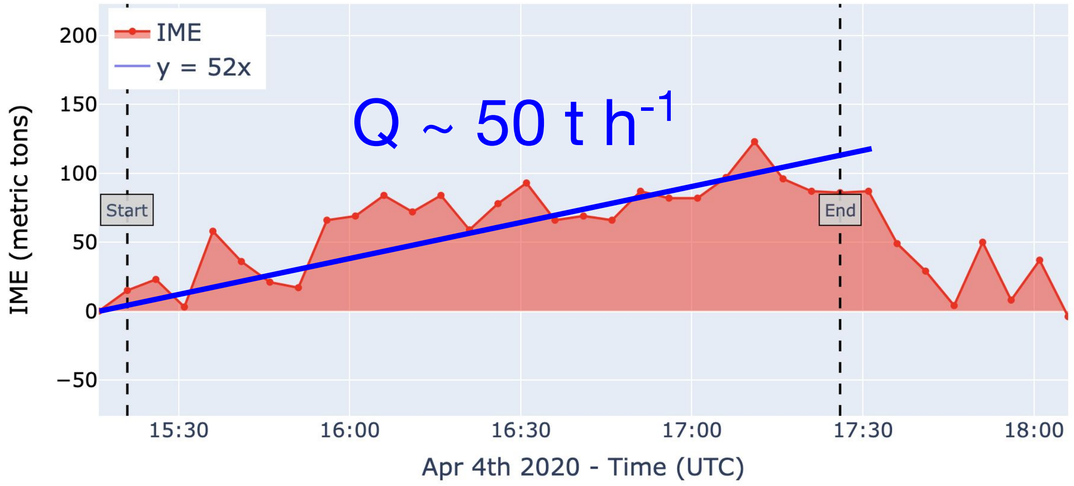
Empirical estimate of minimum detection limit ~50 t h^{-1}





TROPOMI Detection 4 April 2020





GOES ABI minimum detection limit is order tens of t h^{-1}

Distribution of GOES ABI point sources detected to-date

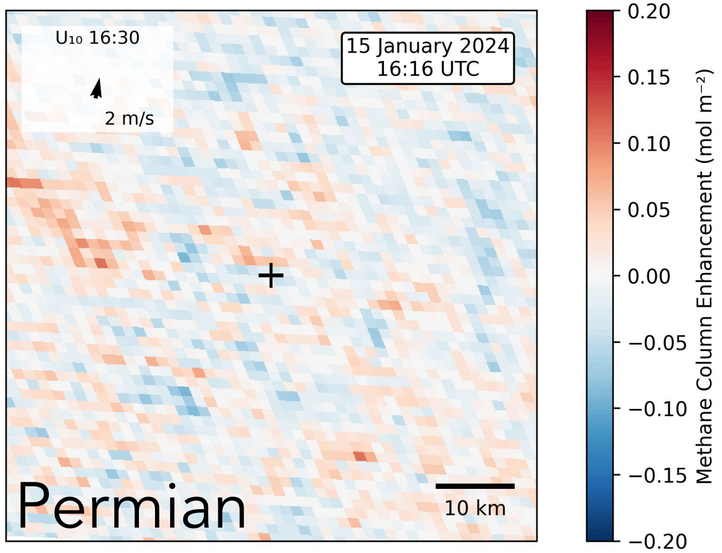
38 plumes with wide range of release durations, rates, masses:

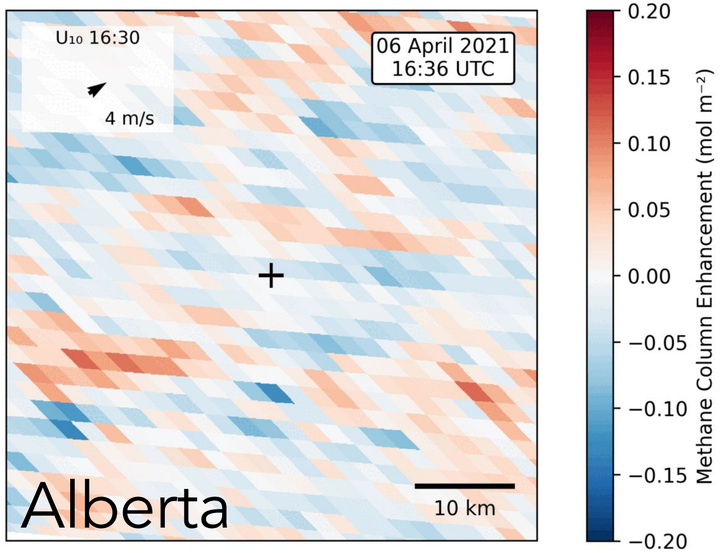
Duration:
15 min to 6 h

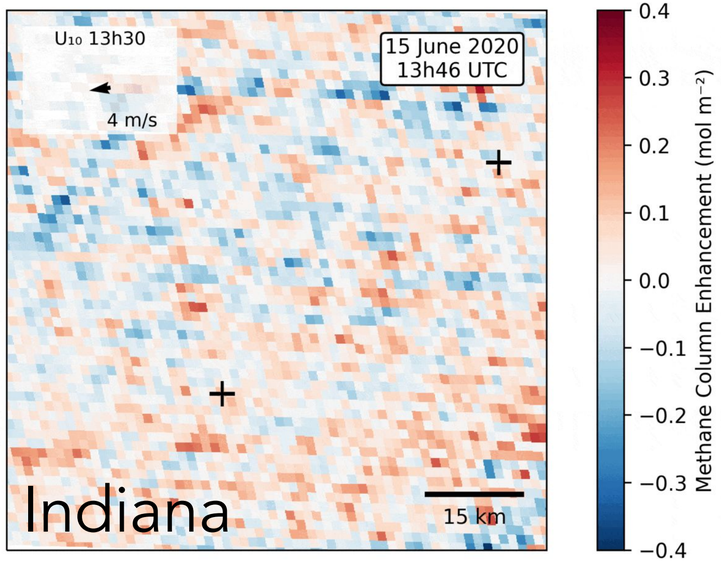
Rate:
50–900 t/h

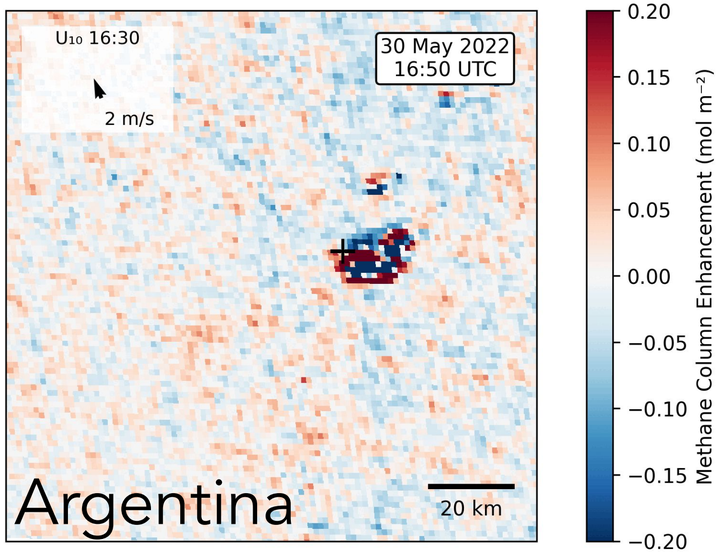
Release mass:
100–1400 t

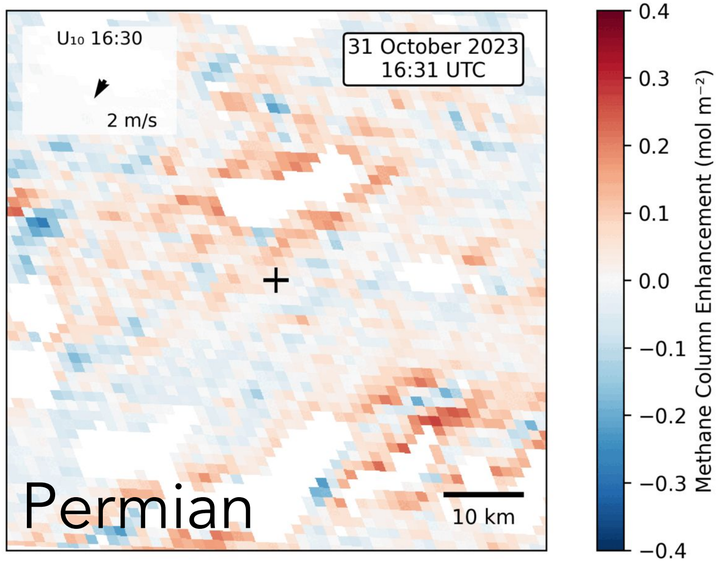
Sample of GOES ABI plume detections

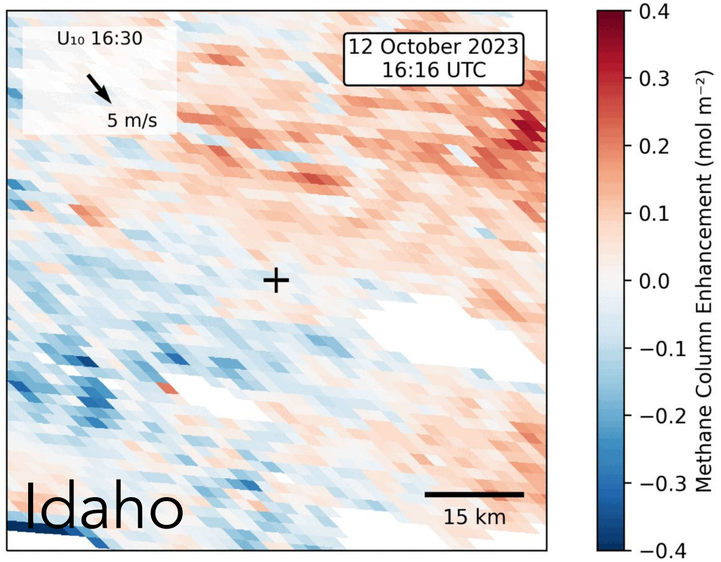












Other operational geostationary systems have similar capabilities