Pinpointing the location of methane leaks using the frequent revisit and fine resolution of multispectral satellites.

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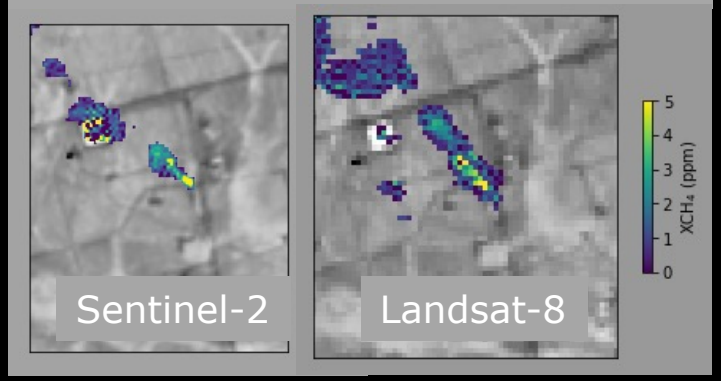
Main case study
A Permian Basin gas leak

10 t/hr methane leak was detected in the EDF/Scientific Aviation aircraft observations on 2020-9-23. Here, using methane retrievals from multispectral instrument

- We pinpoint the source location of the leak to a storage tank.
- We find regular leaks from the tank dating back to early 2018.

Methane observations from two multispectral satellites on 2020-9-24



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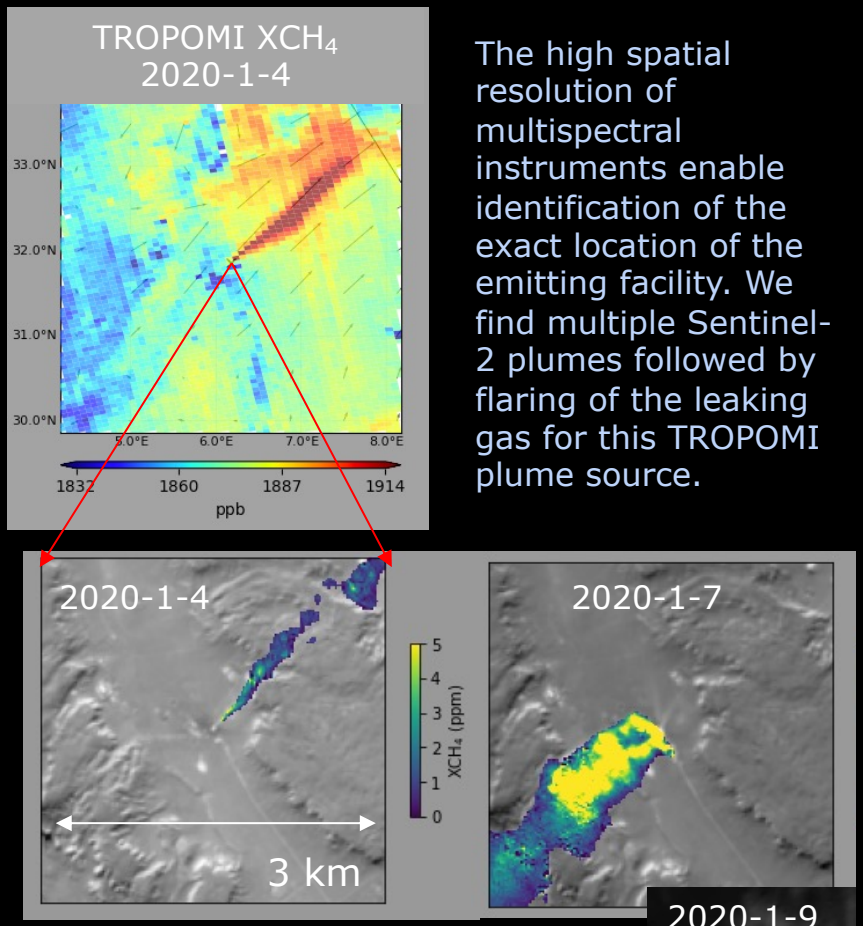
Finding & monitoring leak locations
Large TROPOMI plume in Algeria



The high spatial resolution of multispectral instruments enable identification of the exact location of the emitting facility. We find multiple Sentinel-2 plumes followed by flaring of the leaking gas for this TROPOMI plume source.

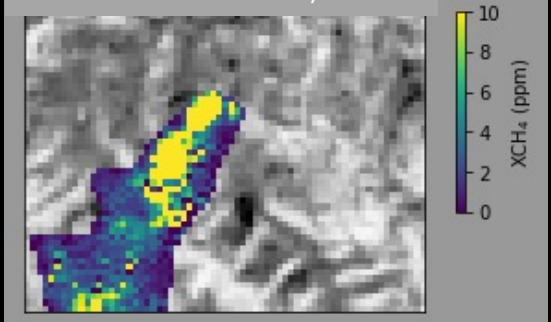
Flare detected in Sentinel-2 SWIR-1

Historical event assessment
Aliso Canyon blowout

An infrared camera image of the gas leak in December 2015. (Image/EDF)

Multispectral instruments with SWIR sensors date back to 1999. They can be used to reassess historical emission events.

Landsat-8 methane observations on 2015-10-26. Source rate: 45±15 t/hr



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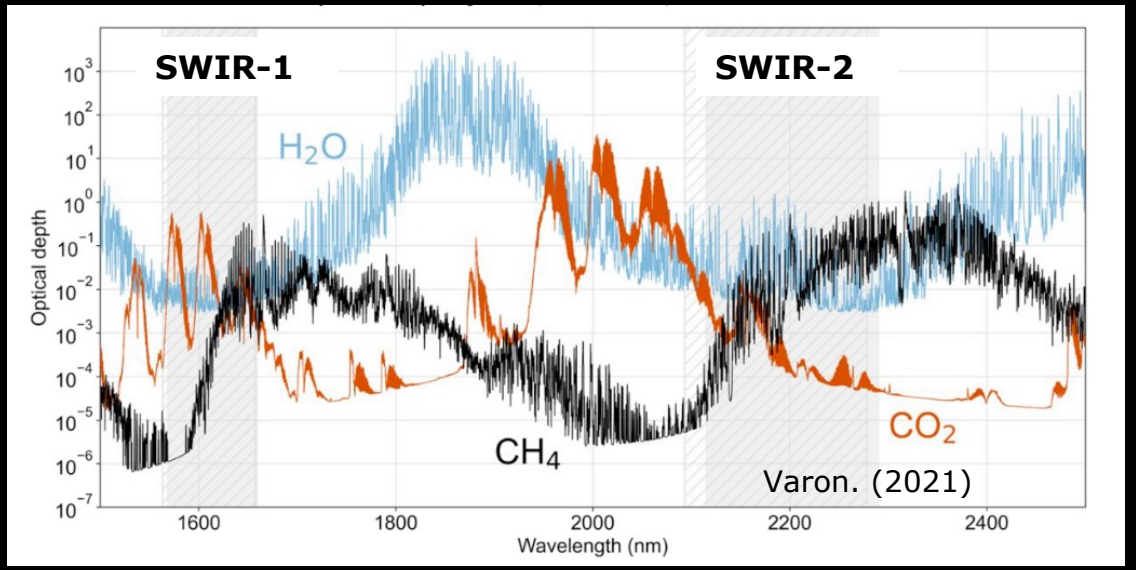
Methane observation capability of multispectral satellite instruments

- Methane retrievals are performed using the SWIR channels of multispectral instruments.
- Despite the low spectral resolution, methane retrievals are possible in the close vicinity of a source, where methane enhancement can be > 1000 ppb within a 20 to 30 m size pixel.
- We use a reference observation day to get more information to reduce the noise due to surface features (Varon. 2021).



Multispectral satellite instruments with SWIR channels

Combined median revisit time of **2.3 days** (Li et al., 2020)

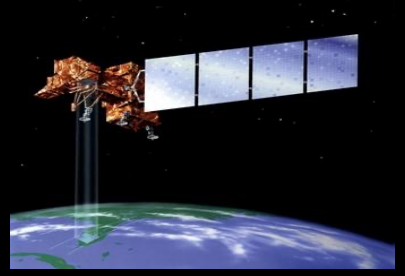
Sentinel-2
Revisit < 5 days

S-2A (2015)

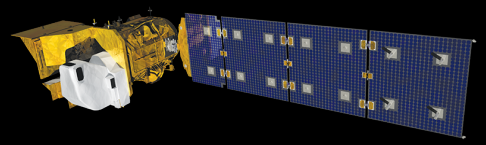
S-2B (2016)

Landsat-8 (2013)
Revisit < 16 days

Landsat-7 (1999)
Revisit < 16 days

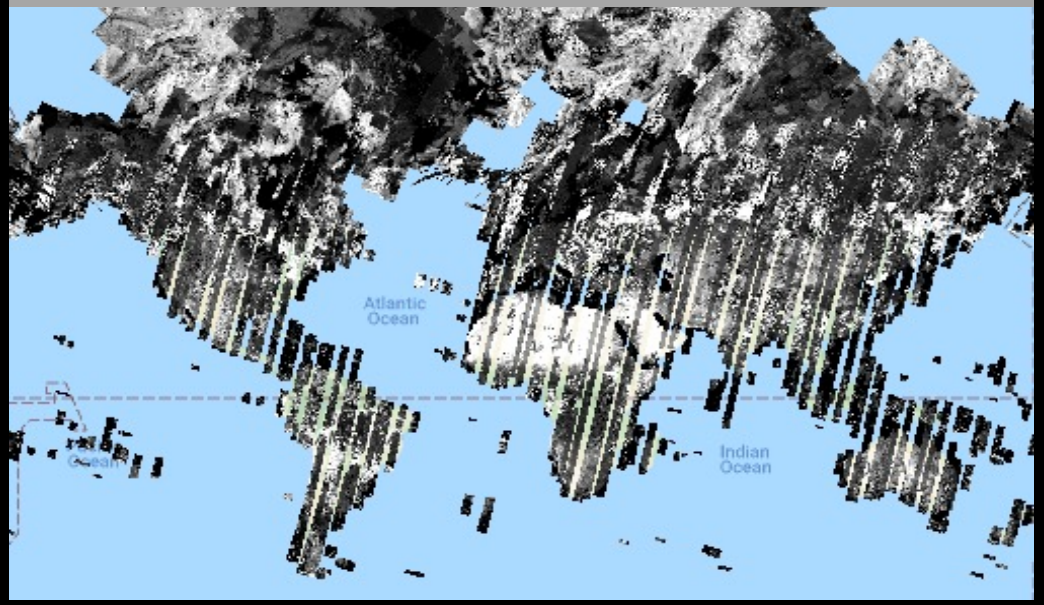


Landsat-9 (2021)
Revisit < 16 days



Methane observation capability of multispectral satellite instruments

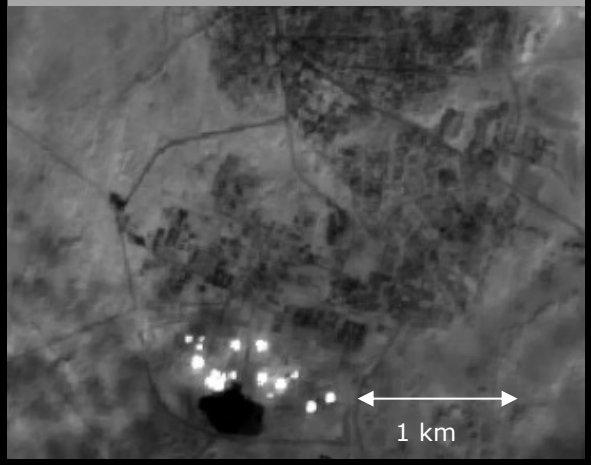
Figure. Combined 3-day coverage of Sentinel-2 and Landsat-8 satellites (source: Google Earth Engine)



Flare Detection

The SWIR bands of multispectral satellites are sensitive to gas-burning or flaring. Flares can be detected at a much higher spatial resolution than with VIIRS, MODIS.
The associated flaring or lack of flaring can be used as another piece of information for methane monitoring.

A cluster of flares observed at an oil/gas facility in Algeria as bright spots in SWIR-1 of Sentinel-2.



The regular coverage of multispectral instruments in combination with medium emissions detection limit is useful for

1. Source identification of plumes detected by global methane imagers like TROPOMI.
2. Large methane leak monitoring.
3. Historical emission assessment of point sources.

Satellite instruments	Coverage	Emission detection limit	Spatial resolution
TROPOMI	Global	5 t/hr	7 x 5.5 km^2
Hyperspectral, GHGsat	~30 x 30 km^2	0.2 t/hr	30 m
Multispectral Instruments	**Global (2 days)**	**2 t/hr**	**20 m**

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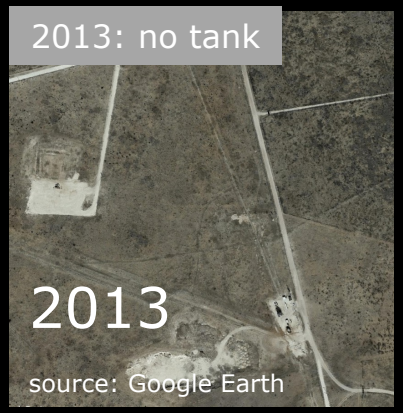
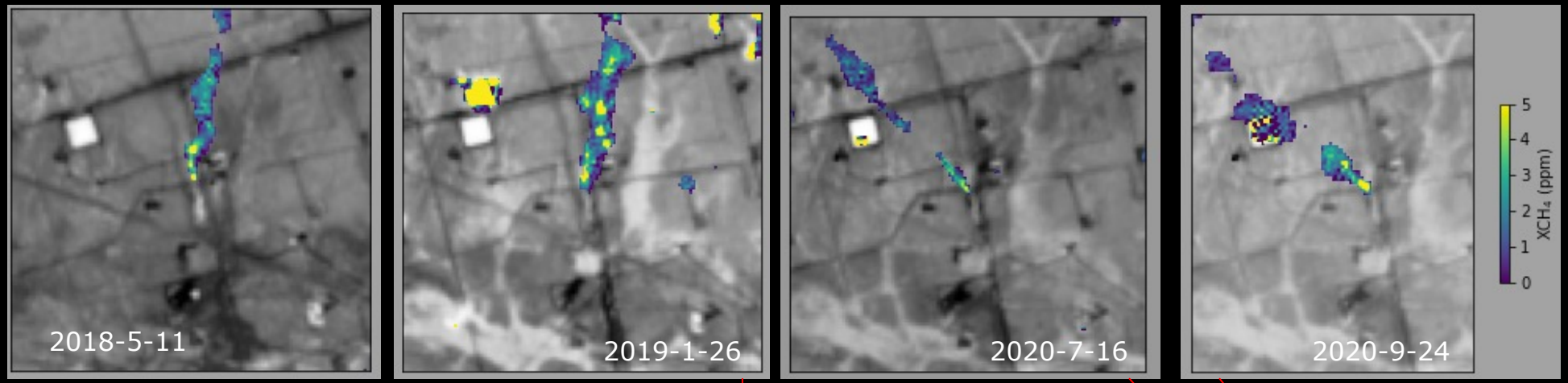
Large methane leak in the Permian Basin

Emission history of a storage tank



The official accident report states the leak started on 2021-9-23 and ended in two days. We do a full historical emission assessment of the storage tank since its installation using Sentinel-2 data.

- We observe methane leaks dating back to 2018.
- A continuous emission event from 2020-7-4 to 2020-9-24.



Large methane leak in the Permian Basin
Pinpointing the leak location at sub-facility scale

- For the continuous emission period of July-September-2020, we perform wind rotation (Maasakkers et al., in prep) to pinpoint the exact source location.
- TROPOMI wind rotation suggest persistent methane plumes originating within 2 km of the actual storage tank.
- Zooming in further with Sentinel-2 plume rotation gives the exact location (within a few meters) of the emitting storage tank in the 200 x 80 m^2 facility.