High-resolution mapping of methane point emissions in Turkmenistan’s west coast

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Study area

→ The study area is the West Coast of Turkmenistan, which is located in the Middle East on the shores of the Caspian Sea.

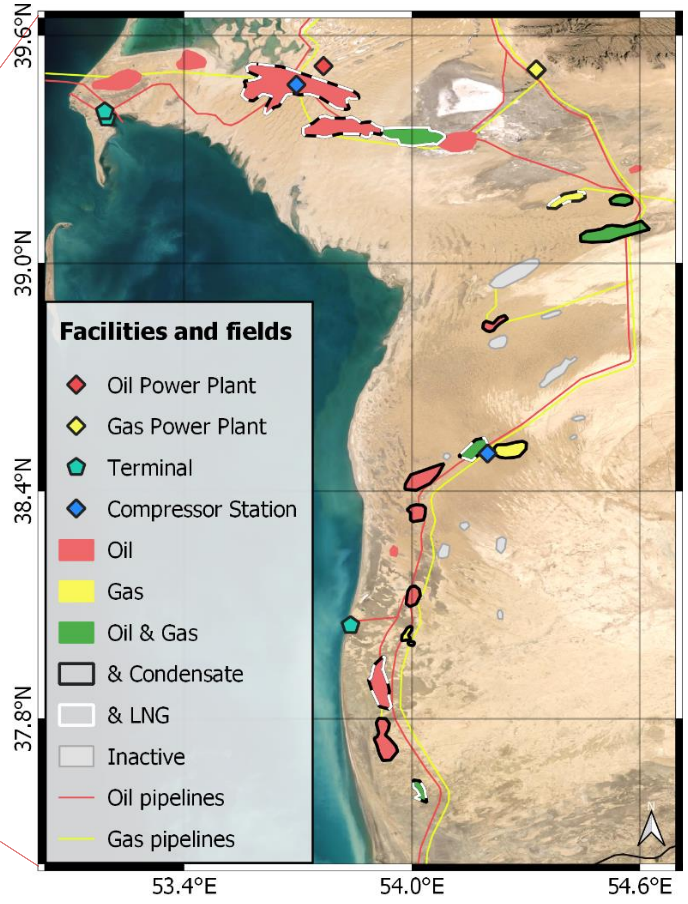
→ It is a desertic region with high O&G activity.

→ It has been identified as a methane emission hotspot region.

→ It is an especially optimal area: no vegetation, low precipitation, low surface variability, homogeneous and bright surface.

→ The O&G fields are highly concentrated (not spaced as in the United States, for example).

→ Powerful and quite constant point source emissions.



O&G fields thorough the study area.

Satellite data

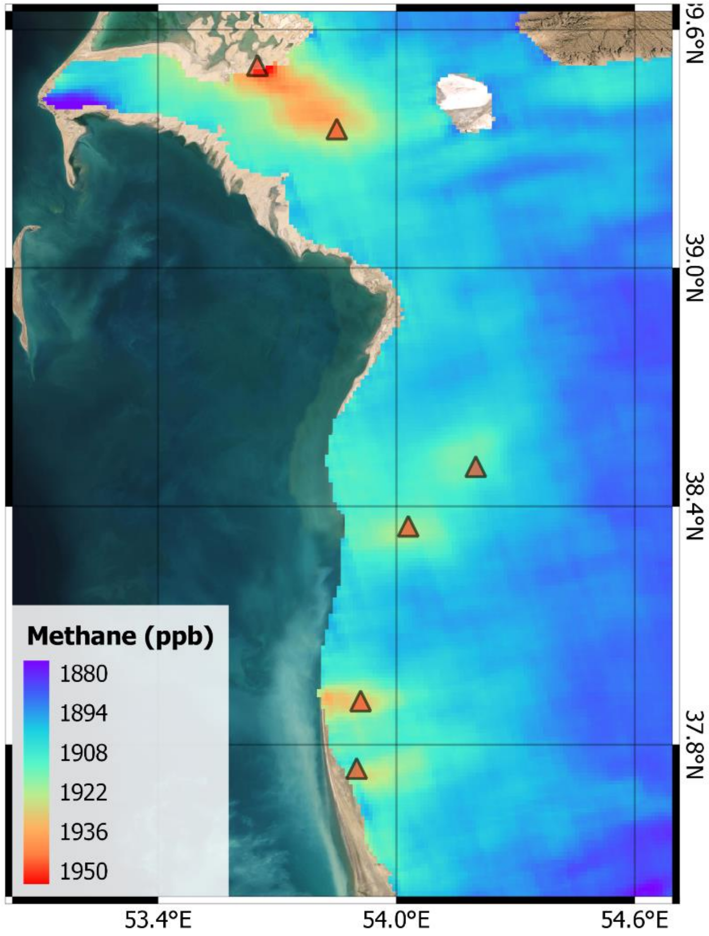
→We have combined three types of satellite data:

⇒ **TROPOMI** data: 7-5 km spatial resolution, daily and global scale.

⇒ Hyperspectral data from **ZY1** and **PRISMA**: 30 m spatial resolution, medium sensitivity (~500 kg/h) with sporadic acquisitions.

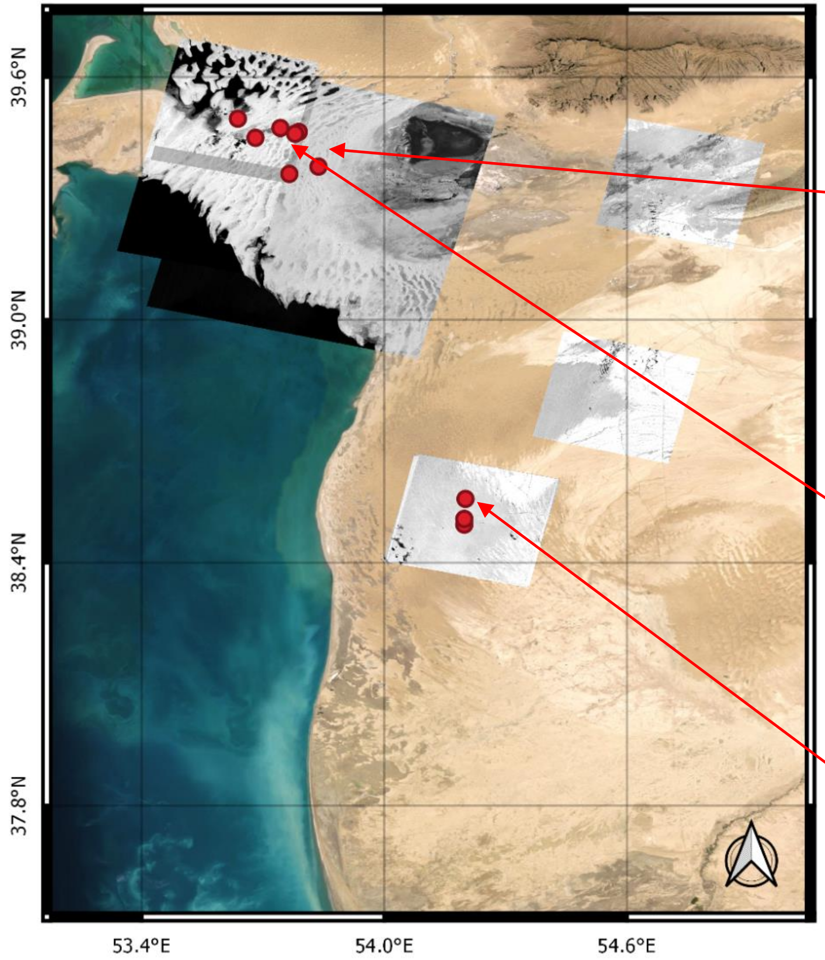
⇒ Multispectral data from **Sentinel-2** and **Landsat**: 20-30 m spatial resolution, low sensitivity (~1800 kg/h) but frequent and global coverage.

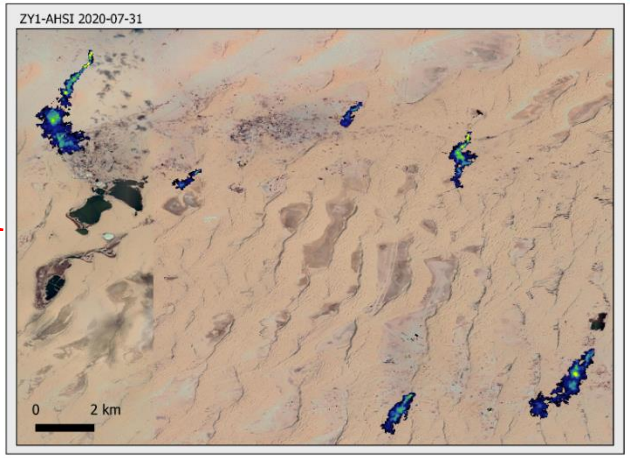
→ This synergy allows us to detect, quantify and monitor emissions over the study area.

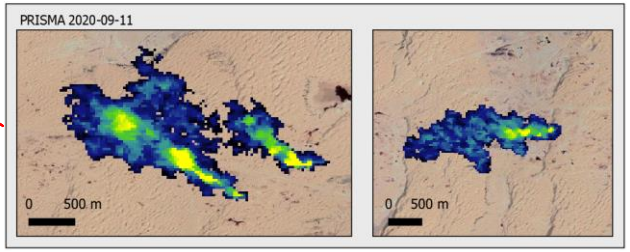


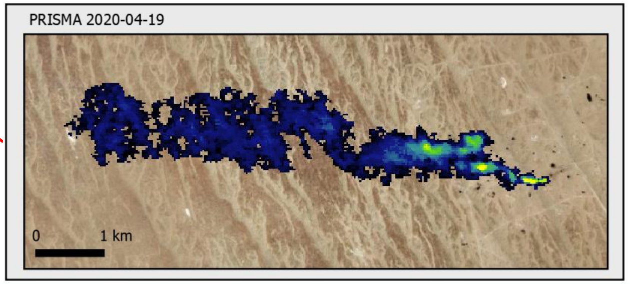
TROPOMI 0.1º grid oversampled map from Nov. 2018 to Nov. 2020 with the locations pinpointed by TROPOMI.

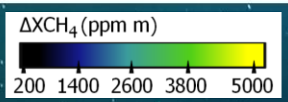
Hyperspectral data





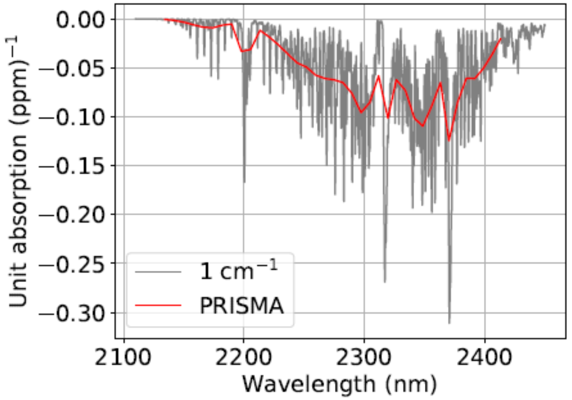






→ We have used the Chinese ZY1 mission and the Italian PRISMA mission which sample the 2100-2450 nm window with tens of spectral channels.

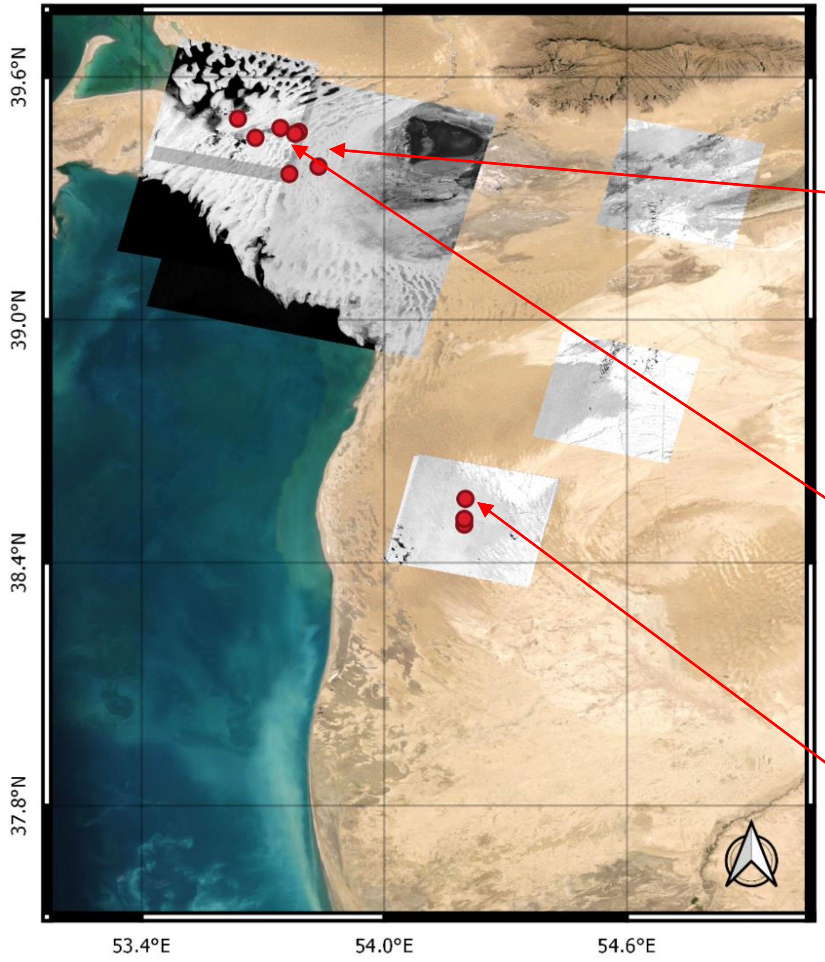
→ We have applied a data-driven method (Matched Filter) for methane retrieval.

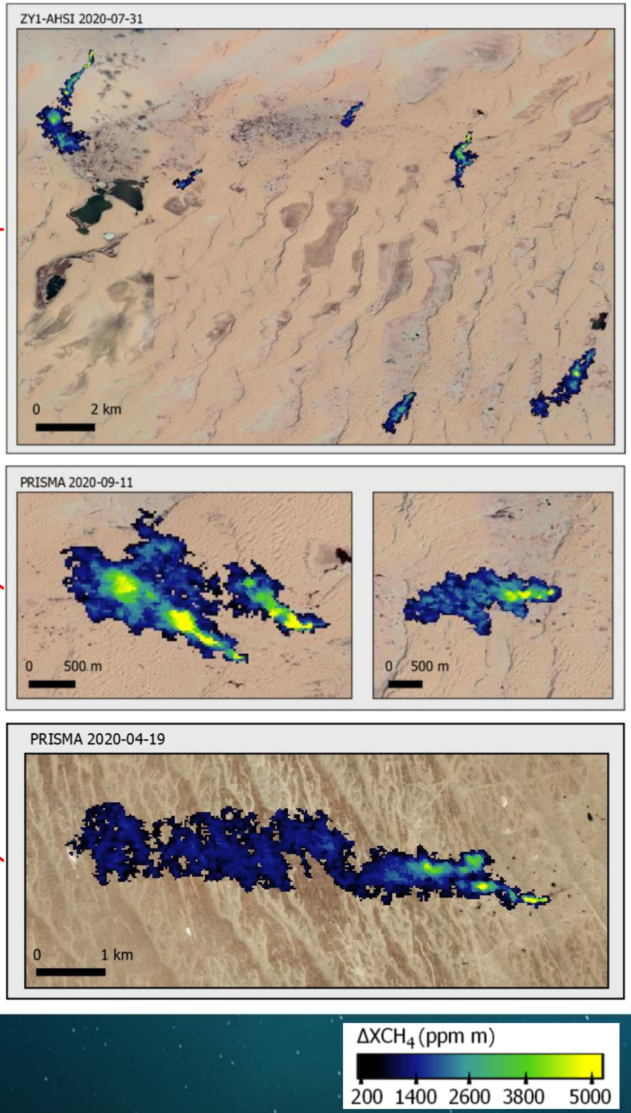


Example of a unit methane absorption spectrum $\vec{k}$ used as target signature by the matched filter retrieval method.

Guanter et al., RSE, 2021

Hyperspectral data





From:

→ 1 ZY1 image of 60 x 60 km^2

→ 12 PRISMA images of 30 x 30 km^2

→ During 2020

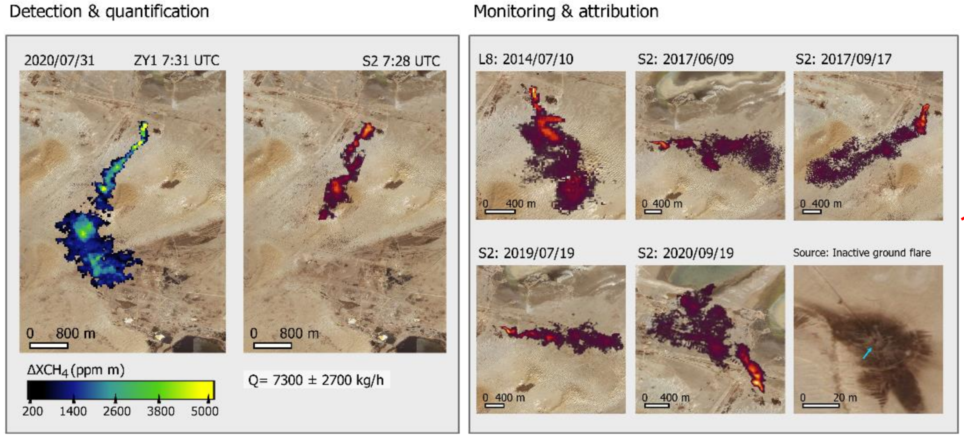
We obtained:

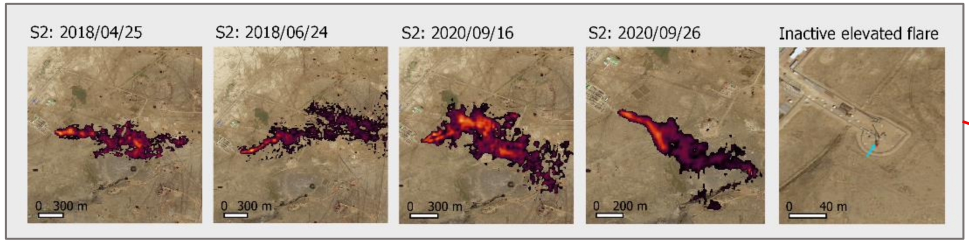
→ 25 plumes from 10 different sources

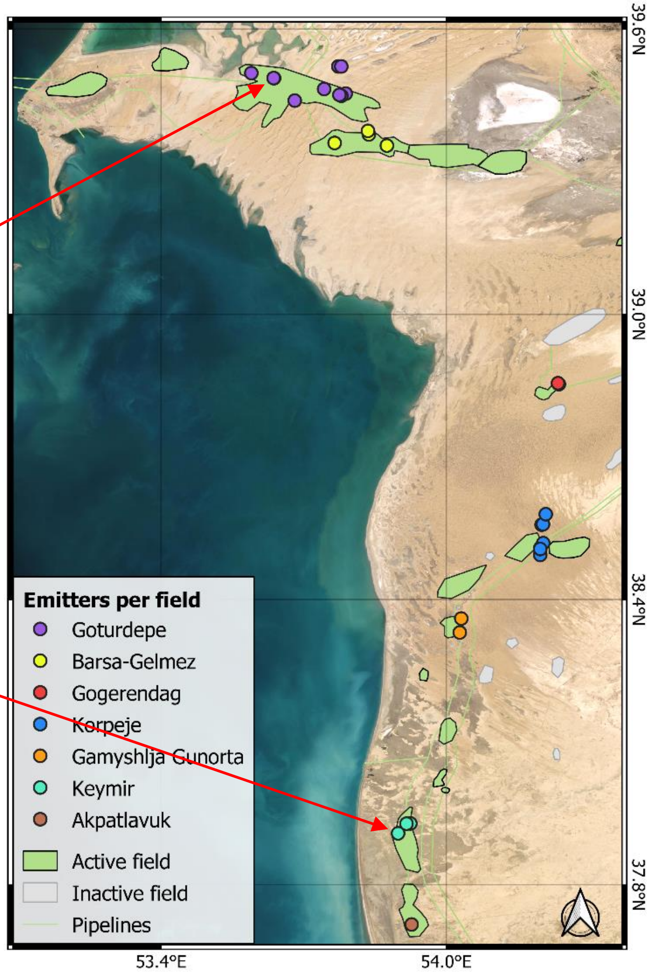
→ Emission fluxes between

1.400 ± 400 kg/h - 19.600 ± 8.000 kg/h

Multispectral data







→ We have used the B12 (~2190 nm) / B11 (~1610 nm) band ratio to detect the emissions.

S2 monitoring:

→ From Jan 2017 to Nov 2020

→ 944 CH_4 plumes

→ From 29 emission sources

Sources:

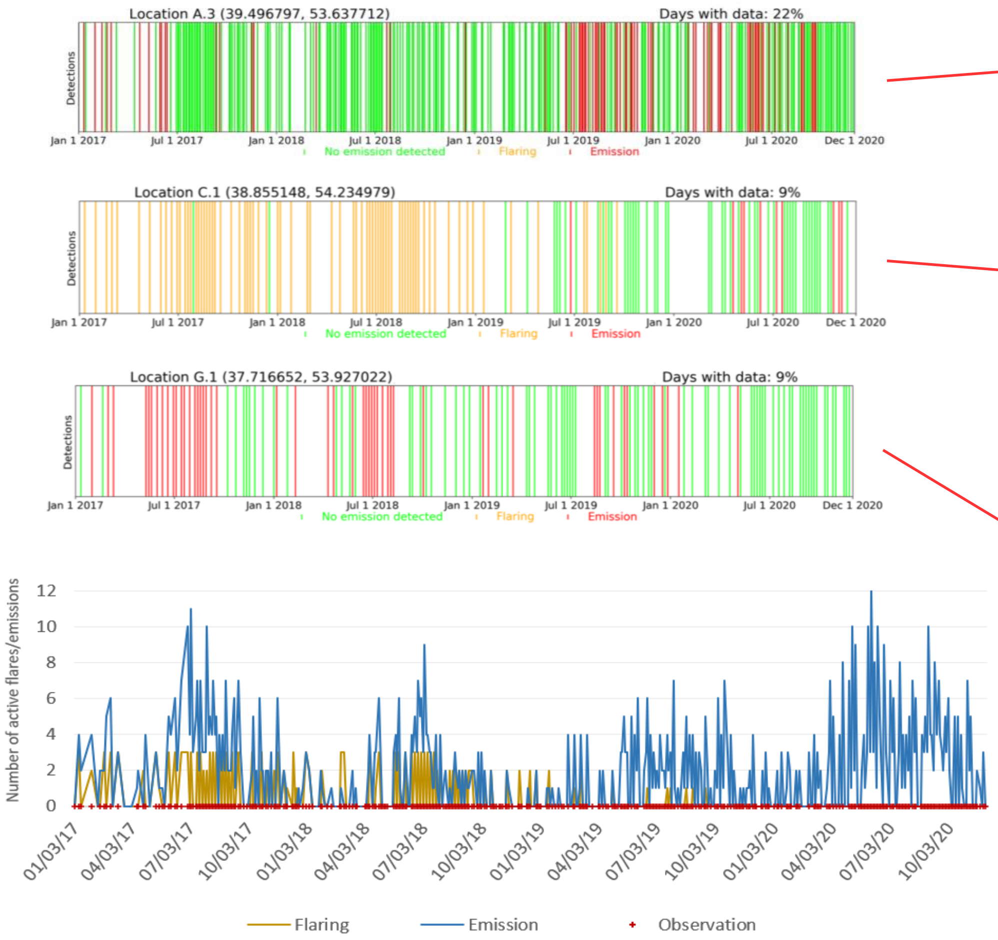
→ 24 flares

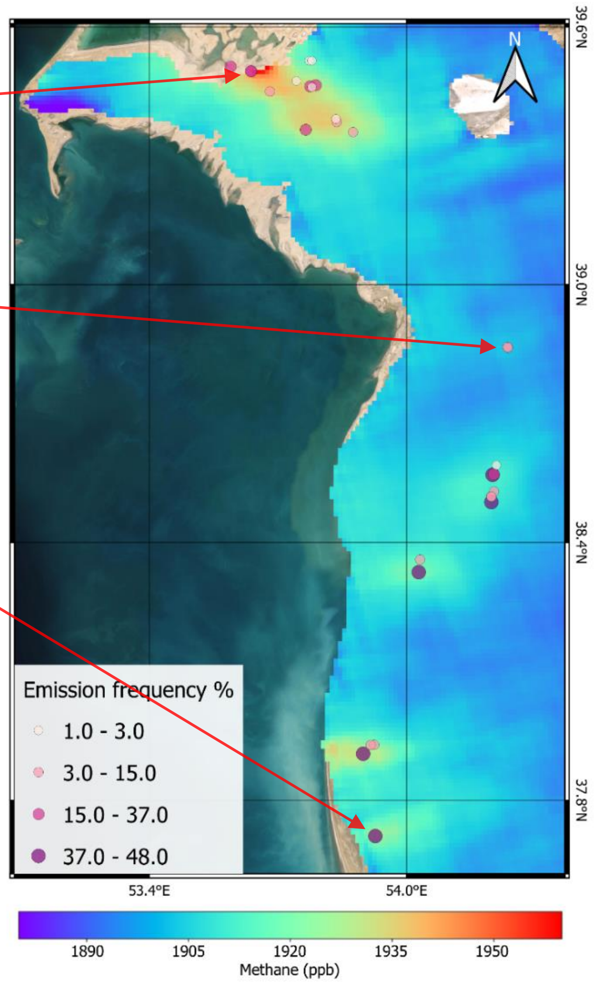
→ 2 pipelines

→ 3 unknown

All located in oil fields, except for one that produces both gas and oil.

Multispectral data





S2 monitoring:

→ From Jan 2017 to Nov 2020

→ 944 CH_4 plumes

→ The timeline of each emitter is very different

→ In the northern fields more emitters with lower emission frequency

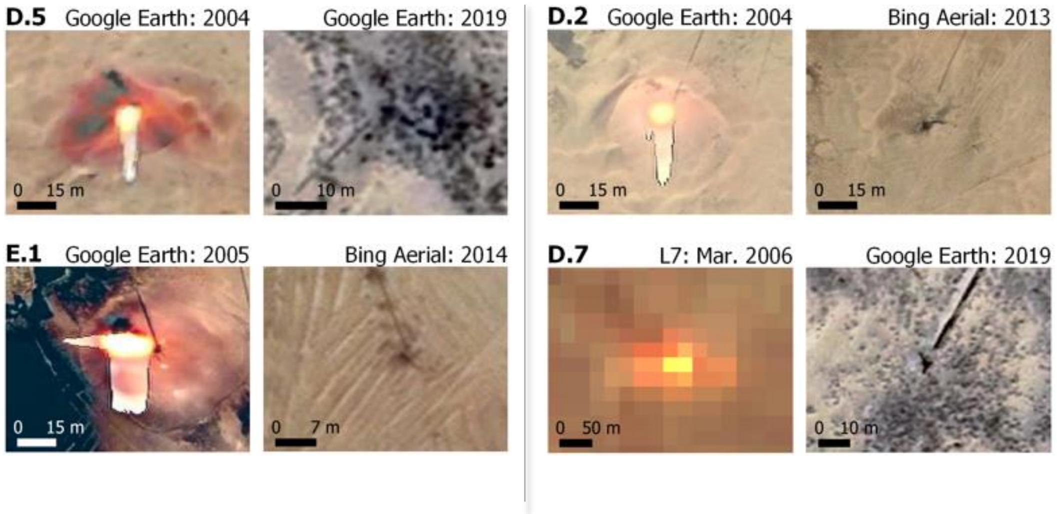
→ In the southern fields fewer emitters with higher frequency

→ In general, 2020 the year with most emissions

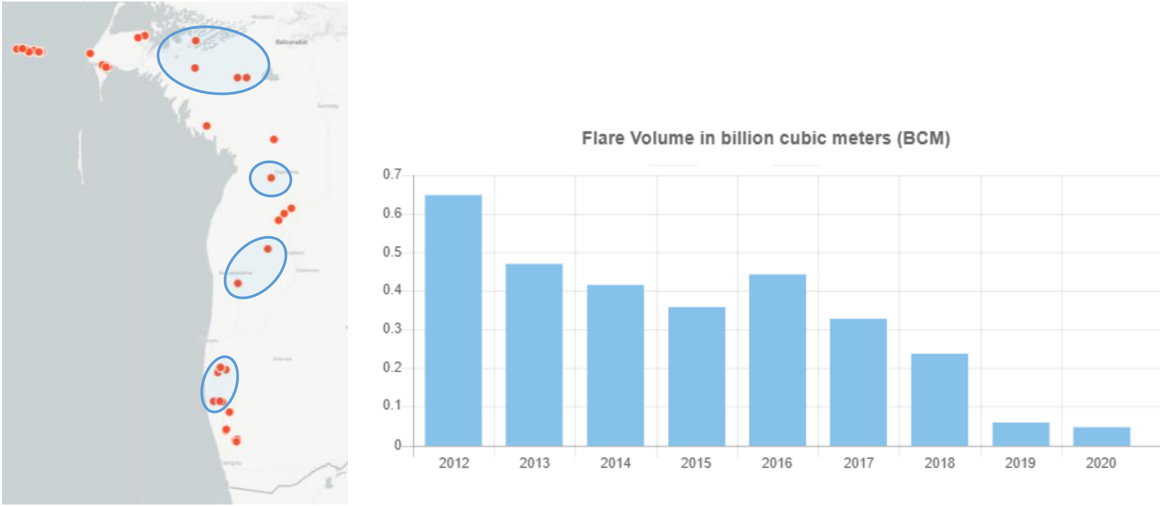
Further results

Decease of the flaring at the cost of venting.

→Nine emitters have had active flaring in the past.



→According to VIIRS data, flaring has been declining in these fields since 2012.



VIIRS data from 2012 to 2020 in fields where we have identified emitters.

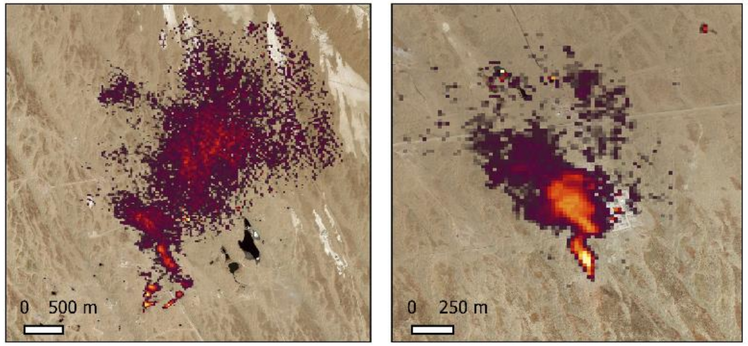
Further results

Long-standing emissions.

→We have observed the emitters in the past using Landsat 8 images.

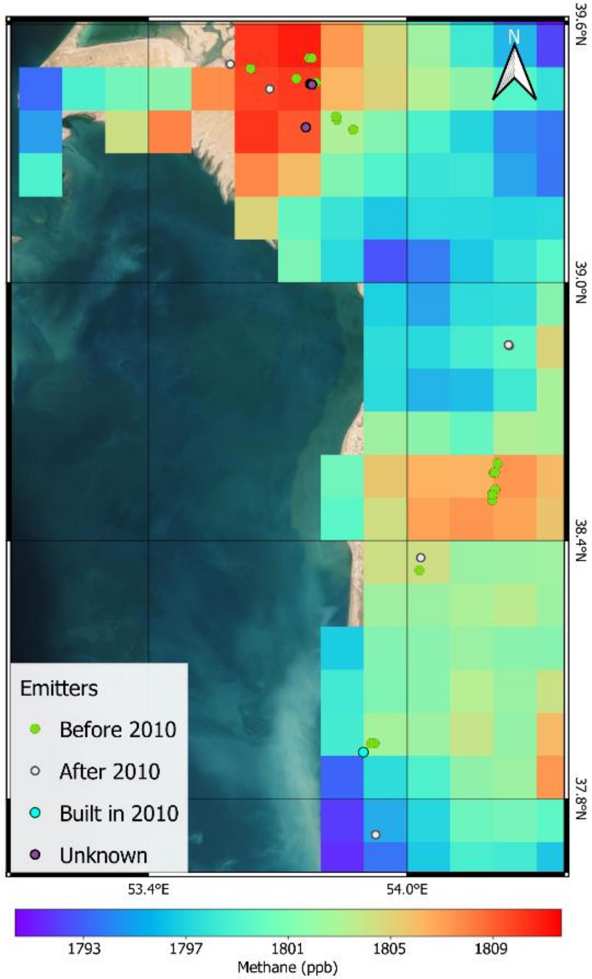
→ Ratio B07 (2.11 - 2.29 µm) /B06 (1.57 - 1.65 µm)

→15 sources record emissions before 2017.



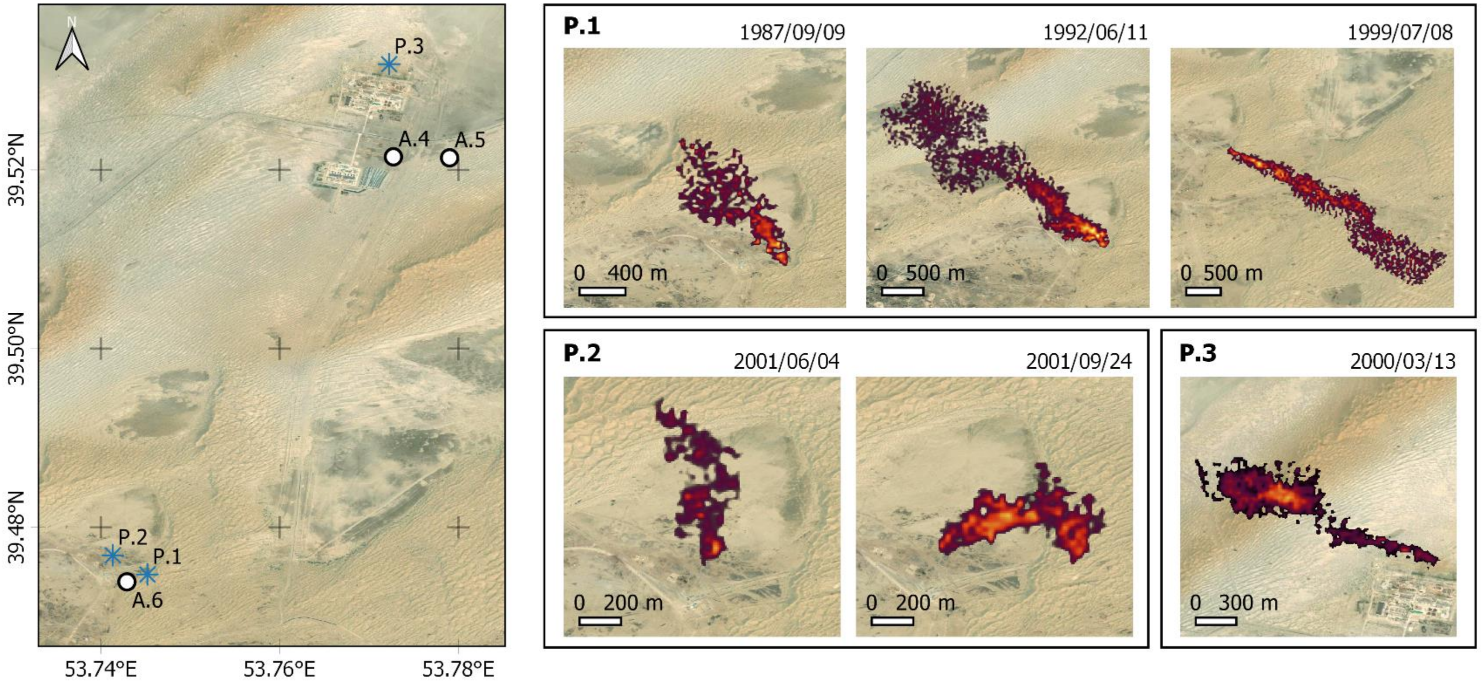
Examples of Landsat-8 detections in 2013.

→2003-2010 SCIAMACHY data is consistent with the age of the emitters identified in the study.



SCIAMACHY data oversampled to a 0.1º grid between 2003 and 2010 combined with the existence of the emitters.

Further results



→In the same way we can go back to 1982 with Landsat 4 and 5.

→ Ratio B07 (2.08 - 2.35 μm) /B05 (1.55 - 1.75 μm)

→The oldest observed emission in 1987.

→Since then, we have detected more emissions but with lower frequency in the 80s and 90s compared to the most recent years.

→The emission sources were different but were very close to the current emitters.

→More details about the study in preprint version: https://doi.org/10.31223/X56G7R

And now…

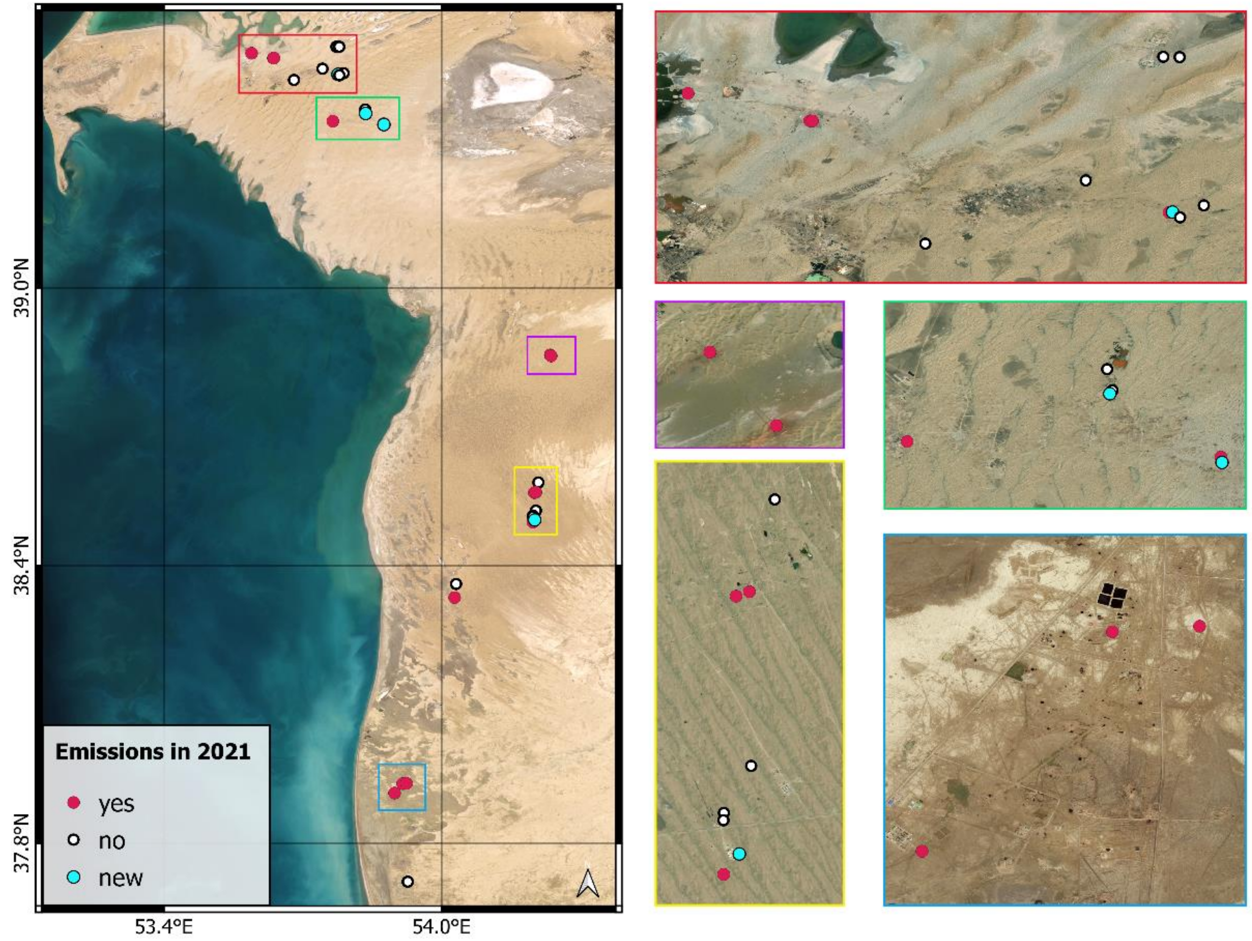
→So far this year:

⇒15 of the 29 emitters identified during the study continue recording emissions.

⇒Three more additional sources have been found: 3 pipeline leaks and one flare.

→The detected emitters are being reported to the corresponding organizations so they can be fixed.

→We are applying this methodology in other countries and trying to improve the detection methods for more complex areas.



Main conclusions:

→We have exploited the synergy between 3 types of methane-sensitive remote sensing datasets.

→We have identified 29 CH_4 point emitters.

→Most of them are inactive flares venting gas linked to oil production fields.

→Some of them have been emitting large amounts of CH_4 for decades.

→This type of emissions have been happening at least since the 80s in Turkmenistan.

→The emissions come from anthropogenic sources, and they can be rapidly fixed.

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