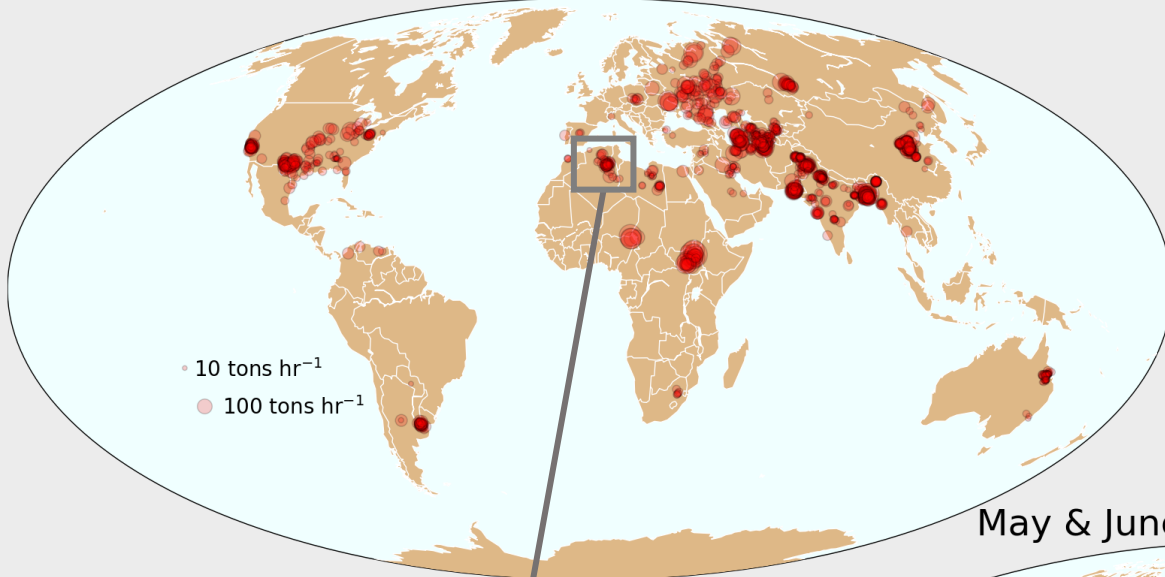


Detecting methane emissions in TROPOMI data using machine learning

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Allard de Boeij¹, Alba Lorente¹, Szu-Tung Chen¹, Pratik Sutar¹, Sander Houweling^{1,2}, Daniel Varon^{3,4},
Dylan Jervis³, Jason McKeever³, Itziar Irakulis-Loitxate⁵, Luis Guanter⁵, Daniel H. Cusworth⁶, Ilse Aben¹

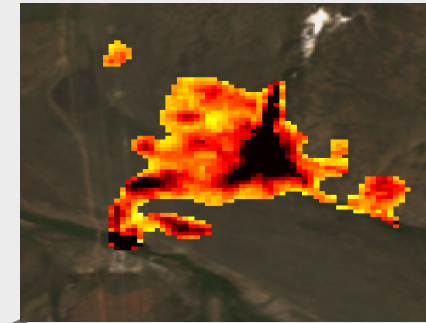
1. SRON Netherlands Institute for Space Research
2. Vrije Universiteit Amsterdam
3. GHGSat Inc
4. Harvard University
5. Universitat Politècnica de València
6. Jet Propulsion Laboratory

2020 Super-emitters

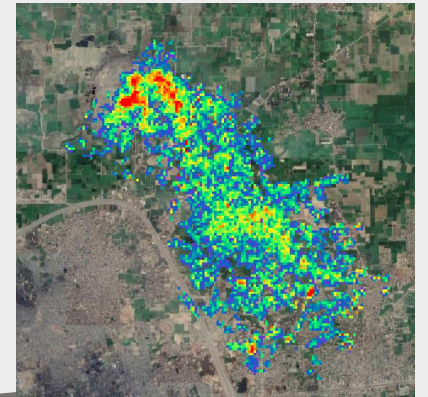


Using a hybrid machine learning approach we can detect and evaluate TROPOMI methane plumes in seconds and point high-resolution instruments towards super-emitters.

Sentinel-2 – Oil/Gas



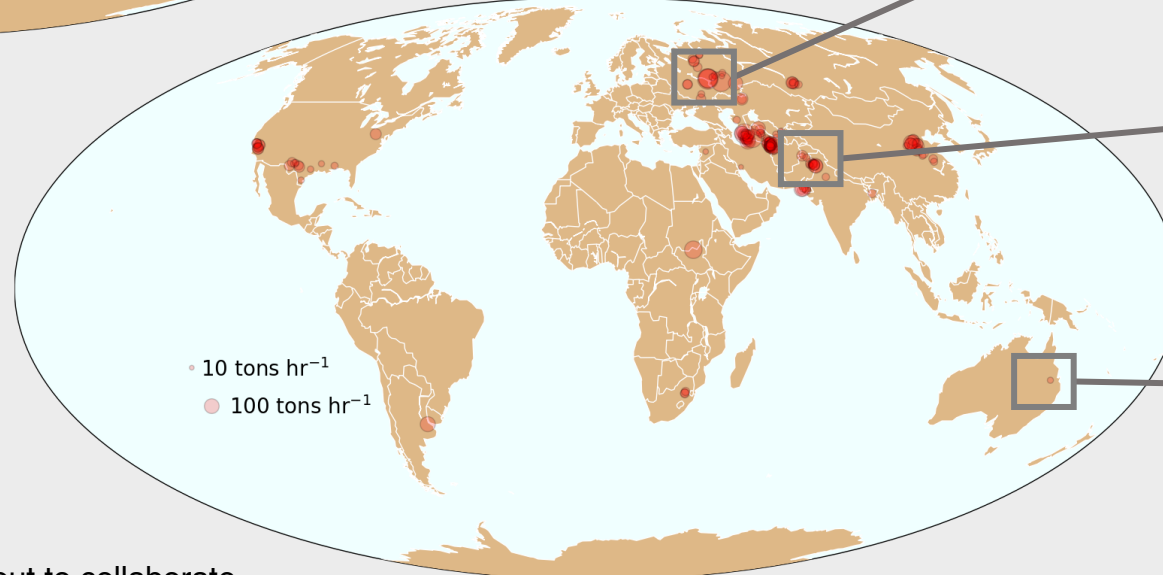
GHGSat – Landfill



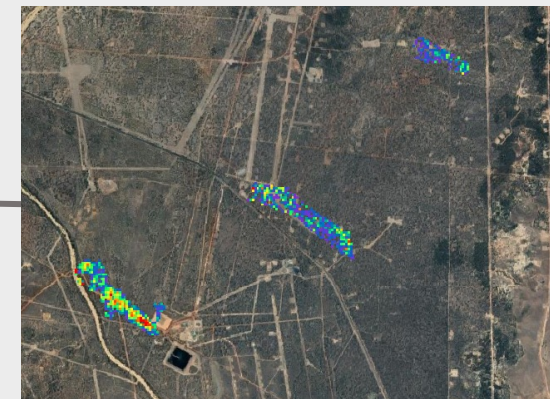
PRISMA – Oil/Gas



May & June 2021 Super-emitters

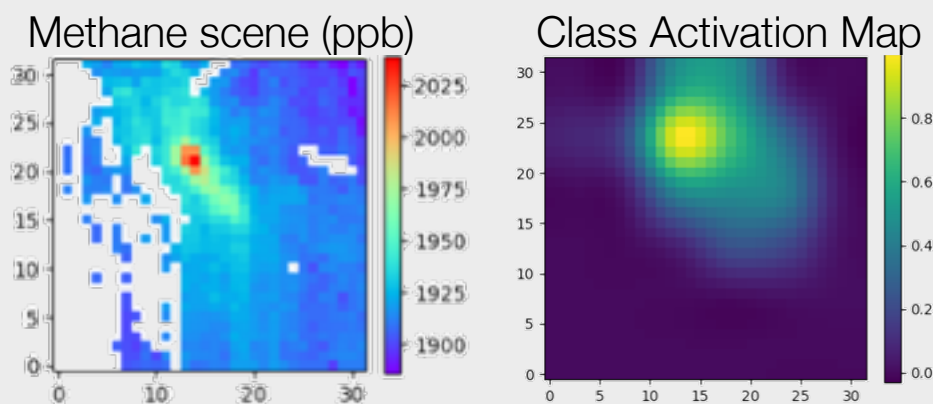


GHGSat – Coal



Plume detection setup

We use the combination of a convolutional neural network and a support vector classifier to detect 1450 plumes in 2020 and 150 plumes in May and the first week of June 2021.

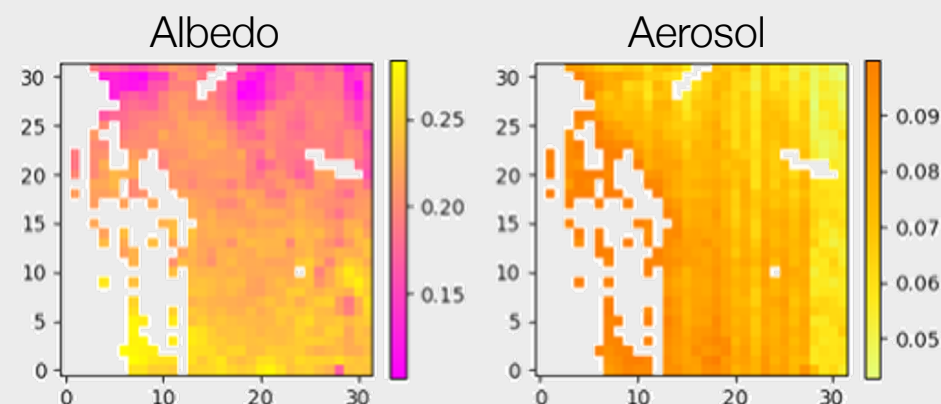
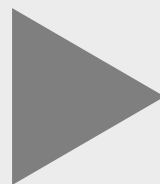


Convolutional Neural Network

Detects plume-like features in 32x32 pixel scenes using a 9-layer network.

Trained on ~2500 labeled scenes.

~0.8% identified as potential plumes.



Support Vector Classifier

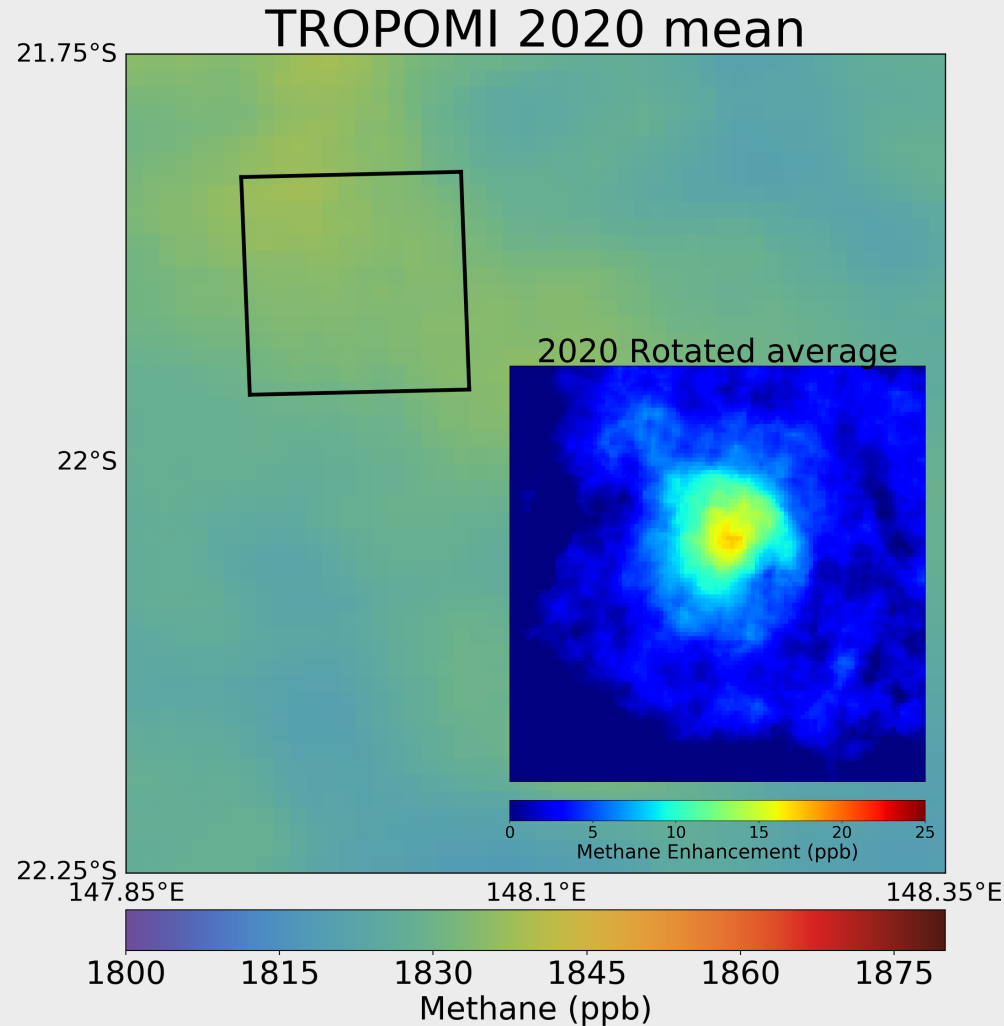
Incorporates supporting data like source rate, albedo, and aerosol optical depth.

Trained on ~1800 labeled samples.

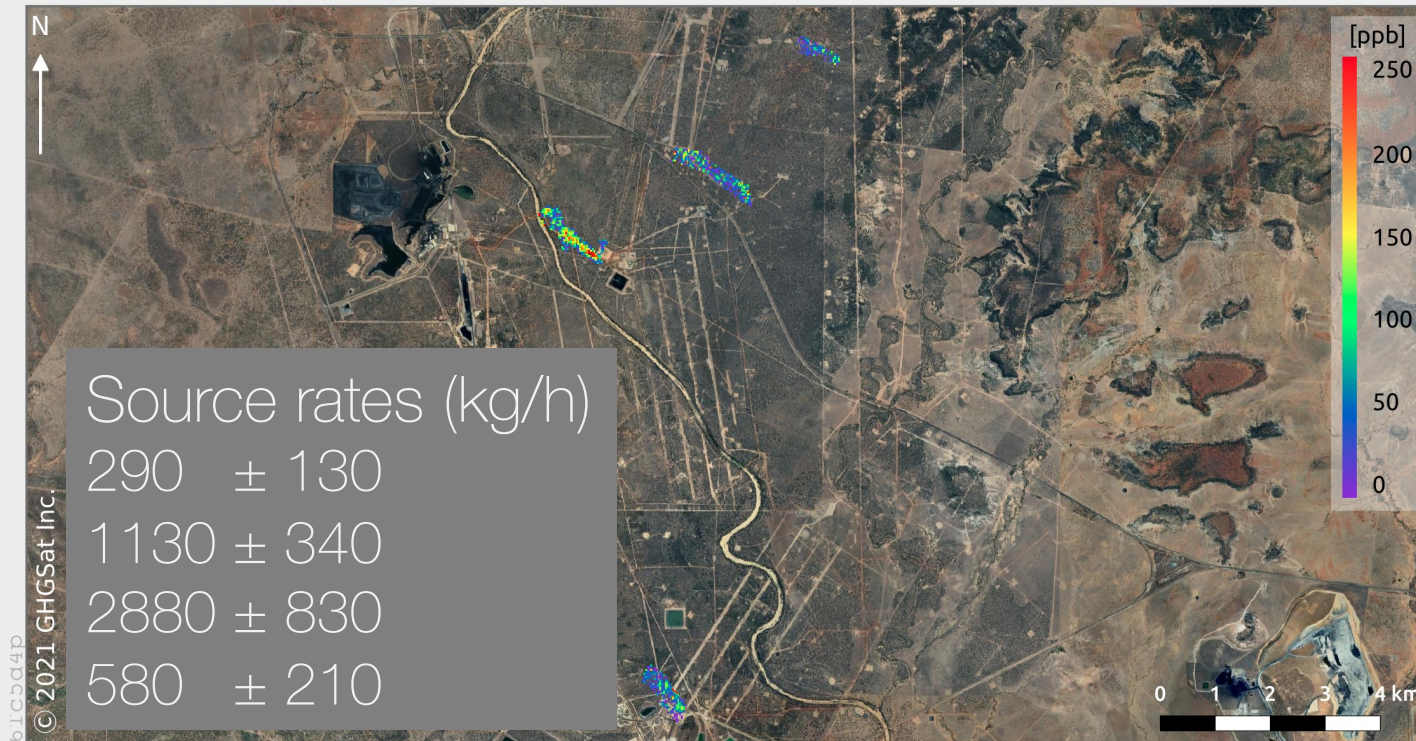
Filters out ~45% of scenes, absolute false positive rate of 4%.

We can use TROPOMI to guide high resolution instruments towards sources

By combining TROPOMI data from multiple days at flagged locations and incorporating the direction of the wind, we can pinpoint the best targets for high resolution instruments, allowing us to identify the exact source(s) of the emissions.



Coal Mine, Queensland - Australia
GHGSat-C1 - CH₄ Measurement



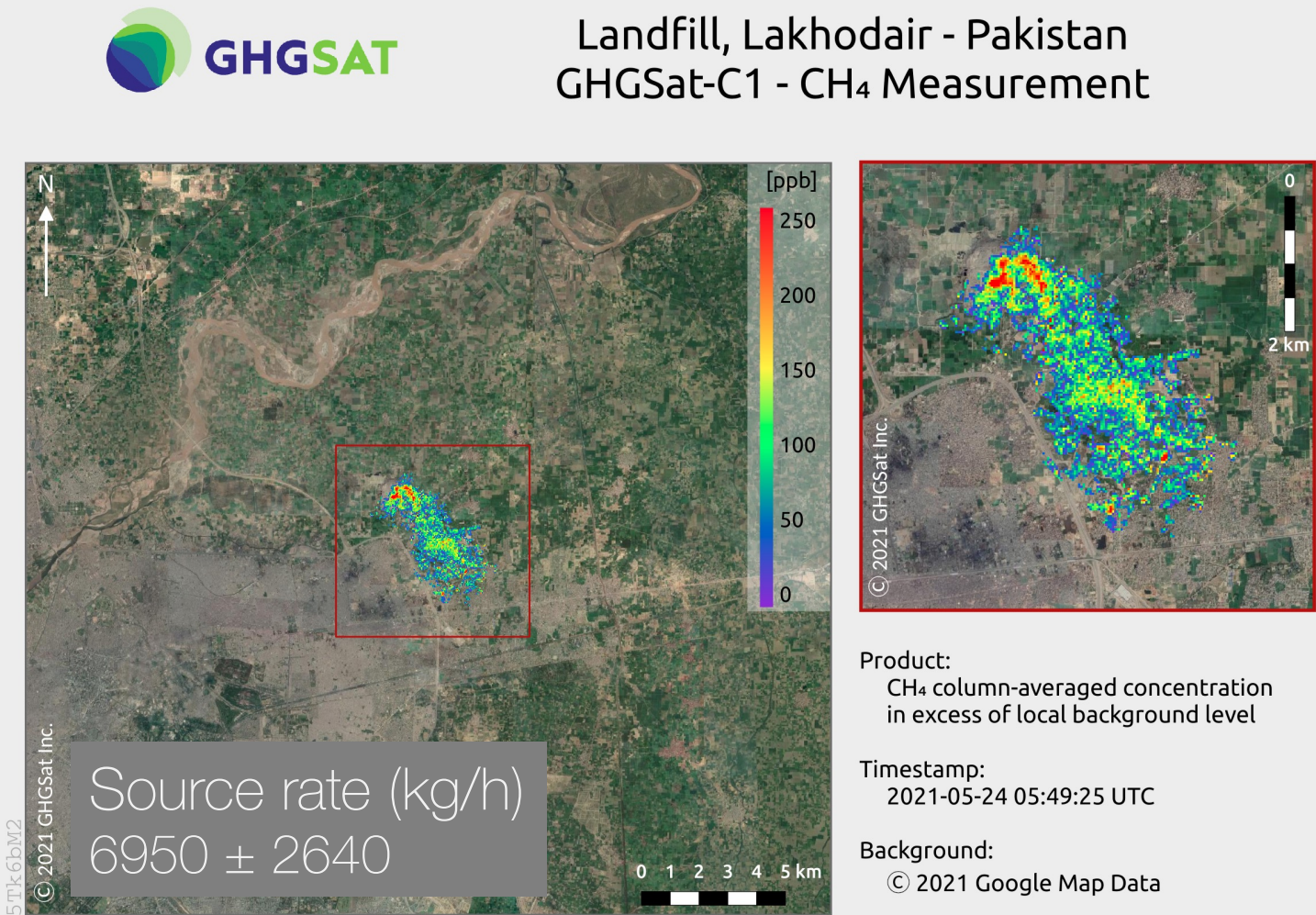
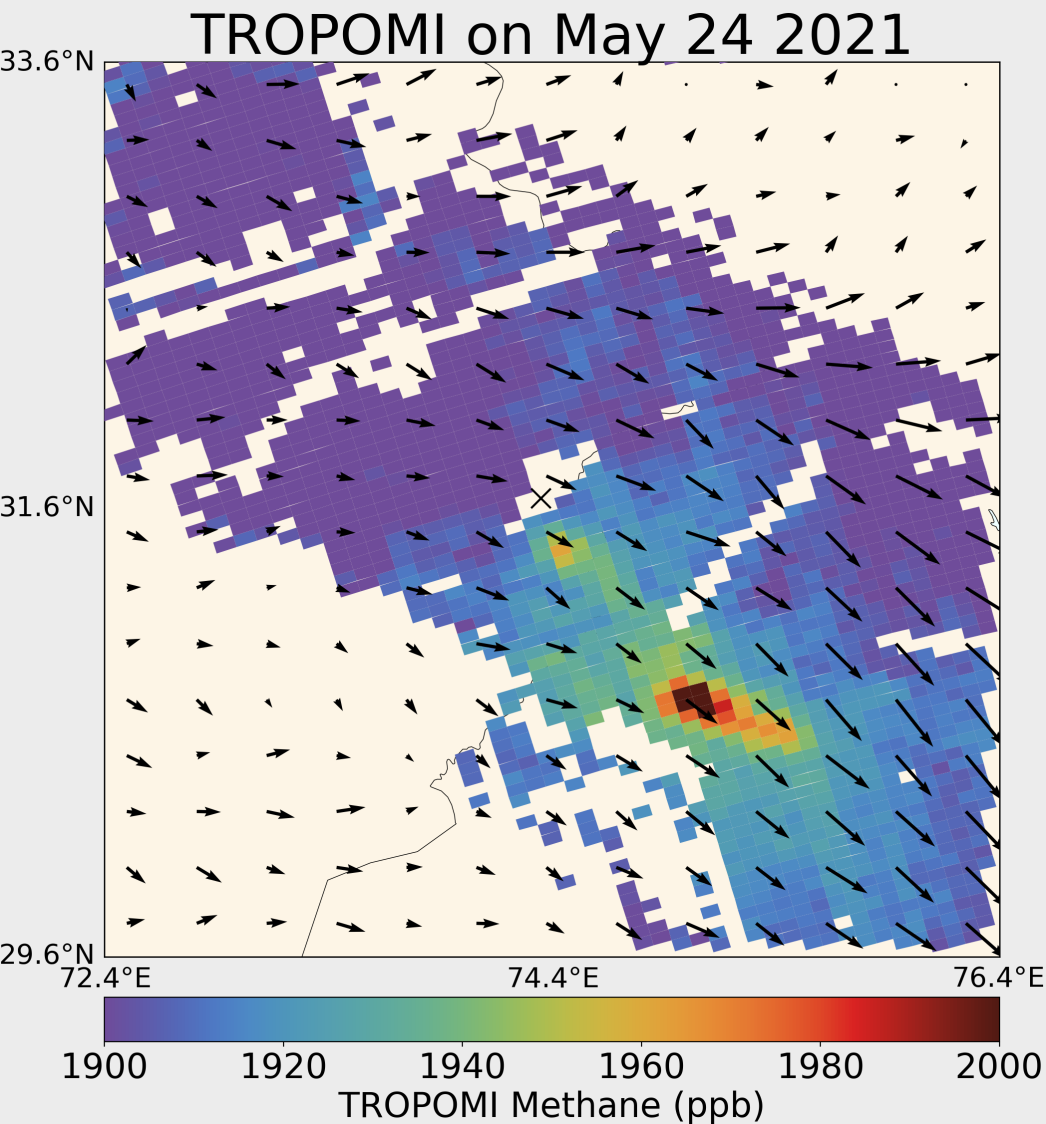
Product:
CH₄ column-averaged concentration
in excess of local background level

Timestamp:
2021-05-15 00:23:37 UTC

Background:
© 2021 Google Map Data

Concurrent high resolution and TROPOMI information give full insight

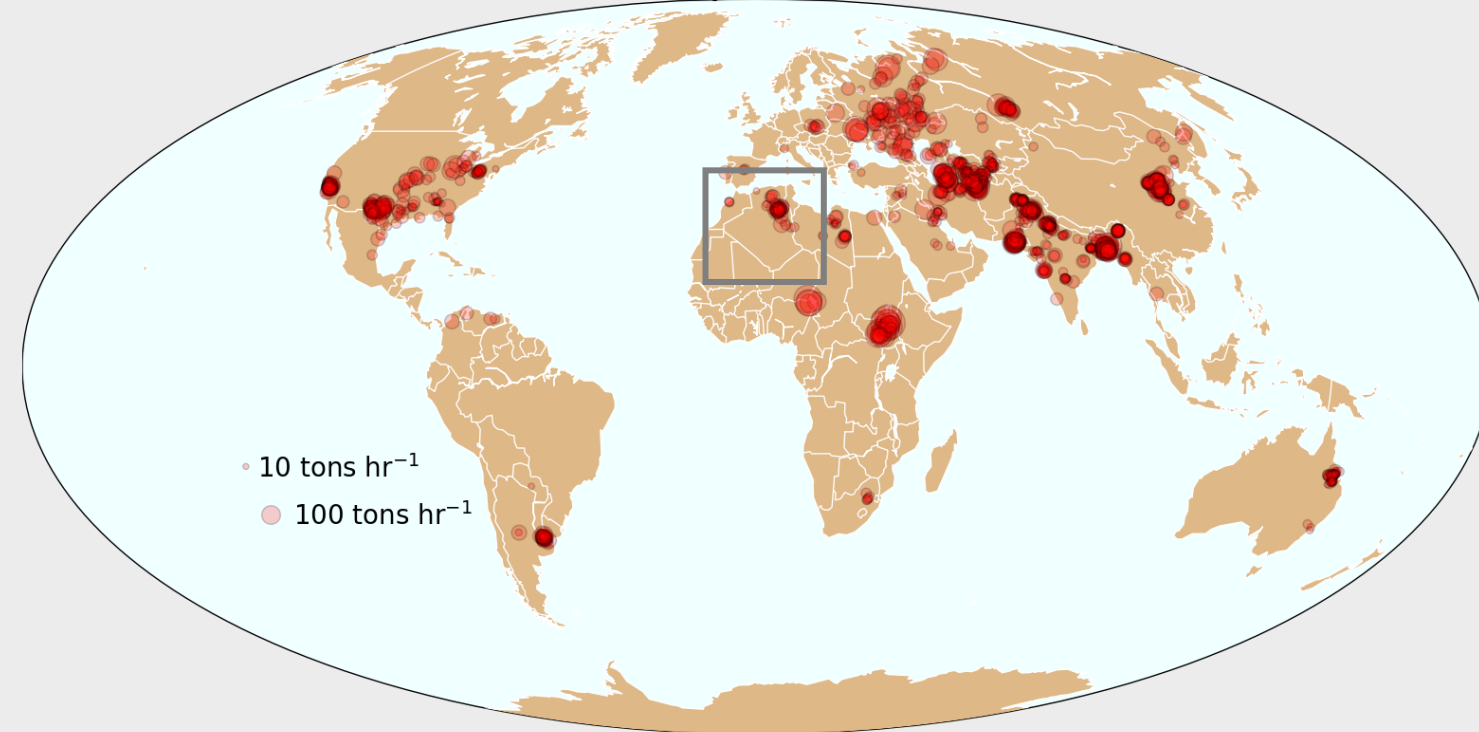
On May 24th we both have a CNN detection as well as a GHGSat targeted observation over Lahore.



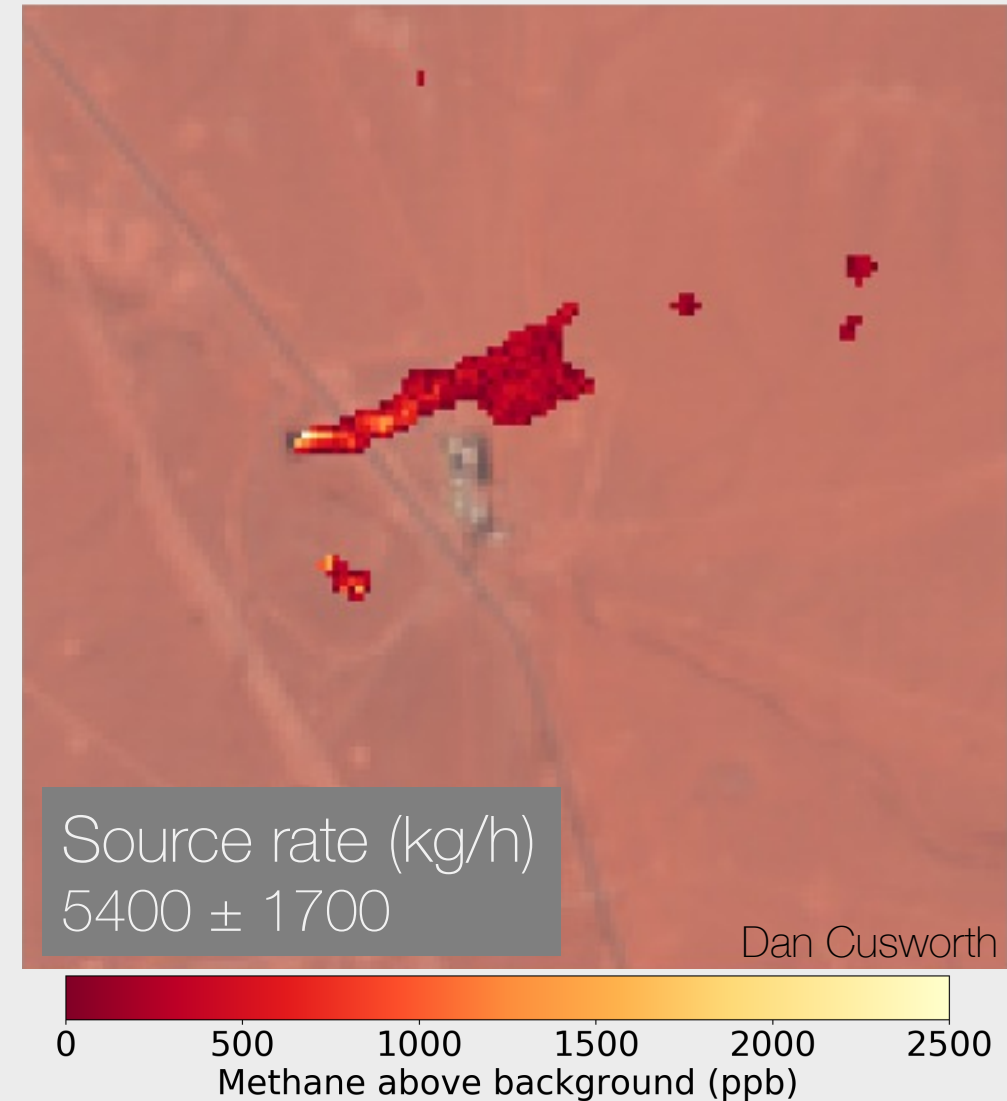
Hyperspectral instruments like PRISMA provide additional coverage

We find several hits related to oil and gas over Algeria, using multiple high-resolution instruments we can break down what is causing these emissions.

2020 Super-emitters

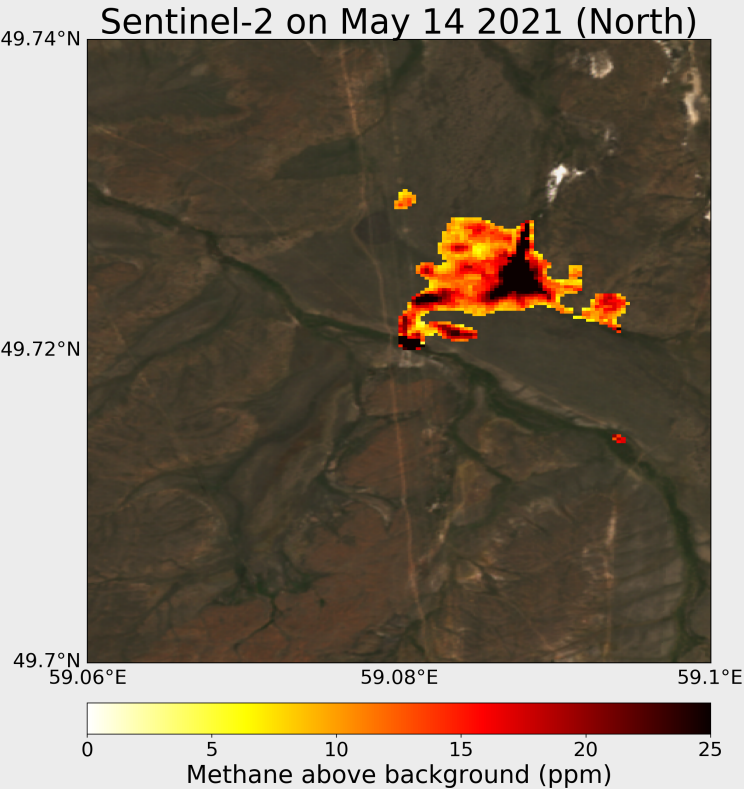
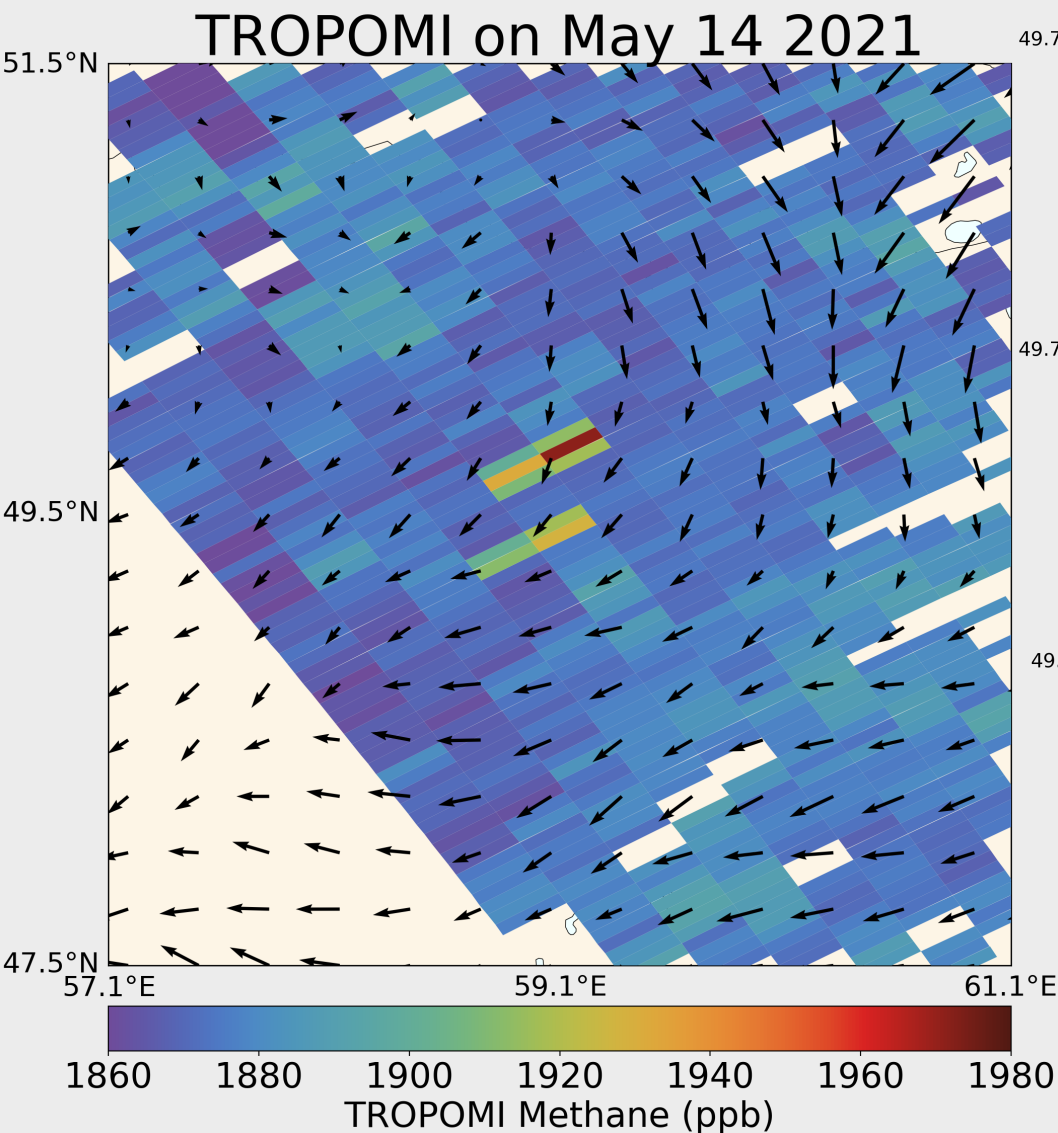


PRISMA Methane plume on 4/8/2020



Sentinel-2 also allows us to look at past events with focused analysis

We detected two plumes over Russia on May 14, analyzing Sentinel-2 data for this event allowed us to identify the facilities responsible for the enhancements in TROPOMI.



Source rates (tons/h)
 150 ± 45
 57 ± 23

