Assessing the importance of super-emitters versus diffuse oil/gas methane emissions in Algeria

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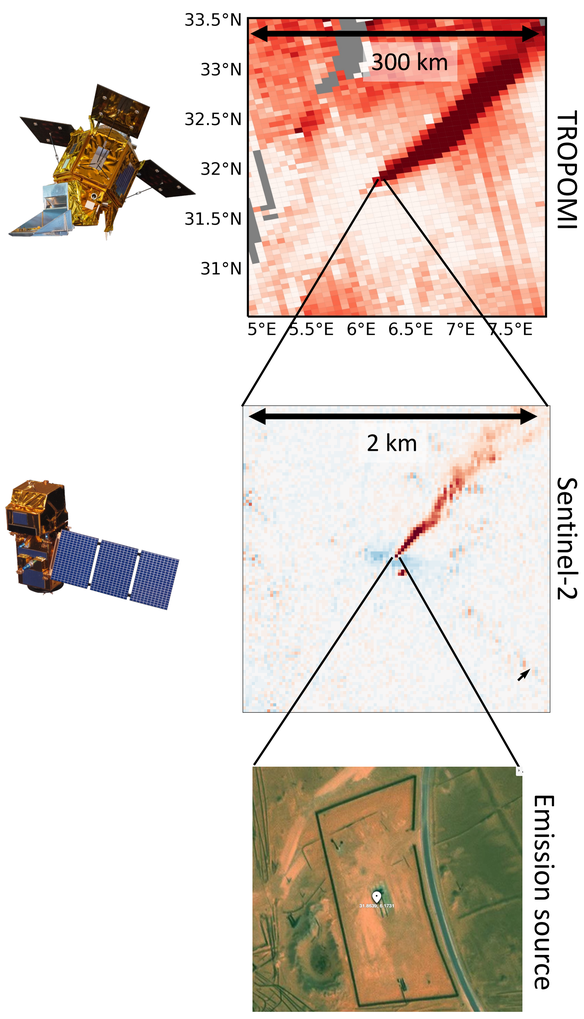
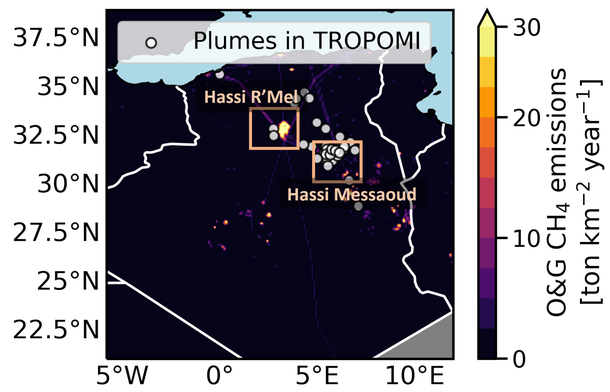
(1) We identify large oil/gas emission sources with high-resolution Sentinel-2 methane data, guided by TROPOMI

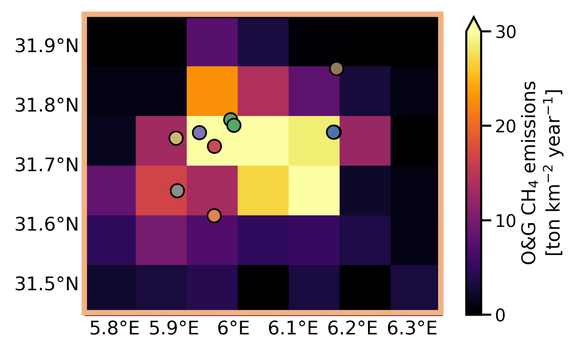
Zooming in and finding the source location for one methane plume.



Both TROPOMI and Sentinel-2 data reveal that the majority of methane plumes in Algeria are located near two oil/gas fields (orange squares)



Plume detections TROPOMI methane data, plotted over bottom-up oil/gas methane emissions from Scarpelli et al. (2021).
Plume detections are retrieved through a neural network approach (Schuit et al. in prep., 2022).

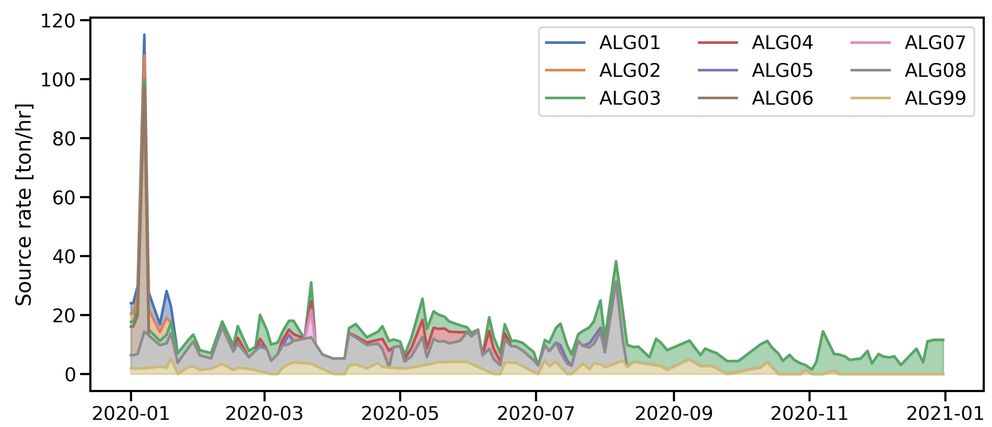


Dots show plume source locations near Hassi Messaoud retrieved with Sentinel-2 data, guided by TROPOMI data as on the left. The bottom-up inventory (background) includes this source area, but it doesn't include point-source level of detail.

Relevance

Top-down methane emission estimates tend to focus either on emission totals over larger regions, or on plume signals. TROPOMI data contains information on both. Here, we estimate both types of sources simultaneously, which gives insight into the role of large point sources in oil and gas methane emissions. Full characterization of the Algerian oil and gas emissions will help in developing effective mitigation strategies. This is important from a European standpoint, since the EU has plans to increase Algerian gas imports.

Source rates estimated with a simple mass balance approach for a collection of point sources in Hassi Messaoud, based on Sentinel-2 data**. The source locations and source rates serve as prior input to the inverse analysis in (2).**



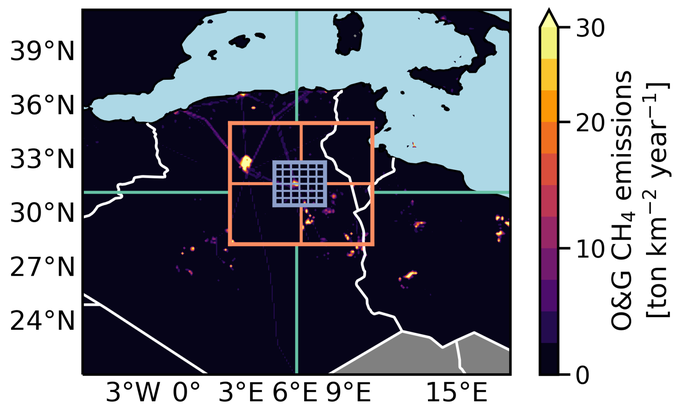
(2) We perform separate inverse analyses with WRF-CHEM for the two Algerian oil/gas fields, to quantify their methane emissions for 2020

a) Simulate prior emissions in WRF-CHEM to retrieve simulated TROPOMI methane columns

For point sources, we start from the result from the Sentinel-2 analysis (see (1))

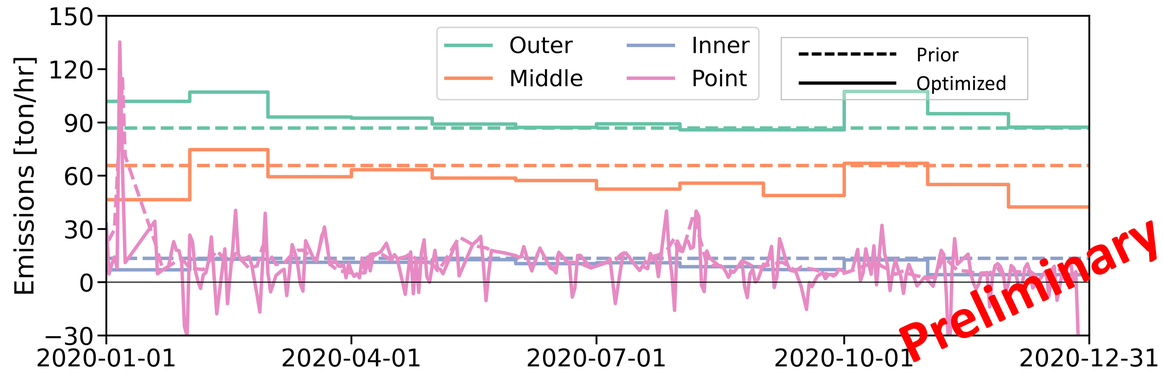
For diffuse sources, we start from a bottom-up emission inventory (Scarpelli et al., 2021), which is optimized piece-wise as below.

Squares indicate the three nested WRF domains we use in the simulations over the Hassi Messaoud fields. The same set-up is used over Hassi R'Mel.



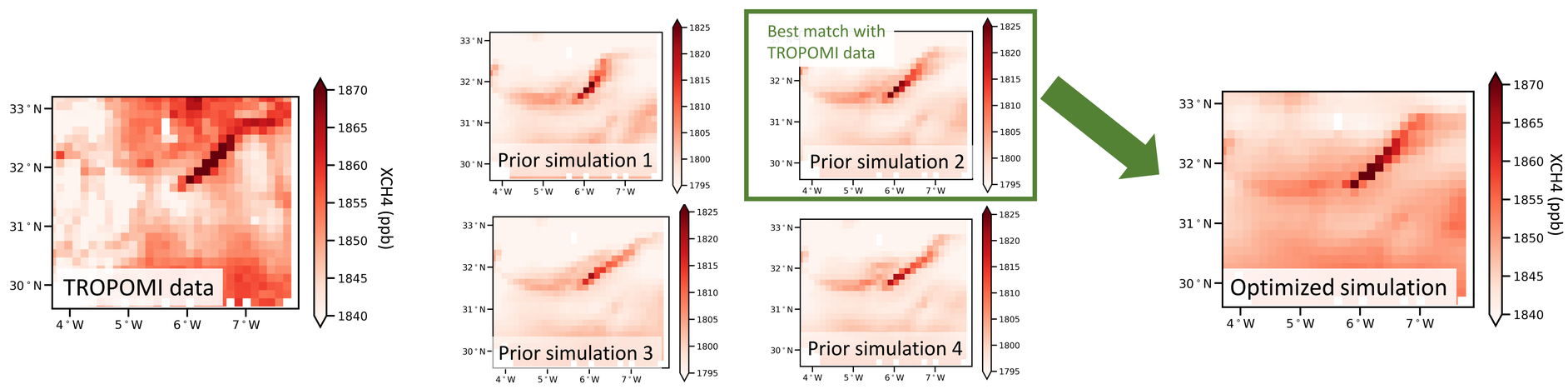
b) Perform an analytical inversion to estimate methane emissions that best reproduce real-world TROPOMI data

In the inverse set-up we co-optimize the CAMS methane background with the different emission components (see left). Diffuse emissions are optimized monthly, point sources are optimized daily.



An example of prior and optimized methane emissions as produced by the latest version of our inverse set-up. These results are preliminary, and are likely to change still.

We generate an ensemble of plumes by running WRF with different physics settings.
For each day, we select the WRF configuration that best matches TROPOMI.



References
- Scarpelli, Tia R., et al. "Updated Global Fuel Exploitation Inventory (GFEI) for methane emissions from the oil, gas, and coal sectors: evaluation with inversions of atmospheric methane observations." *Atmospheric Chemistry and Physics* 22.5 (2022): 3235-3249.
- Schuit, B. et al. "Automated detection of methane super-emitters in TROPOMI data using a machine learning based global monitoring system", in prep.

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