The detection capability of methane emissions over offshore platforms with space imaging sensors

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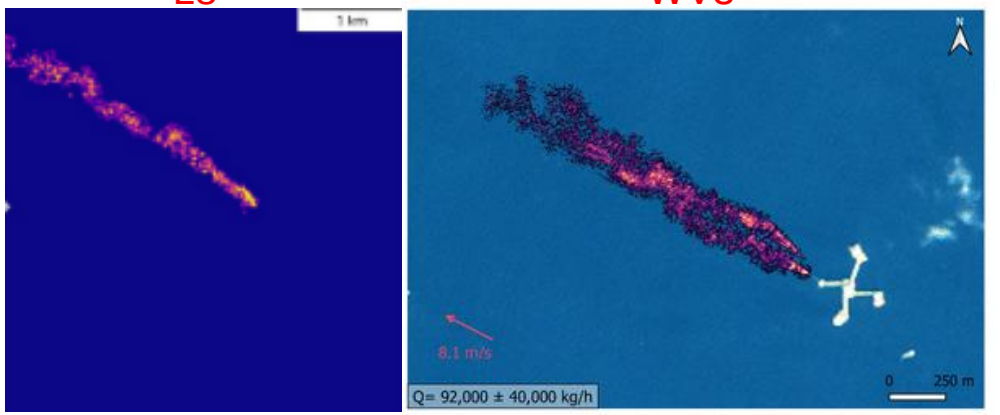
Some context: CH_4 emissions over offshore sources

- CH4 emission mitigation from anthropogenic sources is key to curb global warming
- **Oil and Gas** (O&G) industry:
  - ~35% of anthropogenic sources
  - Remote sensing: point-sources (easier to detect)
  - Observations -> mitigation strategy
- **Offshore O&G**:
  - ~30% of O&G production
  - Issue: typical low radiance (Rad) of water
  - But... sunglint effect!
  - Probability to detect with satellite-based sensors?
  - We will study this aspect for...

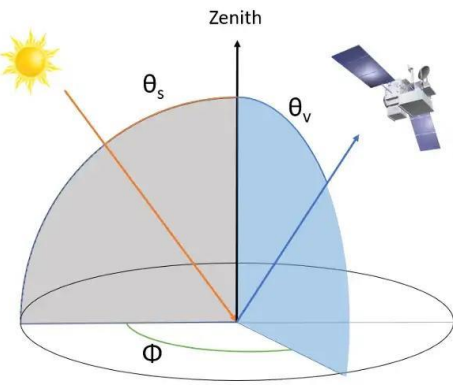
    EnMAP (~PRISMA) and **EMIT**

    (Public data + instrumental for point-sources)

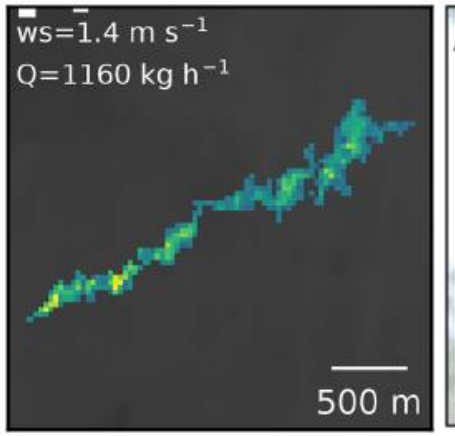
L8 WV3



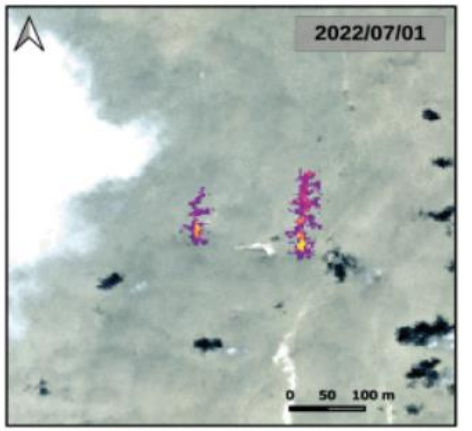
Irakulis-Loitxate et al. (2022)



GHGSat EnMAP



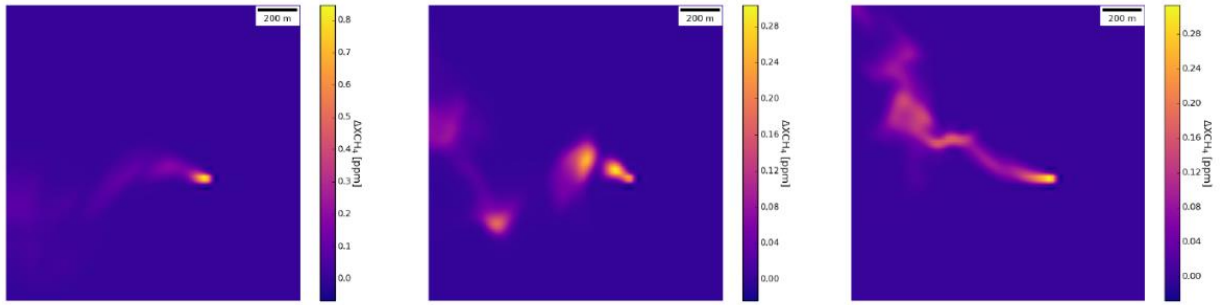
MacLean et al. (2023)



Roger et al. (2024a)

How do we determine the chances to detect?

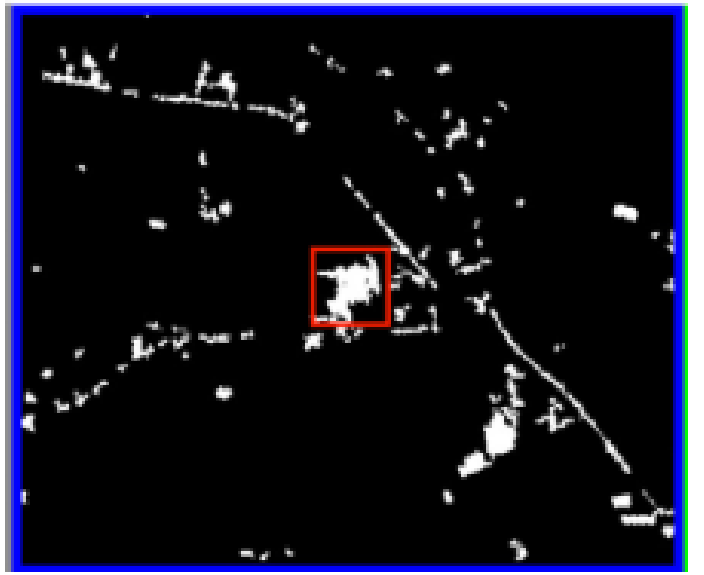
- **Chances to detect** -> Detection Limit (DL) concept:
  - Flux rate (Q, t/h) value in which we detect 50% of the plumes
  - Rad is the main driver for detection
  - We want to obtain Rad vs DL curves
- L1 data: 67-EnMAP and 27-EMIT acquisitions
- We integrate simulated plumes (x60) into the radiance data
- The matched-filter is used to obtain CH_4 retrievals
- For each plume and acquisition, we find the minimum Q for detection
- DL = Q at which we detect 50% of the plumes (~mean(Q))
- err(DL) = 1-std of the distribution



Gorroño et al. (2023)

Automatic emission detection algorithm

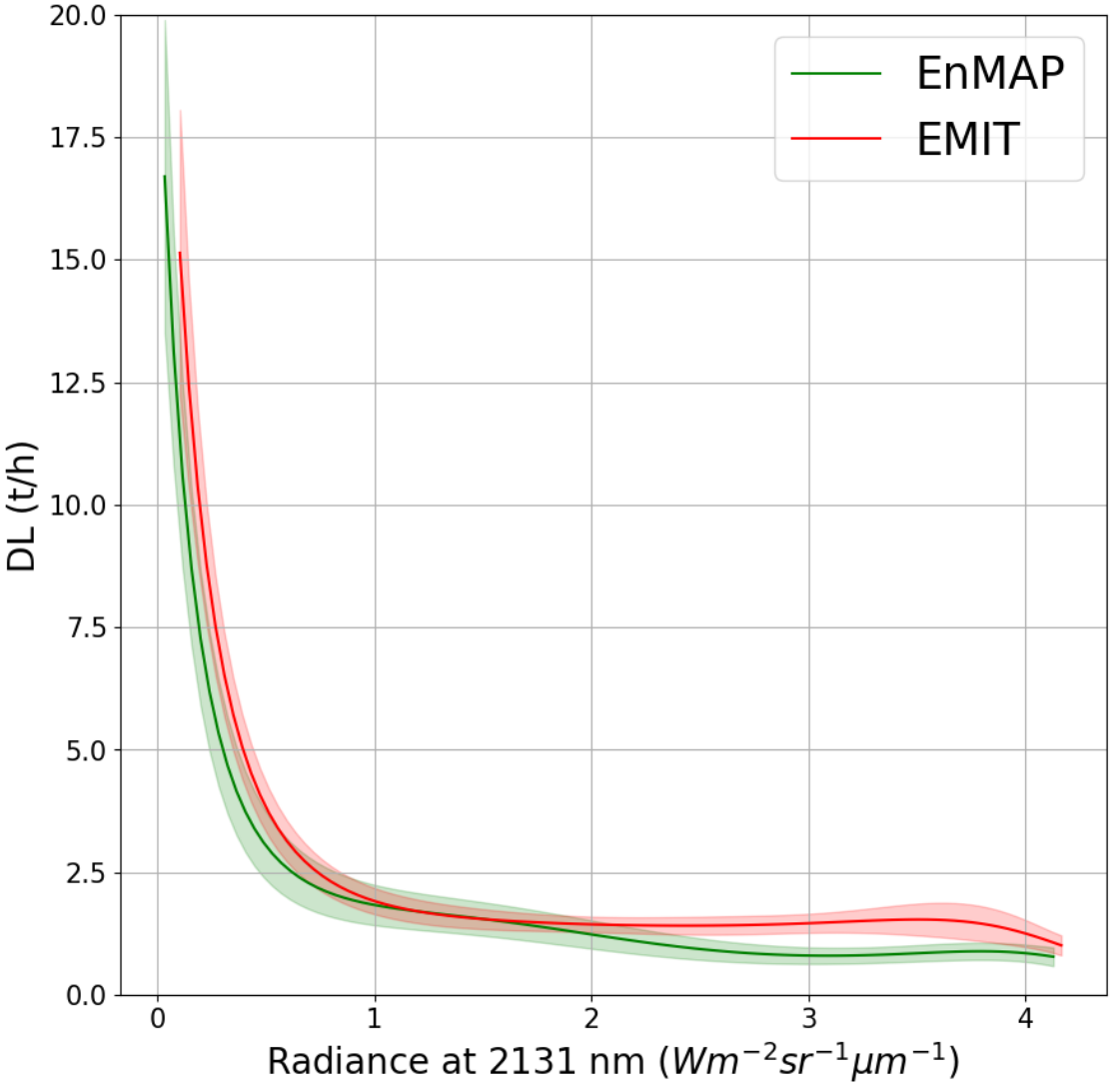
(test for emission detection)



Roger et al. (2024b)

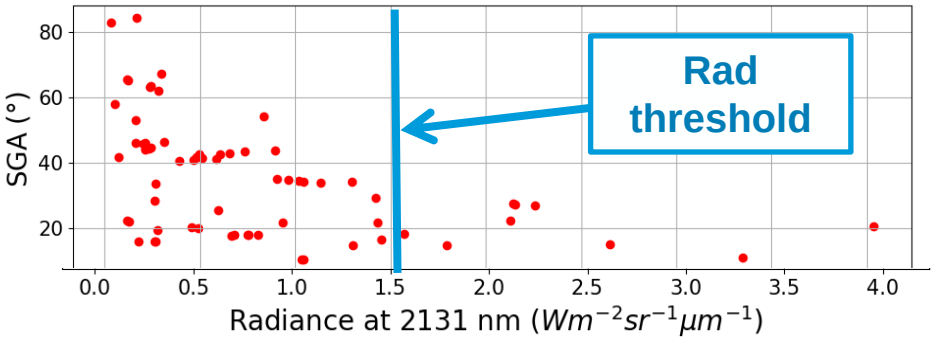
Radiance vs DL curves

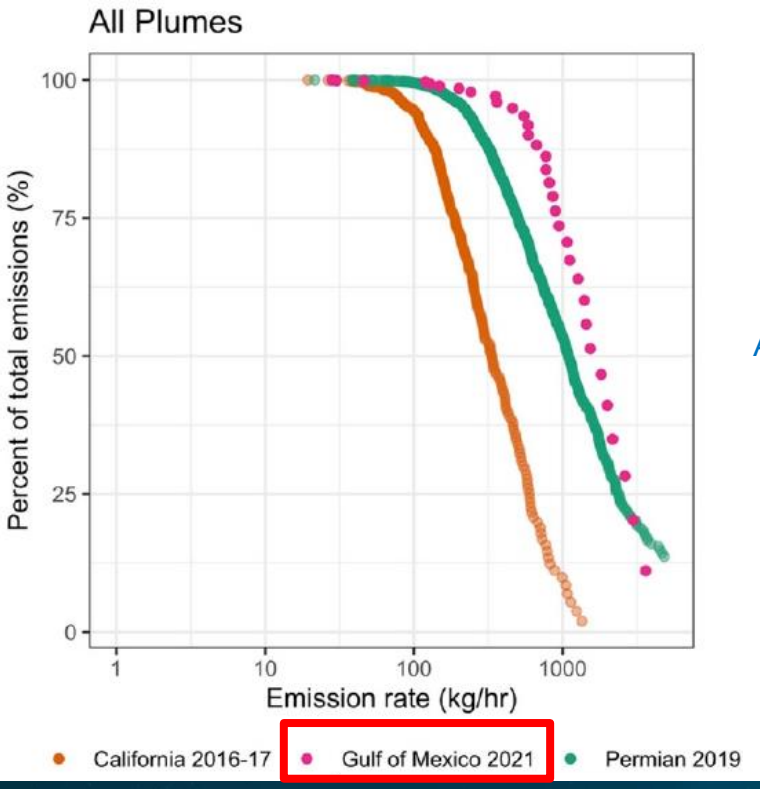
- EMIT curve is more unstable:
  - Lower number of acquisitions *(we can improve this)*
- DL(EnMAP) < DL(EMIT)
- Now, questions:
  - How much impact has the sunglint in these results?
  - Can we see typical offshore emissions?



Sunglint importance - Analysis made on EnMAP data

- Scattering Glint Angle (SGA):
  - SGA = Angular distance to the sunglint configuration
  - We manually separate ↓ Rad from ↑ Rad (*Rad threshold* ~ 1.5 $Wm^{-2}sr^{-1}\mu m^{-1}$)
  - ↑ Rad only for SGA <30°:
    - **↑ Rad only with sunglint!!**
    - Just a few points: **+ difficult to find close-to-sunglint data**
- Typical offshore plumes:
  - At *Rad threshold*, DL = 1.5 t/h.
  - Airborne campaing in the GoM (Ayasse et al., (2022))
  - > 100 plumes detected
  - No plume with Q > 1.5 t/h
  - **Sunglint needed for typical offshore plumes!!**

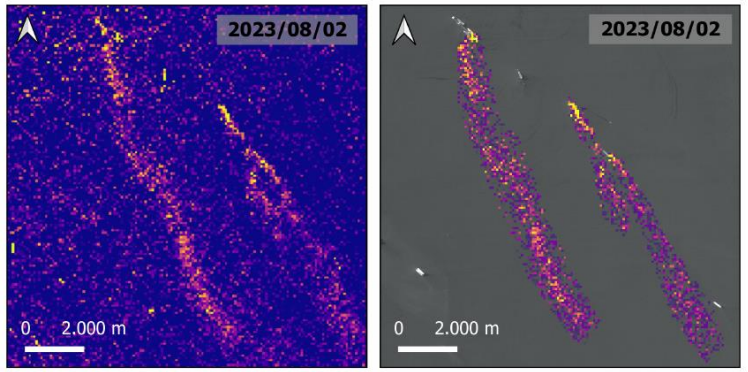




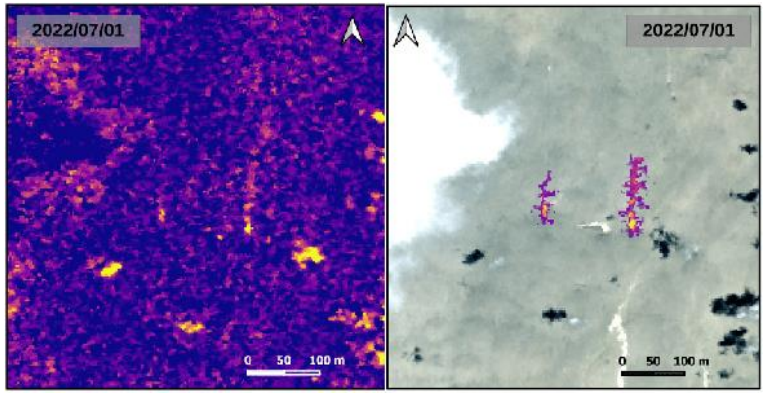
Ayasse et al. (2022)

Show cases - CH_4 emissions from offshore platforms

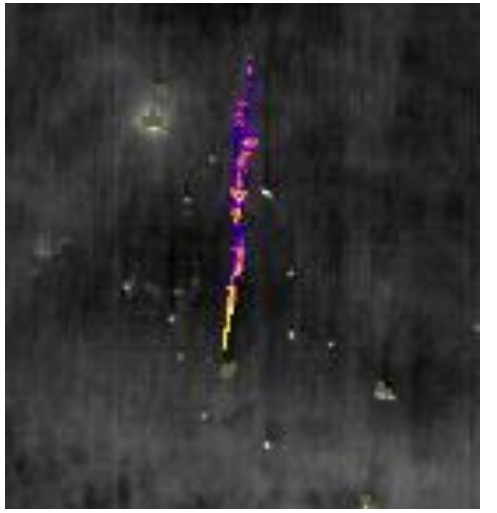
EMIT - Persian Gulf - JPL portal



EnMAP - US GoM - Roger et al. (2024) - UPV

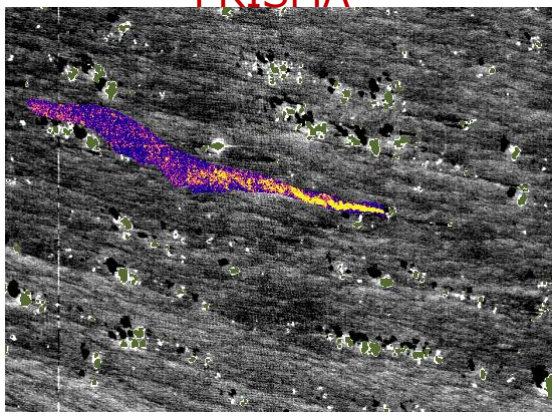


EMIT - Mexican GoM - UPV

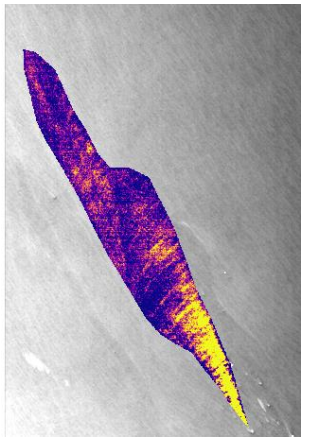


Mexican GoM - Ultra-emitter identified in Irakulis-Loitxate et al. (2022)

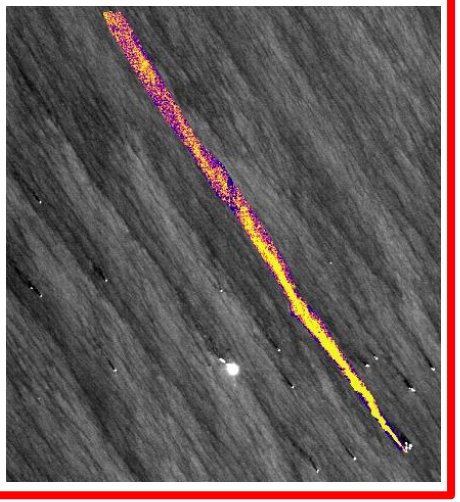
PRISMA



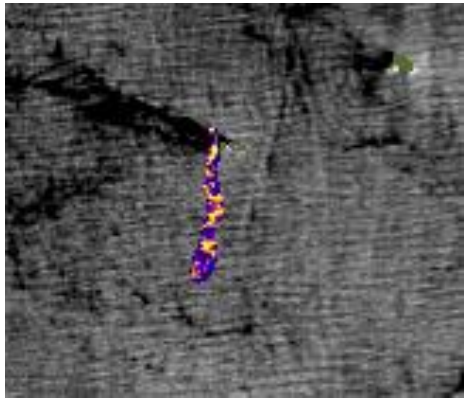
EMIT



EnMAP



PRISMA - Angola - IMEO Methane Data portal



Conlusions and future work

Conclusions

- In similar radiance conditions, EnMAP is more suitable to detect emissions than EMIT
- The sunglint effect is key to detect typical offshore emissions, but it is difficult to obtain data of this kind.
- Some offshore emissions have been collected using PRISMA, EnMAP and EMIT

Future work

- We will increase the number of acquisitions to obtain more robust results
- We will attempt to adapt the empirical results to a model using the IME quantification method (more general result)
- A manuscript will be written and submitted to a journal for publication

Acknowledgements

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Thank you for your attention...

Questions?