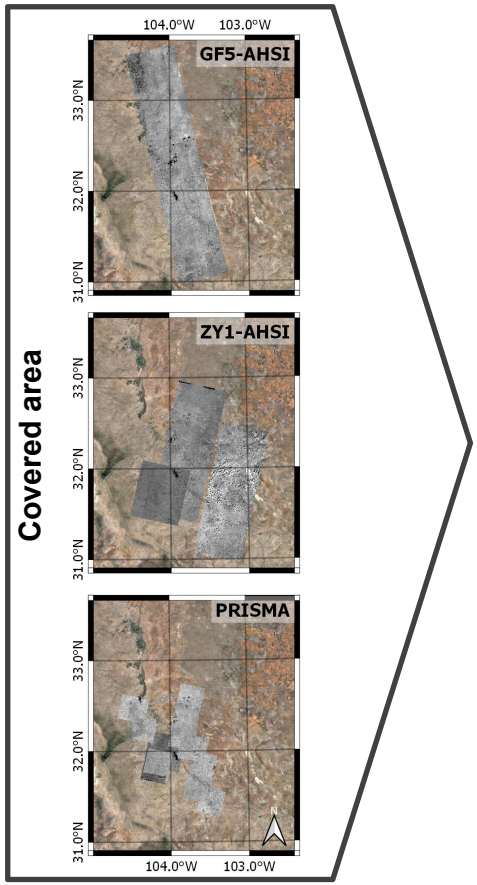
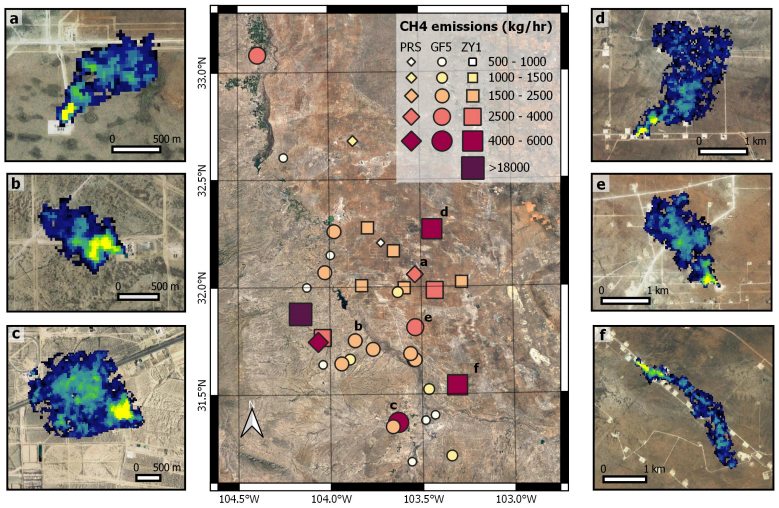
Survey of methane super-emitters in the Permian Basin with spaceborne hyperspectral data

Guanter, L., Irakulis-Loitxate, I., Liu, Y., Varon, D. J., Maasakkers, J. D., Zhang, Y., Chulakadabba, A., Wofsy, S. C., Thorpe, A. K. , Duren, R. M., Frankenberg, C., Lyon, D., Cusworth, D. H., Zhang, Y., Segl, K., Gorroño, J., Sánchez-García, E., Sulprizio, M. P., Aben, I., and Jacob, D. J.

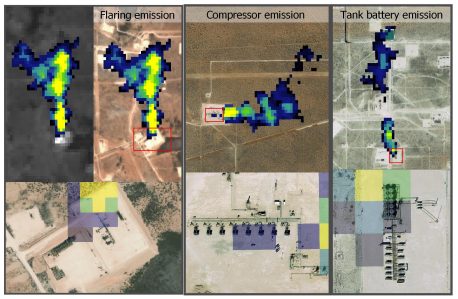
→ 3 hyperspectral satellites with 30 m pixel resolution



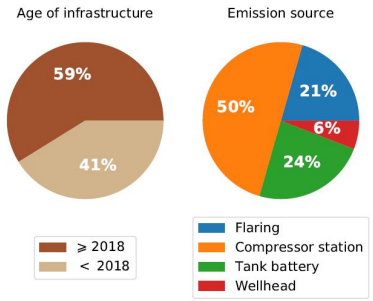
→ A total of 37 methane plumes detected on different days in 2019 and 2020



Attribution of plumes to infrastructures



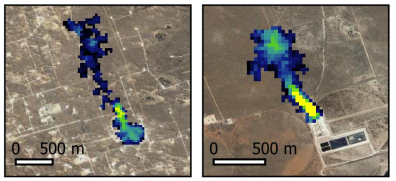
Results from Q≥500 kg/h emissions



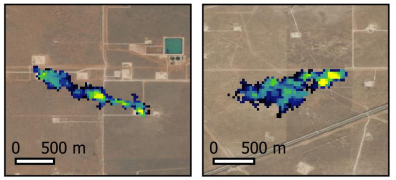
→ New detections on specific days after the end of the study

→ Emissions were reported to O&G facility operators

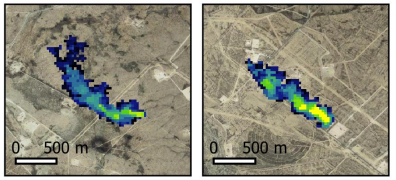
ZY1 detections on 2021/02/01

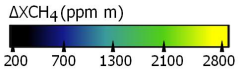


PRISMA detections on 2021/02/17 (during the heavy winter storm)



PRISMA detections on 2021/03/06

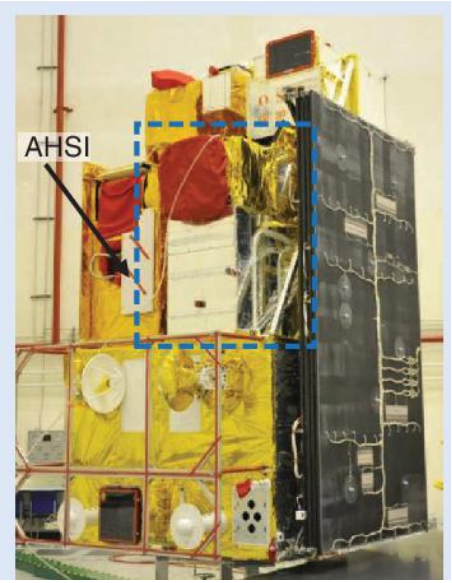


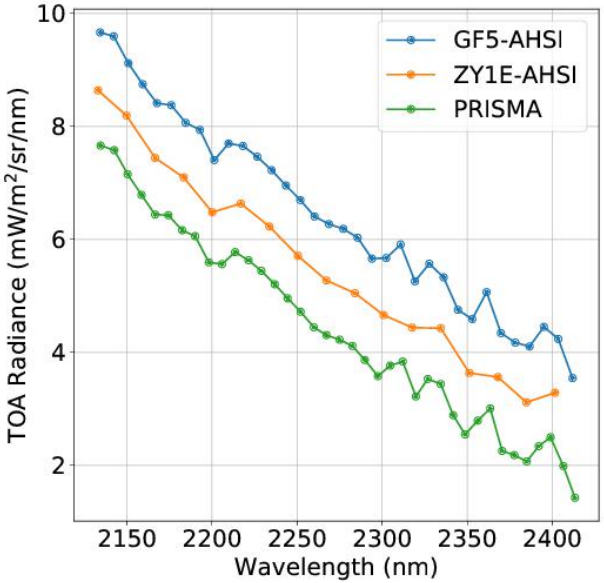


Irakulis-Loitxate, Guanter et al., Science Advances, in press (under embargo)

Methology: hyperspectral satellite missions

- We use recently available hyperspectral satellite data to map methane point emissions in the Permian Basin (USA)
- **Satellite missions:**
  - GaoFen-5 AHSI (China): GSD=30 m, SSD~8 nm, high SNR, swath=60 km (05/18-04/20)
  - ZY1E AHSI (China): same as GF5's but with 2x spectral binning, higher SNR (09/19-)
  - PRISMA (Italy): GSD=30 m, SSD~10 nm, medium/low SNR, swath=30 km (03/19-)
- Data acquisition through user request & mission tasking



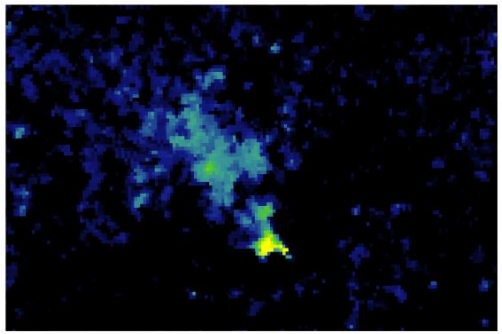


Yin-Nian Liu et al., IEEE GRSM 2019

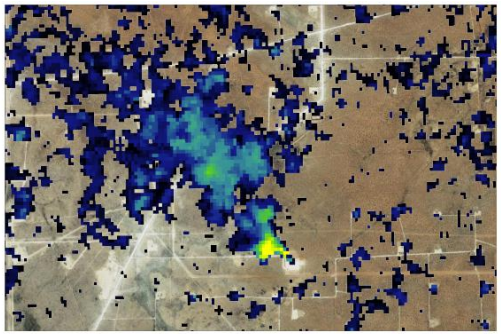
Methodology: methane retrieval & plume identification

- We use recently available hyperspectral satellite data
- XCH4 concentration enhacements quantified through our own implementation of a simple matched-filter retrieval scheme (e.g. Guanter et al., 2021)
- Plume identification with a supervised approach. Main criteria: consistency with winds and no correlation with surface structures.
- Flux rates (Q, in kg-CH4/hr) estimated using the Integrated Methane Enhancement method
- Sensitivity ~500 kg/h, depending on surface type and wind speed

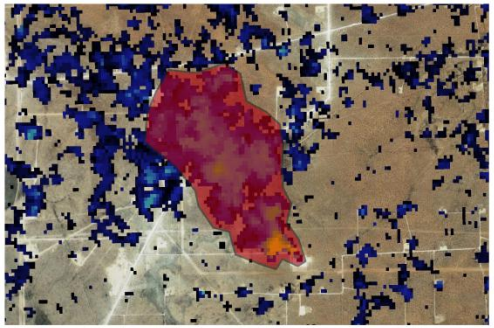
Processing



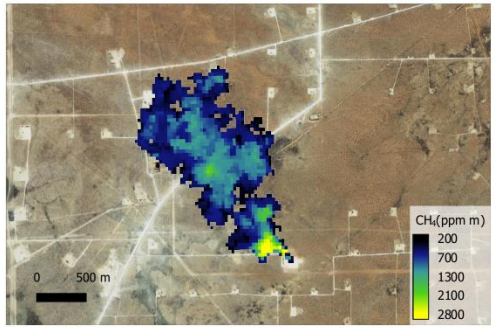
Methane concentration enhancement map



Methane map + 200 ppm·m threshold



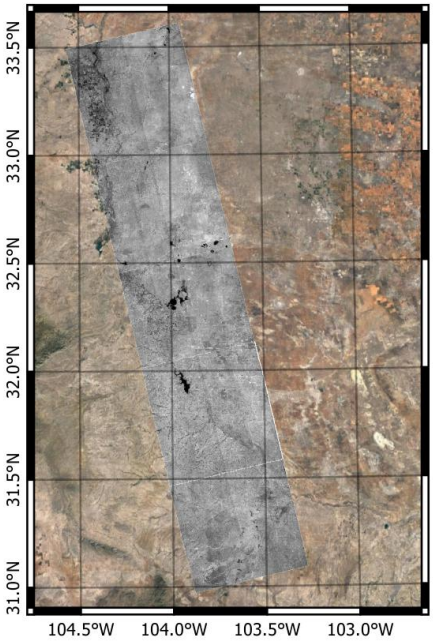
Manual plume mask

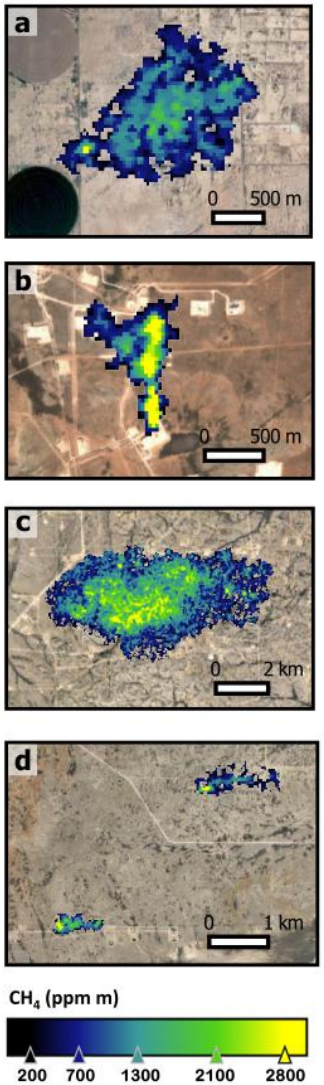


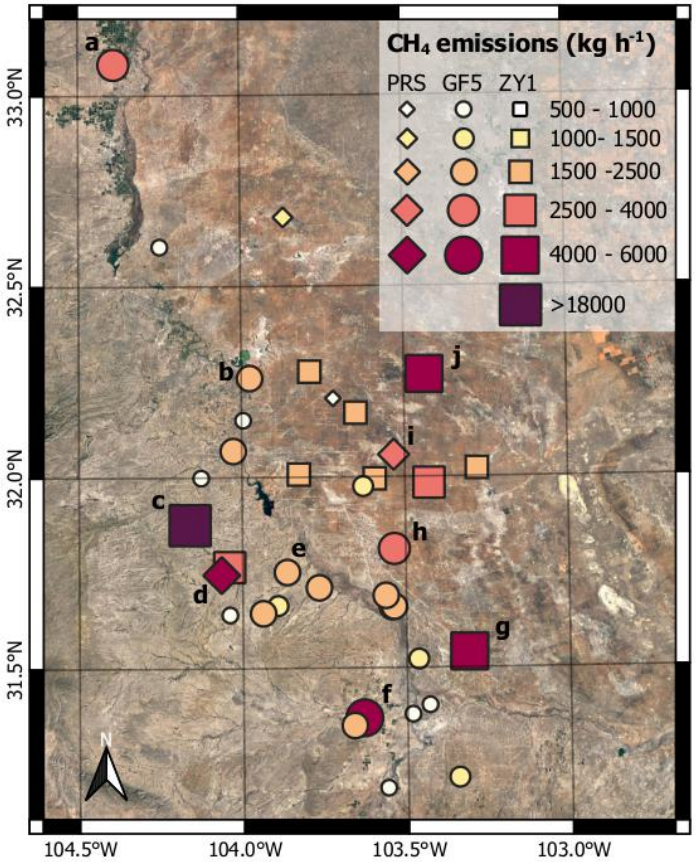
Final plume

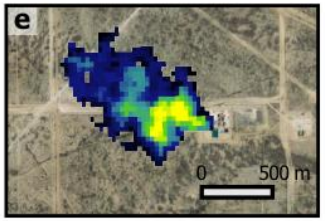
Survey of methane point emissions in the Permian Basin

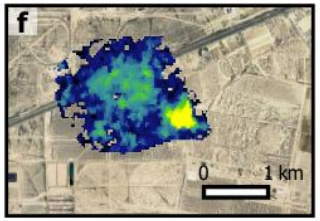
- ~30 hyperspectral satellite images processed to methane concentration enhancement maps
- 19 plumes with Q>500 kg/h found from one single satellite overpass

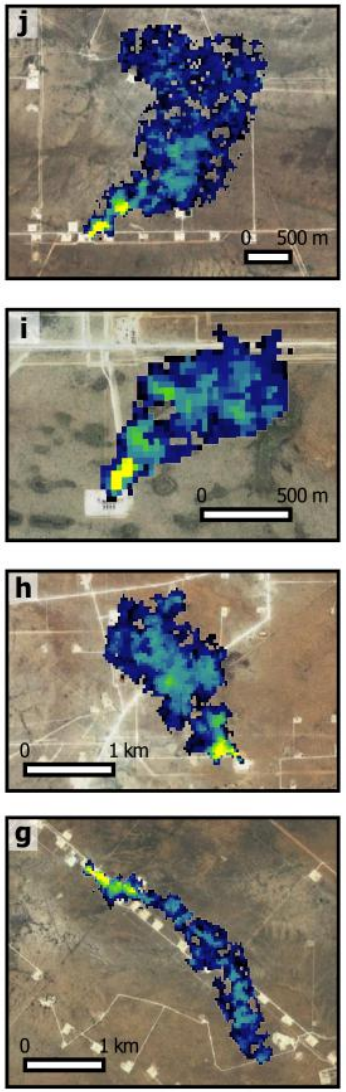








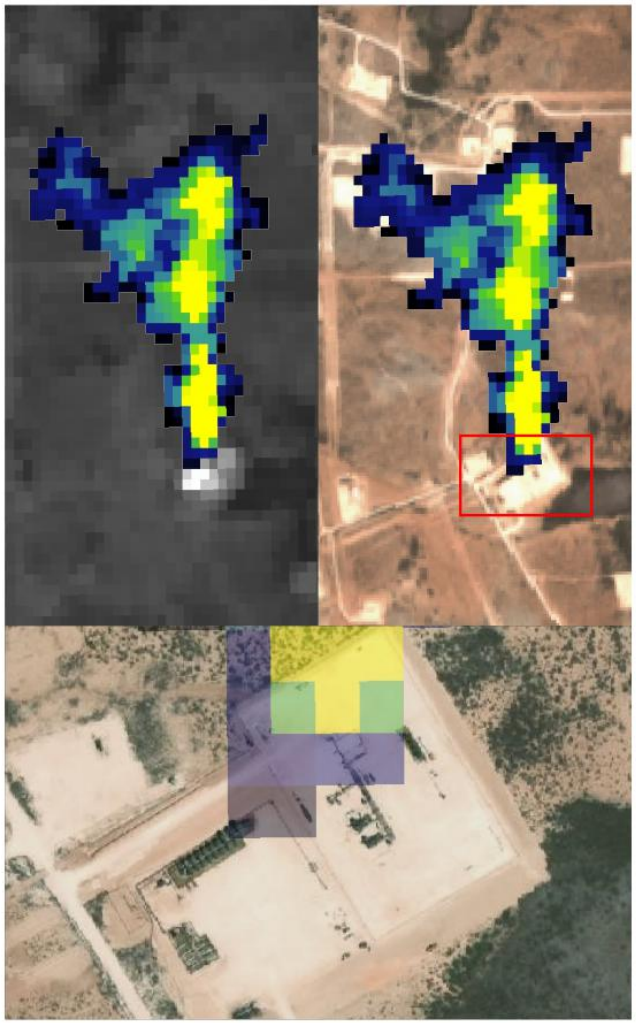




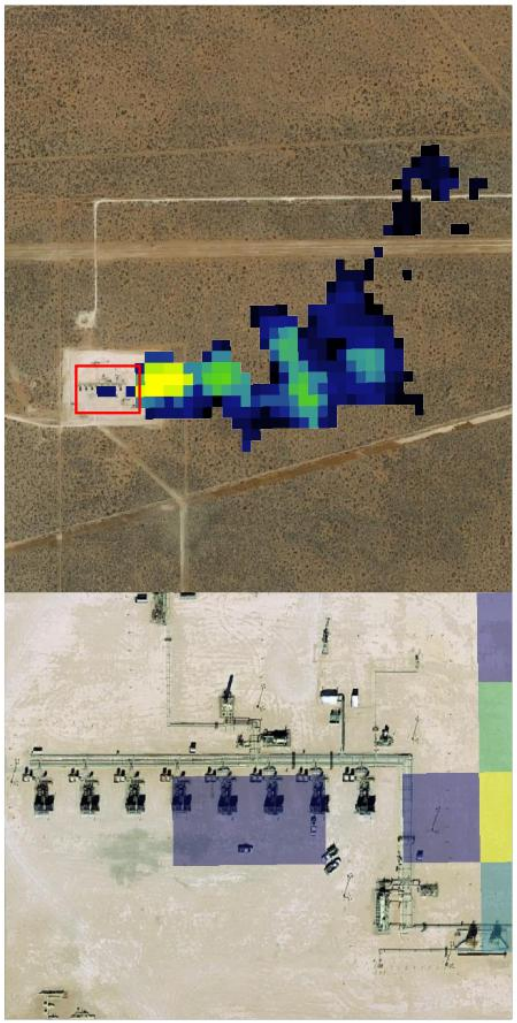
[Irakulis-Loitxate, Guanter et al., Science Advances, in press]

Attributing emissions to infrastructure elements

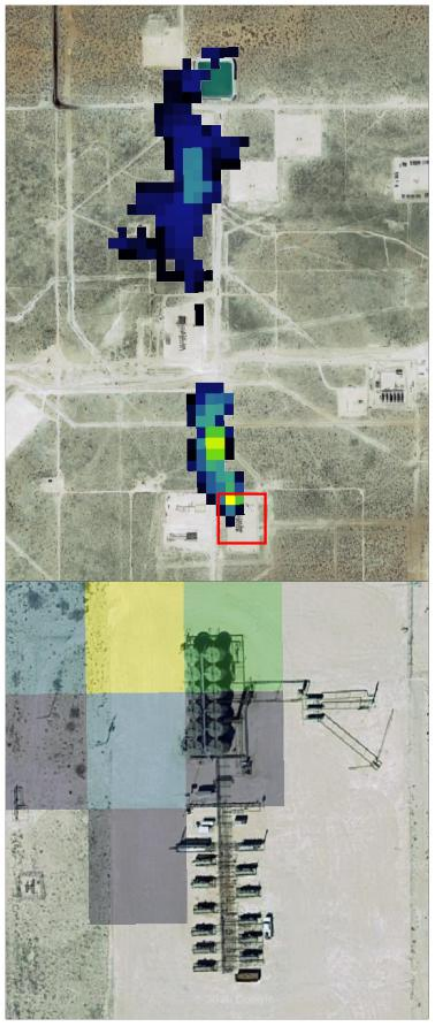
Flaring emission



Compressor emission



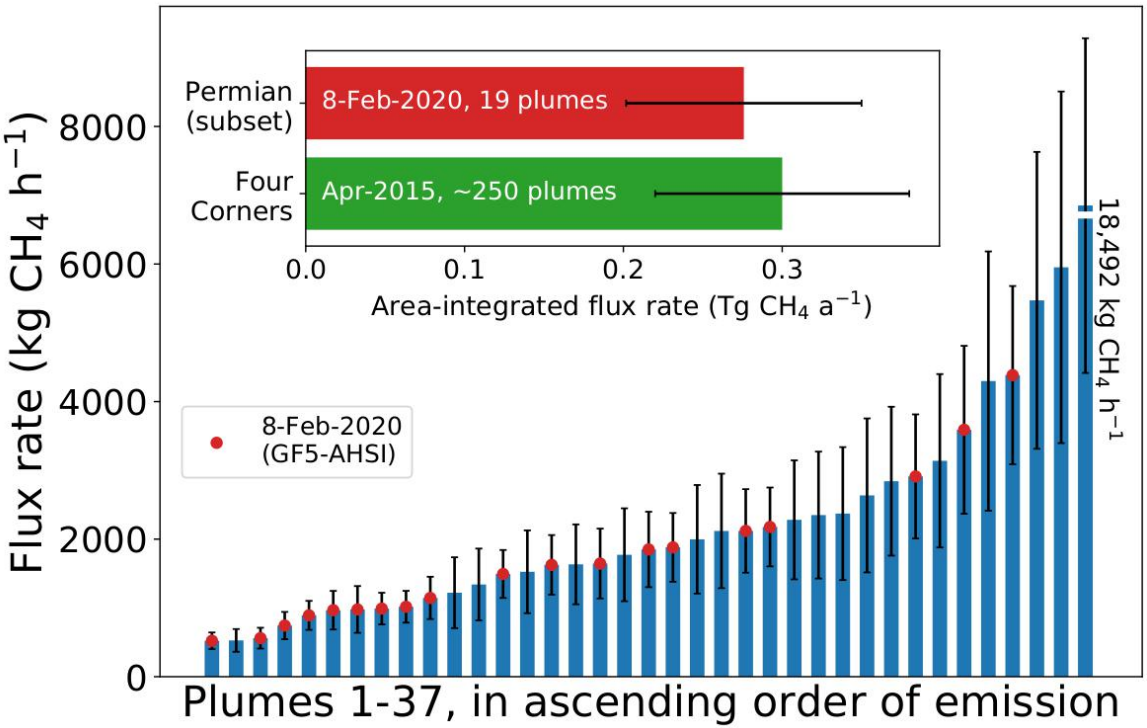
Tank battery emission

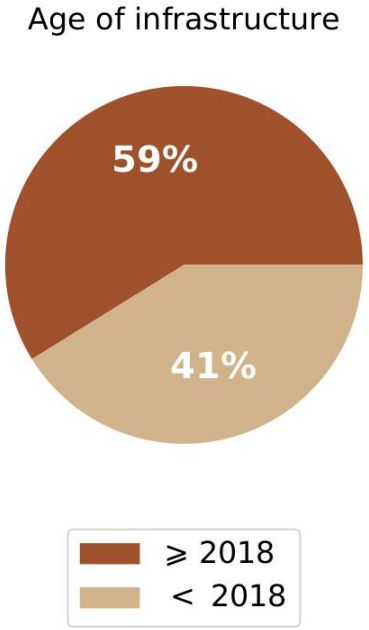


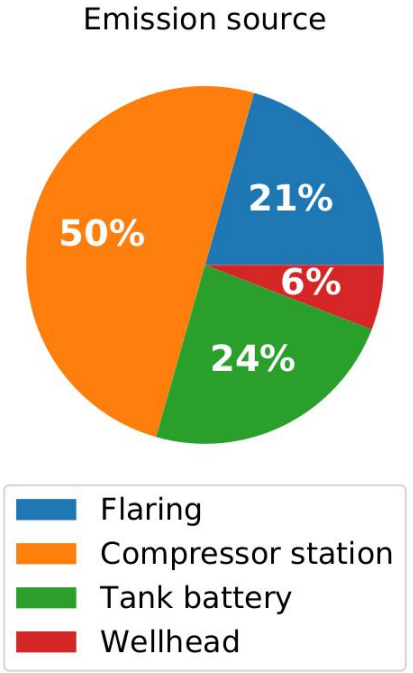
Source attribution within the 30-m pixel size

Breakdown of >500 kg/h emissions in the Permian

[Irakulis, Guanter et al. Science Advances, in press]







- 29 plumes with Q>1000 kg/h, 19 of them detected during one single GF5 AHSI overpass
- More than 50% of the wells with detected emissions started their activity in 2018 or later
  --> extreme emissions occur 2.6 times more frequently for new facilities
- 20% of the emissions are related to flaring