Methane Emissions Detection Using Satellites Assessment (MEDUSA)

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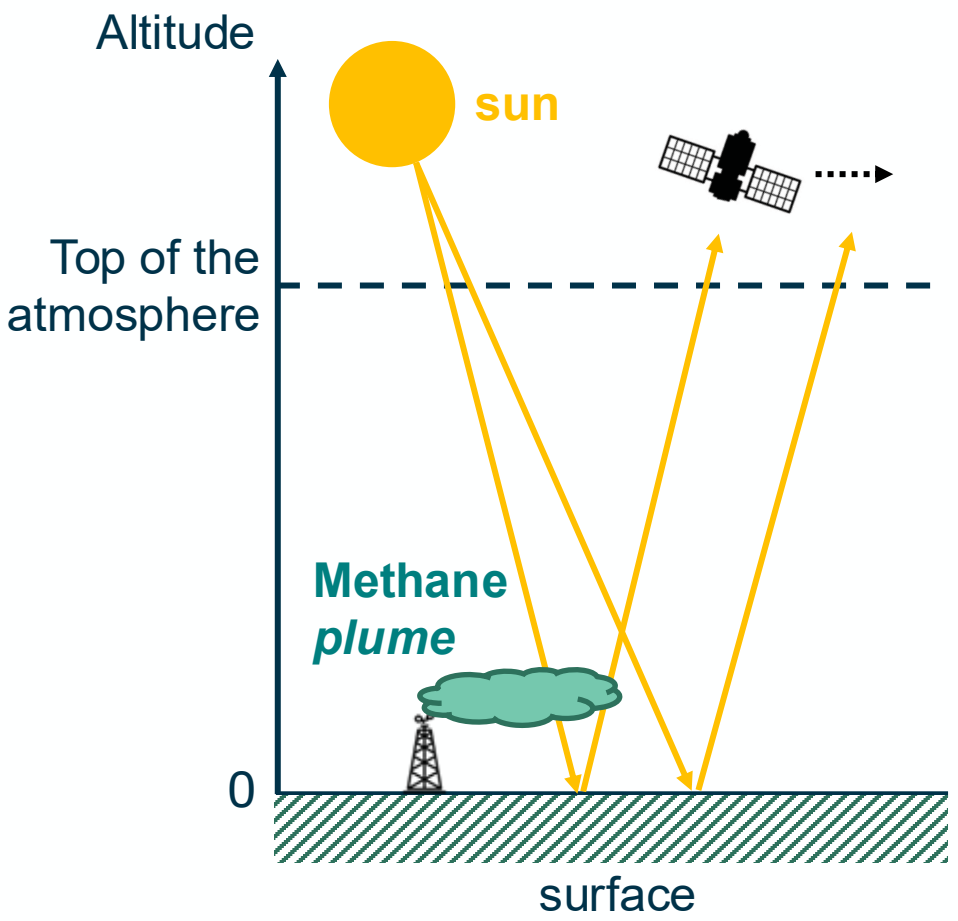
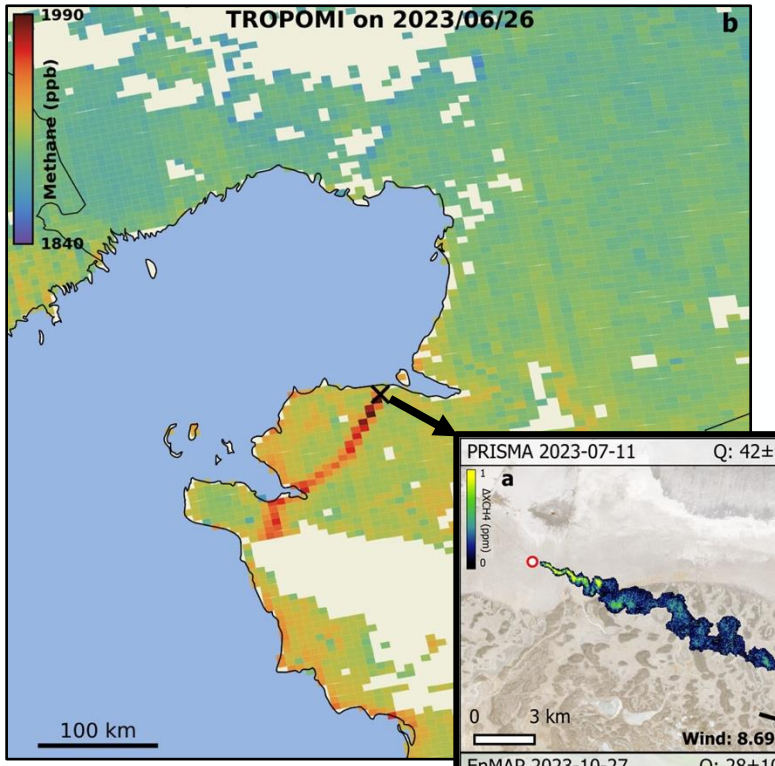
24/03/2026

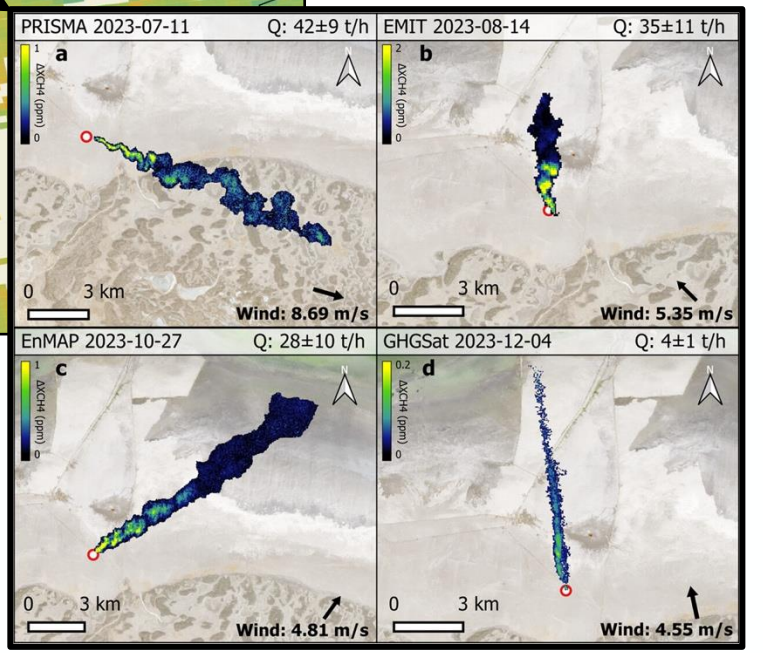
Context: Methane imaging from space





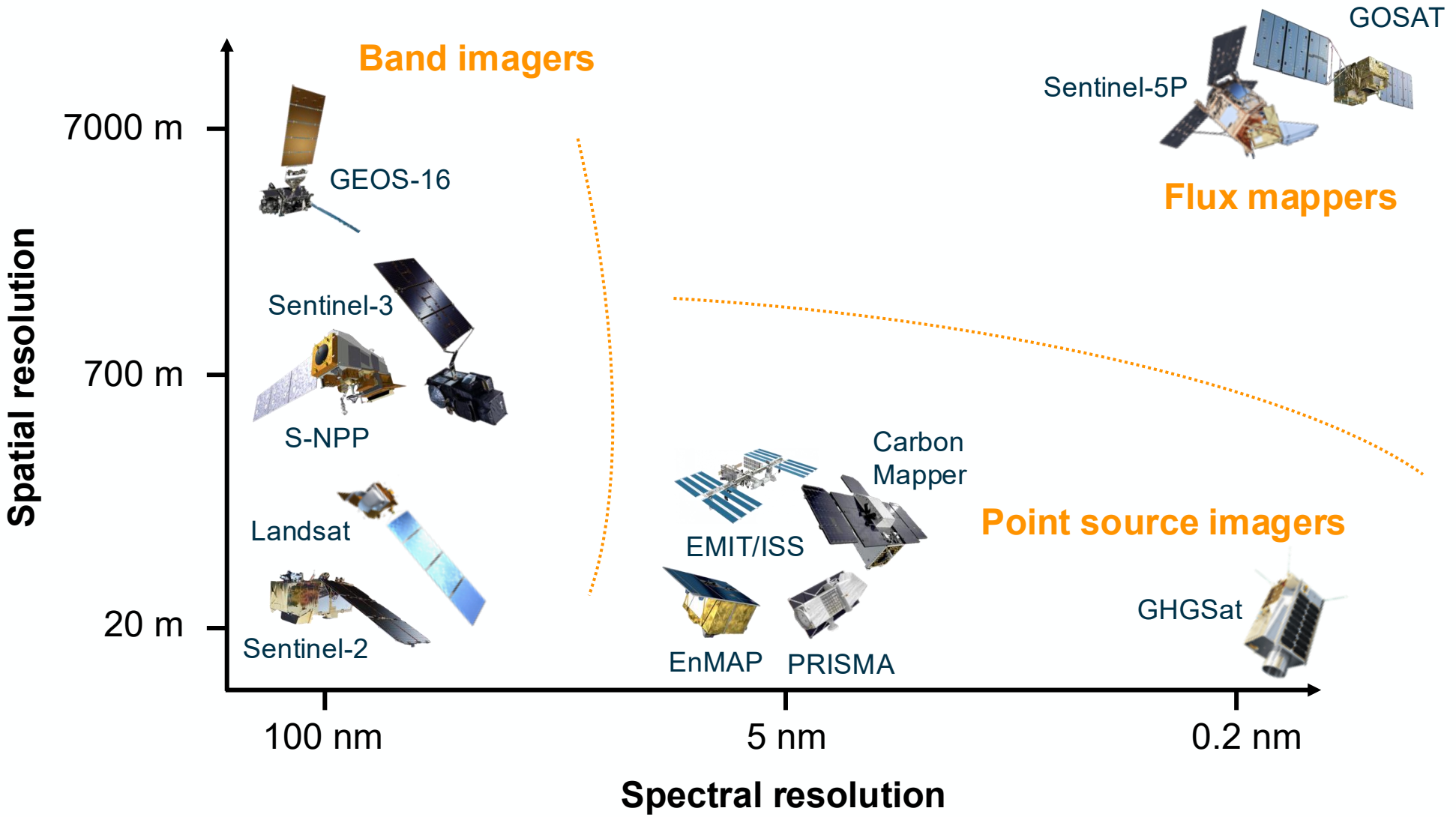
~city resolution
(~ 6 km)

high resolution
(20 - 60 m)



from
Guanter et al.
(2024)

Context: System of methane-imaging satellites



Slide concept from T. A. de Jong

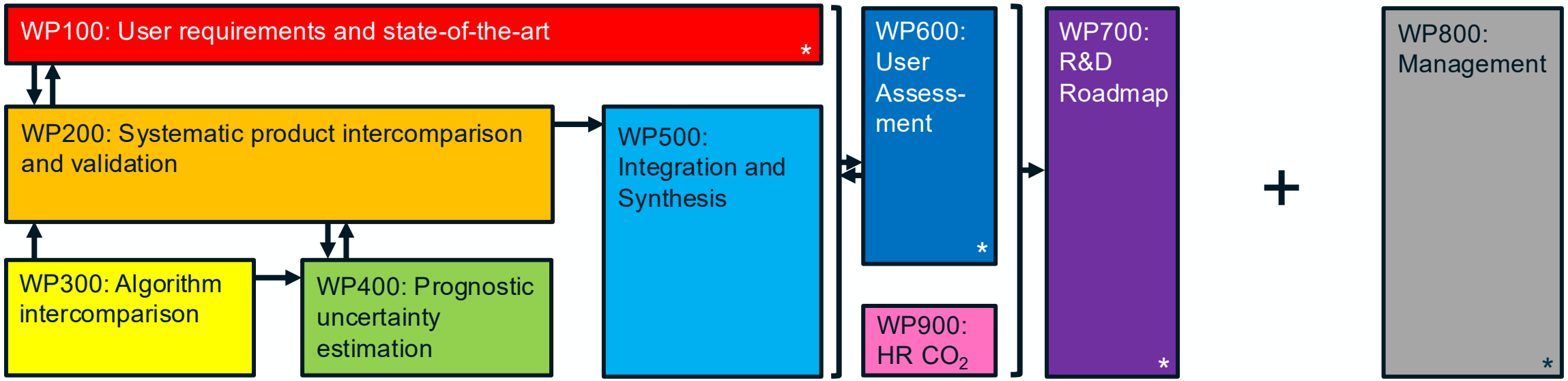
Project Objectives

- ITT entitled GHG EMISSIONS (Tender Action Number: 1-11905)

- Goals of project:
  - "to support the development of techniques and a **pre-operational system** to intercompare, harmonise and integrate information on **sub-national to facility-scale anthropogenic GHG emissions** derived using **diverse satellite instruments** and retrieval algorithms"

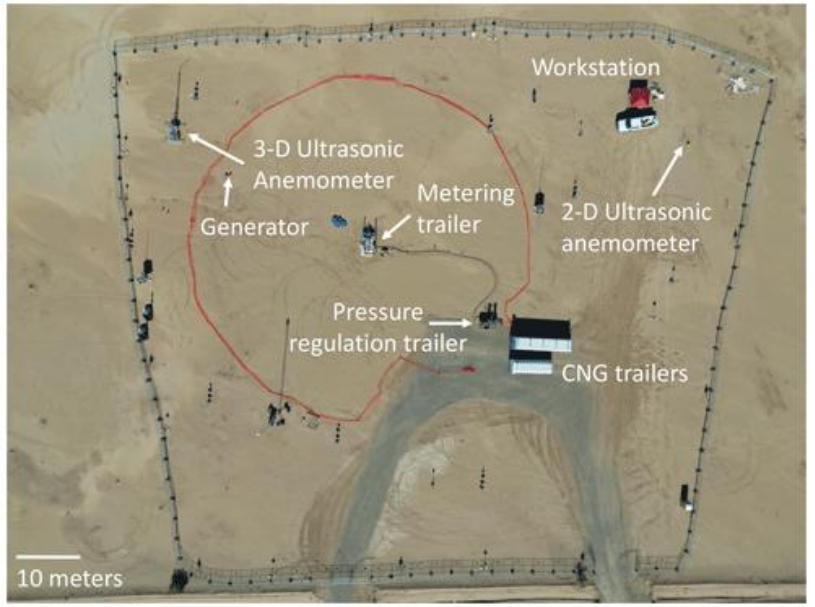
- Strong connections with policy, as illustrated by the **user and advisory group**

MEDUSA overview



* not presented here

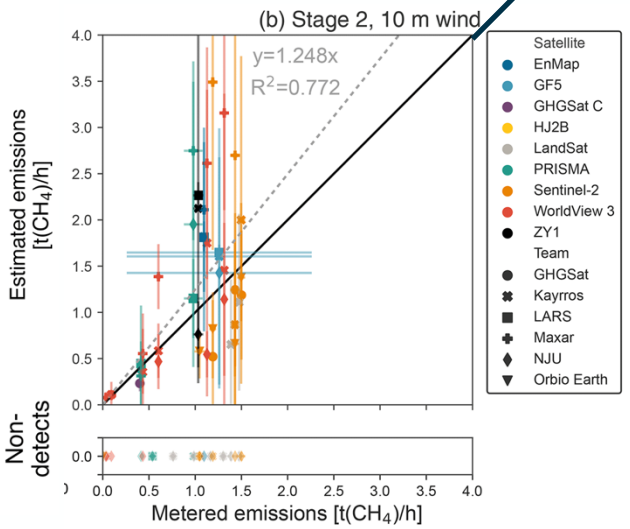
WP200: Validation and intercomparison



from Sherwin et al. (2023, 2024)

Controlled releases of methane are the **gold standard** of emission rate validation

TROPOMI
Detection limit



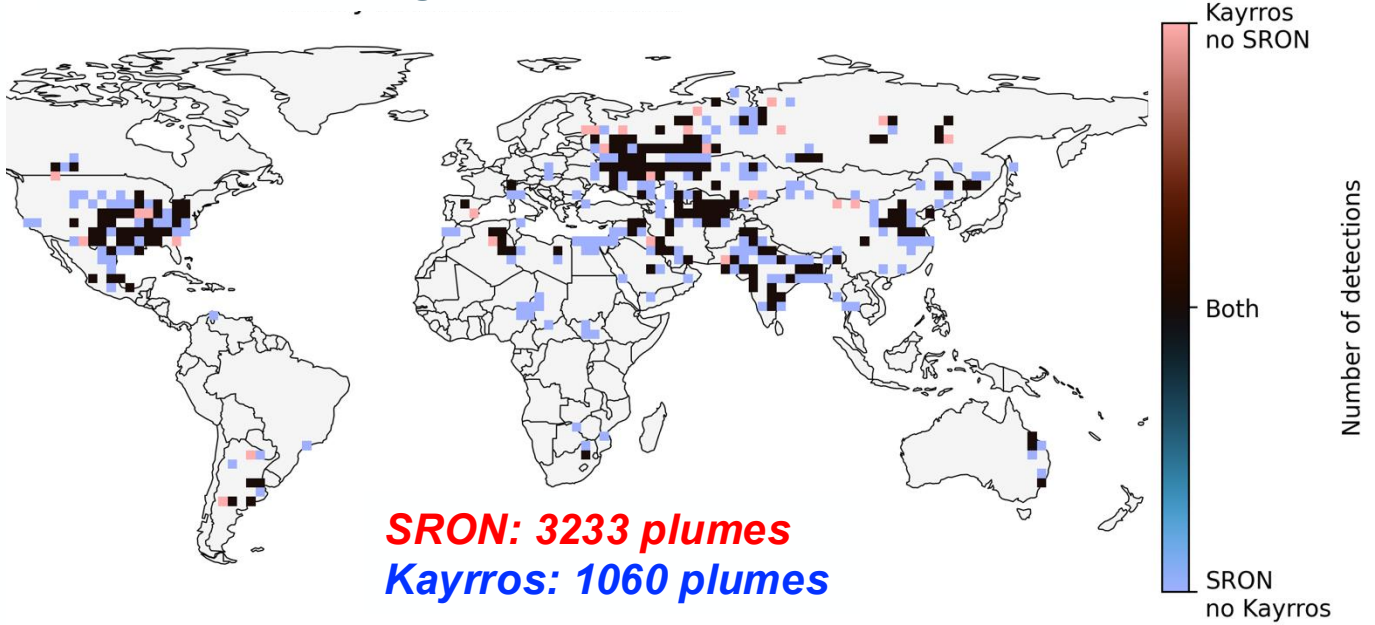
Linking satellites together: find cases where estimates can be compared

It is crucial to **support controlled release experiments**. They need to be organised on a **regular basis**, spanning different surface reflectance (vegetation, desert, etc.), emission (point, diffuse) and elevation (plains, hills, pits) conditions.

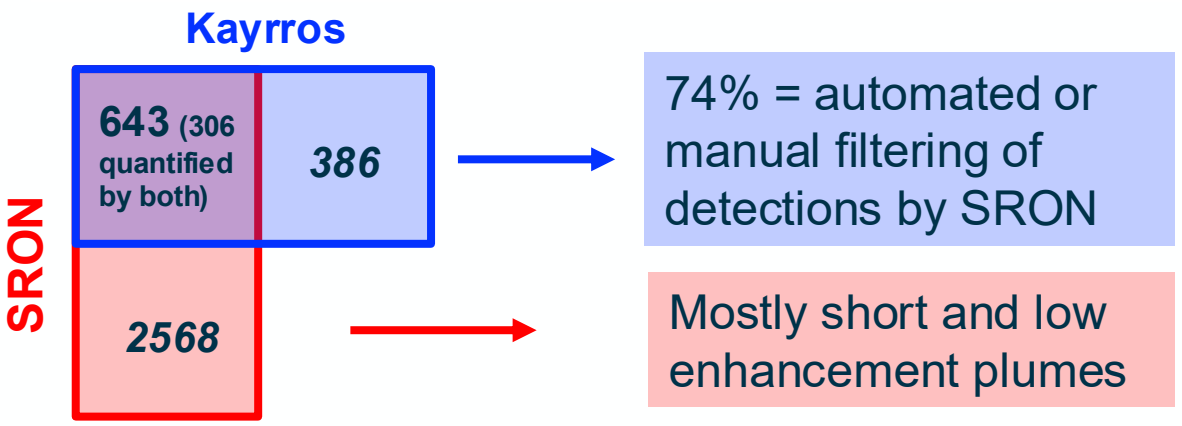
slide adapted from T. A de Jong

WP300: Algorithm intercomparison

Comparison of global plume detections for 2021

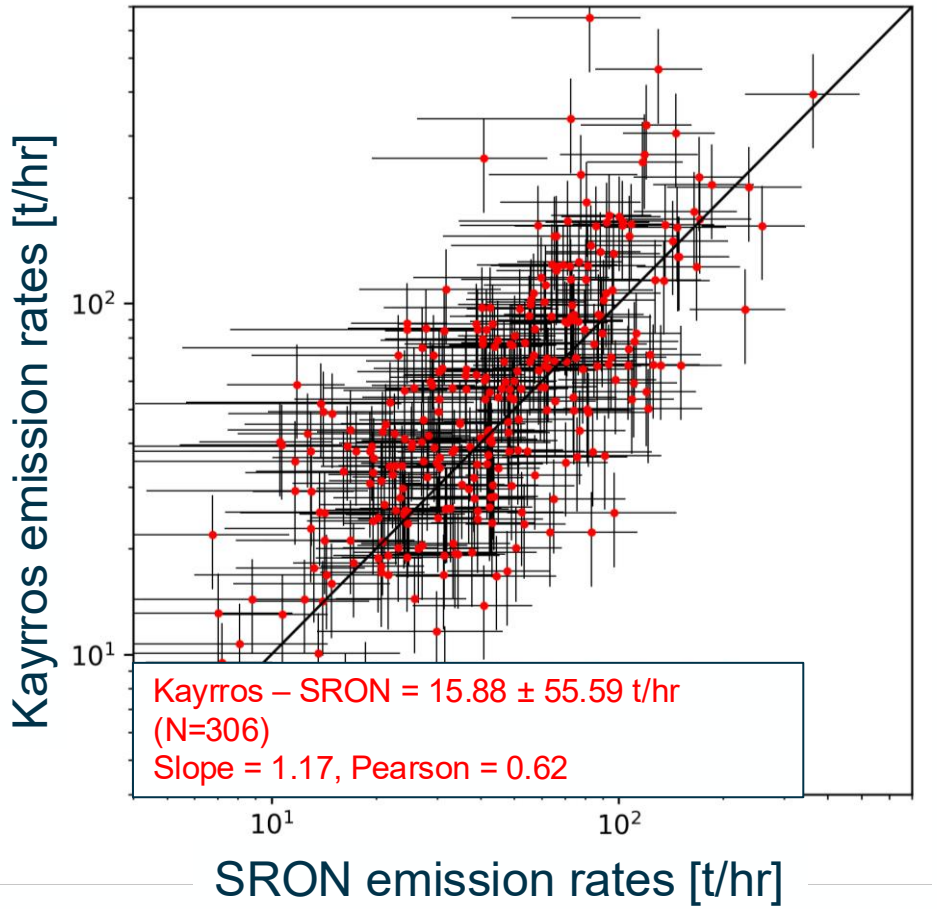


SRON: 3233 plumes
Kayrros: 1060 plumes



74% = automated or manual filtering of detections by SRON

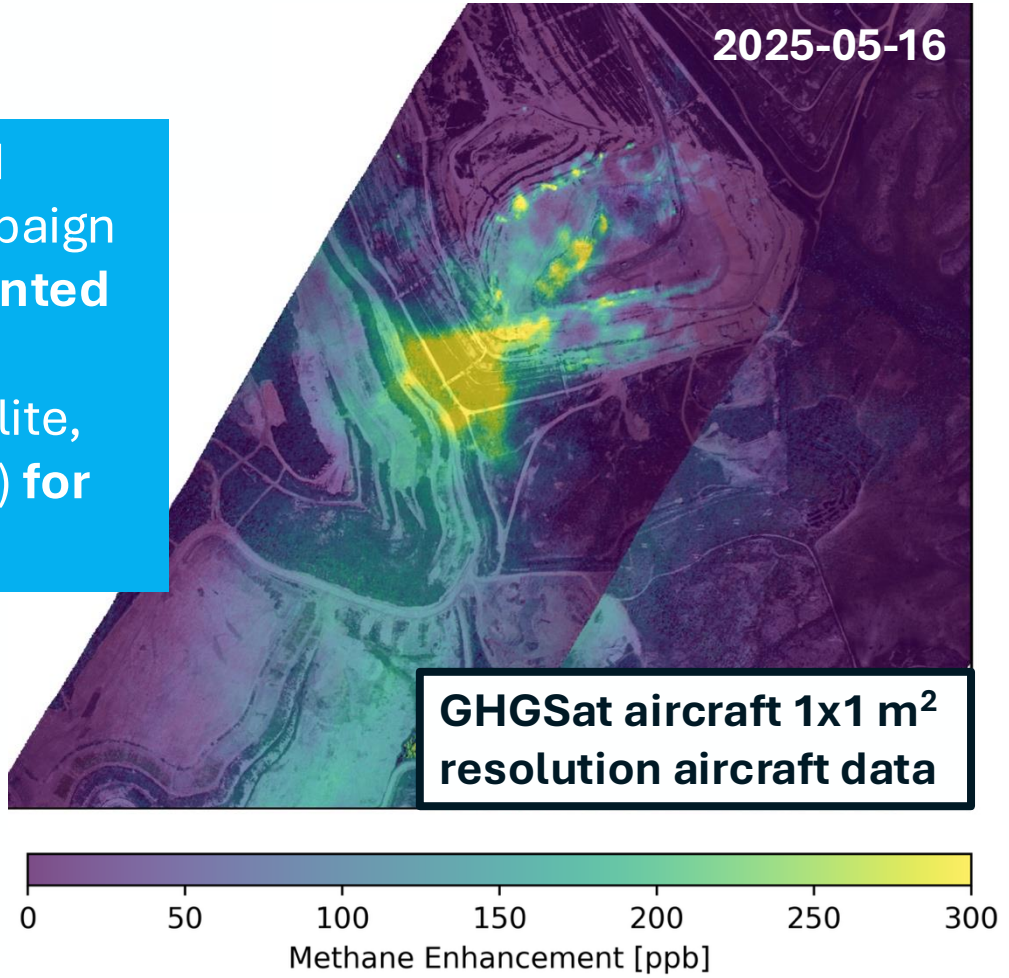
Mostly short and low enhancement plumes

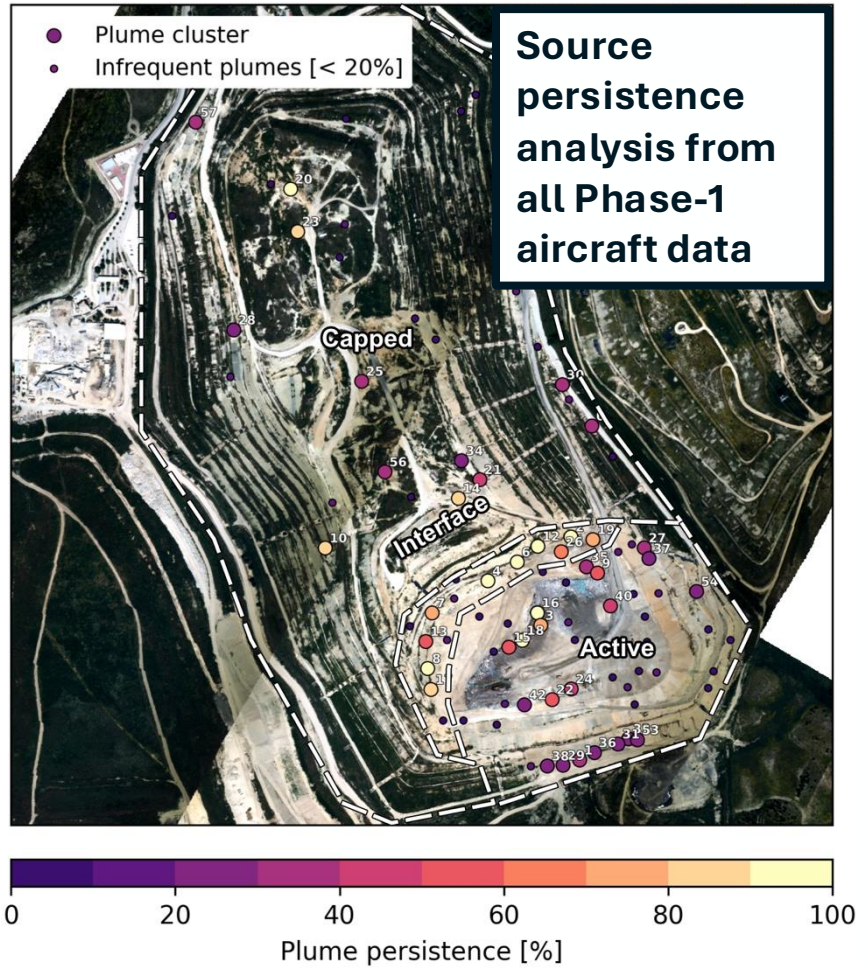


The MEDUSA WP300 covered an **unprecedented scope in terms of instrument variety, methane emission events and partners/algorithms** involved.

WP524: Madrid landfill emissions

Leak Detection and Repair (LDAR) campaign with an **unprecedented combination of instruments** (satellite, aircraft and ground) **for an active landfill.**

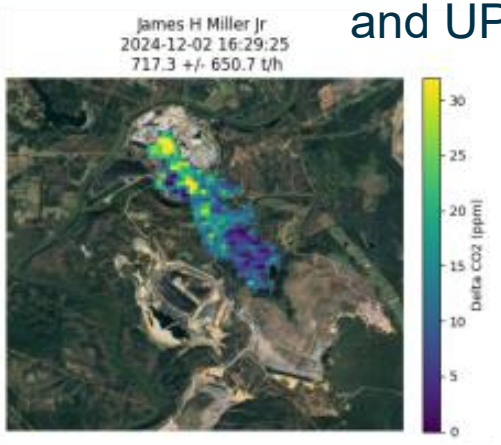
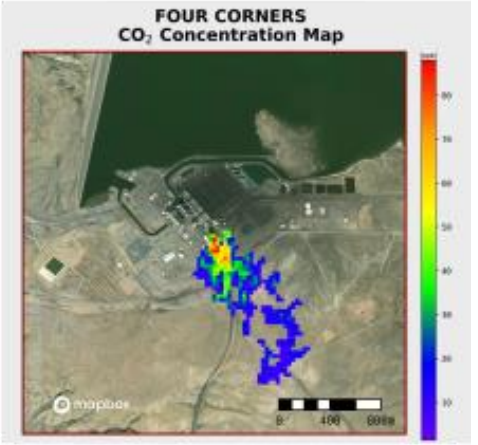
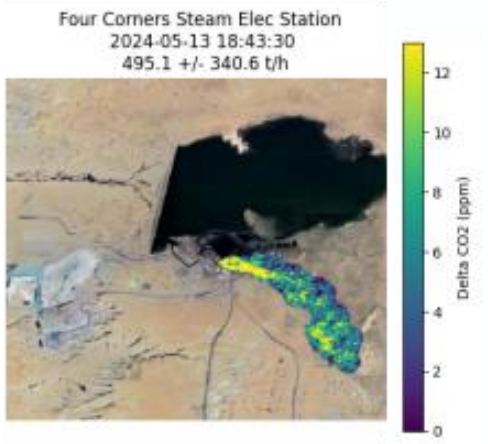




Lead and analysis by H. Sembhi and D. Potts from University of Leicester

WP900: High-resolution CO_2 satellite comparison

+ similar data from SRON and UPV

	Kayrros	GHGSat
EMIT		
EnMAP		

The 3 instruments show **potential to image CO_2 plumes**, with various detection thresholds. **Limitations in transport models** (source elevation and hot gas buoyancy) and retrievals are thought to drive the reported underestimation of CO_2 emissions.

Instrument	Detection threshold (50% probability)	Regression slope	Regression R^2	Number of observations
EMIT	8.2 MT/yr	0.42	0.72	34
EnMAP	4.4 MT/yr	0.47	0.84	32
GHGSat-C10	18.6 MT/yr	0.84	0.90	33

ECVs, Lessons learned, recommendations

ECVs:

- Emissions are the continuation of concentration (~actionable ECV?)
- Wind speed (reanalysis & meteo) are essential

Lessons learned:

- Intercomparison between different satellites is challenging
- Controlled releases are critical: need for more (funding for) diverse locations, source geometries, etc.

Satellite data:

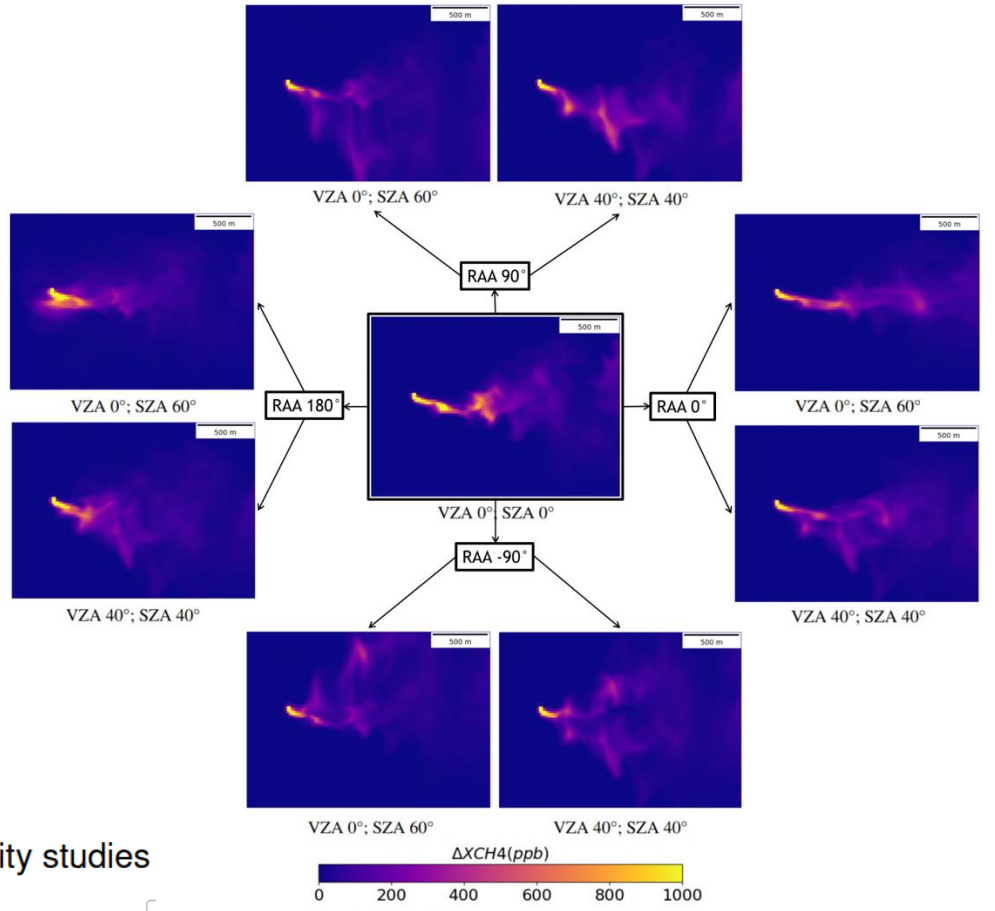
- Need for coordinated observations between satellites
    - Support from Sentinel-2A team to extend observations over methane relevant areas much appreciated!
- Data access: Easier/more complete cloud access for lower level data products (e.g. Sentinel-3 SLSTR L1A) and/or facilitate more interactions/discussions between data processing teams and users, especially later in the mission (e.g. striping corrections).

WP400: Recent publication

Considering the observation and illumination angular configuration for an improved detection and quantification of methane emissions

Javier Gorroño[1], Zhipeng Pei[2], Adriana Valverde[1], and Luis Guanter[1,3]

https://doi.org/10.5194/amt-19-1245-2026



- **Scene angular mismatch.** Parallax of angular illumination/observation results in errors in the flux rate calibration, training models and PoD.
- **Benchmark simulations.** LES database published in Zenodo to analyse the impact of source typology or the simulations accuracy against controlled releases.

Benchmark simulations for methane emissions validation and sensitivity studies

Gorroño, Javier (Project leader)[1]; Pei, Zhipeng (Researcher)[2]; Guanter, Luis (Supervisor)[1]

https://doi.org/10.5281/zenodo.18161182

Slide by Javier Gorroño, UPV