GHGSAT

ACCESSING GHGSAT METHANE DATA THROUGH ESA TPM

Bryn Orth-Lashley | Technical Operations & Service Delivery Manager

Carles Debart | Director of Business Development, Europe

GHGSAT

PANEL DISCUSSION ON

EMPOWERING CLIMATE RESEARCH WITH EMISSIONS DATA

Meet our Panelists

Carles Debart
Director of Business Development
Europe - Institutional

Bryn Orth-Lashley
Technical Operations and Service
Delivery Manager

Ready to Submit your Proposal?

Click here or scan the QR code below to get started!

AGENDA

- **Introductions**
  - GHGSat
  - European Space Agency (ESA) Third-Party Mission (TPM) program
- **GHGSAT technical orientation**
  - Methodology for emission monitoring
  - Data products
- **How to apply for GHGSat data?**
- **Q&A**

A recording of the session will be shared as soon as it's available

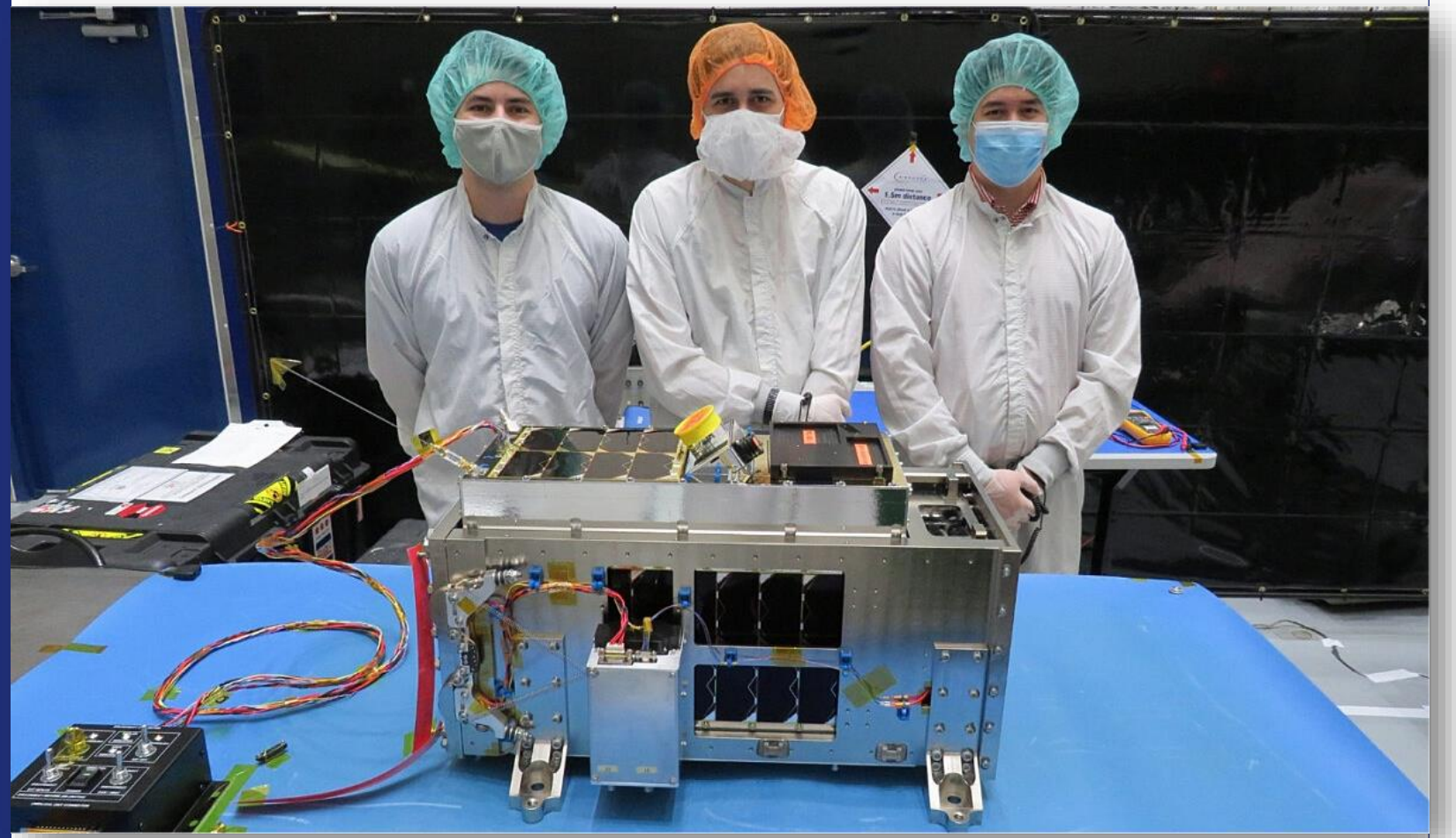
INTRODUCTION

GHGSAT

INTRODUCTION

GHGSAT

A team of 160, including engineers, scientists, data analysts, and sector specialists with the goal of supporting emission reduction goals

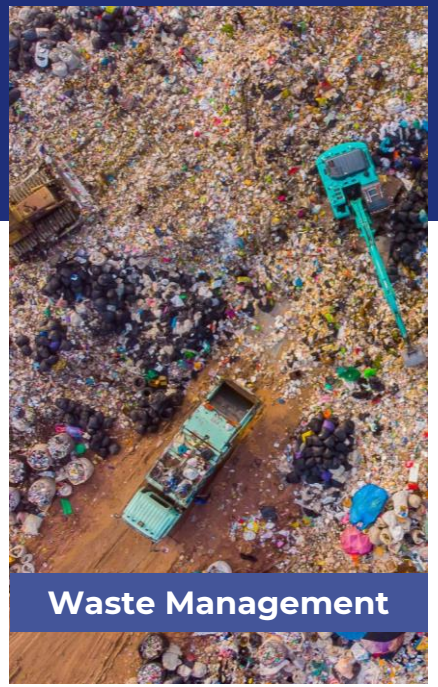


GHGSAT

Data suitable for several applications

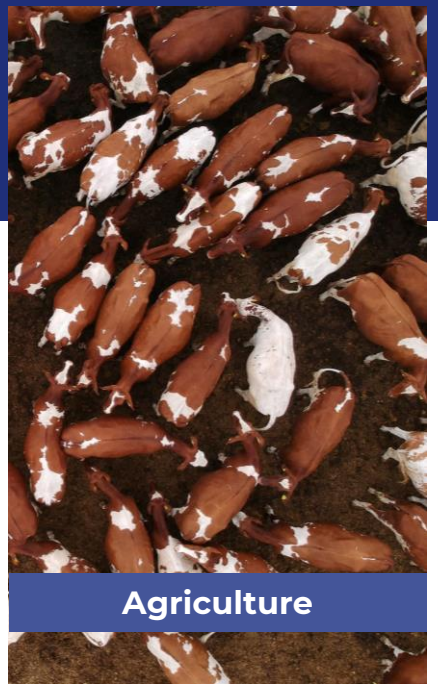
Oil and Gas

Wells, batteries, compressor stations, pipelines, tailing ponds, etc.



Waste Management

Landfills, waste water, etc.

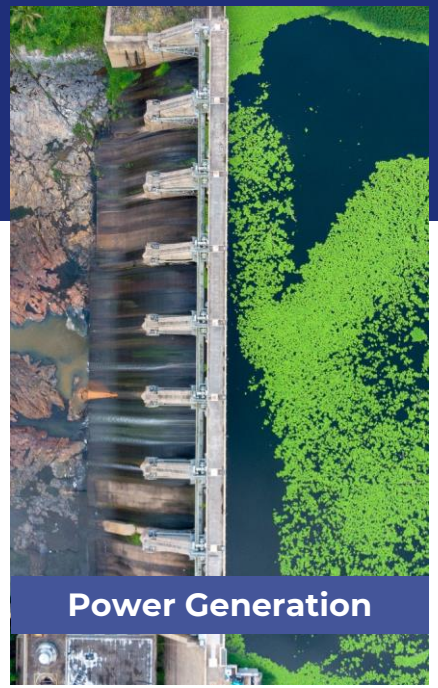


Agriculture

Animal feedlots and waste recovery

Mining

Underground and open pit coal mines, and coalbed methane production



Power Generation

Thermal generation, hydroelectric, biomass, etc.

About ESA
THIRD PARTY MISSIONS PROGRAMME OVERVIEW

What are TPMs?

Third Party Missions are earth observation missions that are not owned or operated by ESA. The agency has an agreement with these third parties to distribute data products from their missions to scientific users

History?

ESA's TPM arrangement has been operating for over

45 YEARS

providing EO data to users in **Europe** and **worldwide** for research and pre-operational applications development

How many?

TPMs currently include over 60 instruments on more than 50 missions

<60 INSTRUMENTS **50+** MISSIONS

How?

TPM datasets are distributed under specific agreements with the owners or operators of the mission – some sets are available under the free dataset policy, requiring only a fast registration, others are part of a restrained data set and require the submission of a project proposal or service request

Benefits?

Data is offered from a large number of international missions through a single programme.
One of the criteria for selecting new missions is that they utilise instruments that offer similar data to those acquired by ESA missions, contributing to a wide range of data that may be used together.
Other criteria include degree of innovation, opportunity for new international collaboration and experience to be gained for future missions

Innovation?

IN 2018 ESA changed the agreements with the commercial TPM data providers in order to also include start-ups and entrepreneurs in incubators, to access the data. This greatly supports ESA's Technology Transfer Programme Office (TTPO)

Data Access?

https://earth.esa.int/eogateway/search?category=Data

Atmospheric · Optical · SAR · Reflected Global Navigation Satellite System (GNSS-R) and Radio Occultation · Gravity Field

INTRODUCTION

GHGSat & ESA TPM collaboration

- **GHGSat is part of ESA TPM since 2020, extended the collaboration in 2024:**

  https://earth.esa.int/eogateway/missions/ghgsat

  GHGSat Announces Expanded Agreement with ESA's TPM Program

- **Data is available, for non-commercial uses to:**
  - **Research organizations worldwide**
  - **ESA Member State's companies involved in ESA projects/research applications**

    (ESA Member States: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and the United Kingdom + Canada, Latvia, Lithuania and Slovenia)

- **GHGSat offers:**
  - **Data from the catalogue – with more than 3.5M observations from 2016**
  - **New Tasking – collection of new observations tailored to the project needs**

TECHNICAL ORIENTATION

Why measure methane from space?

ECONOMIES OF SCALE
Can measure any site in the world, every 1-2 days

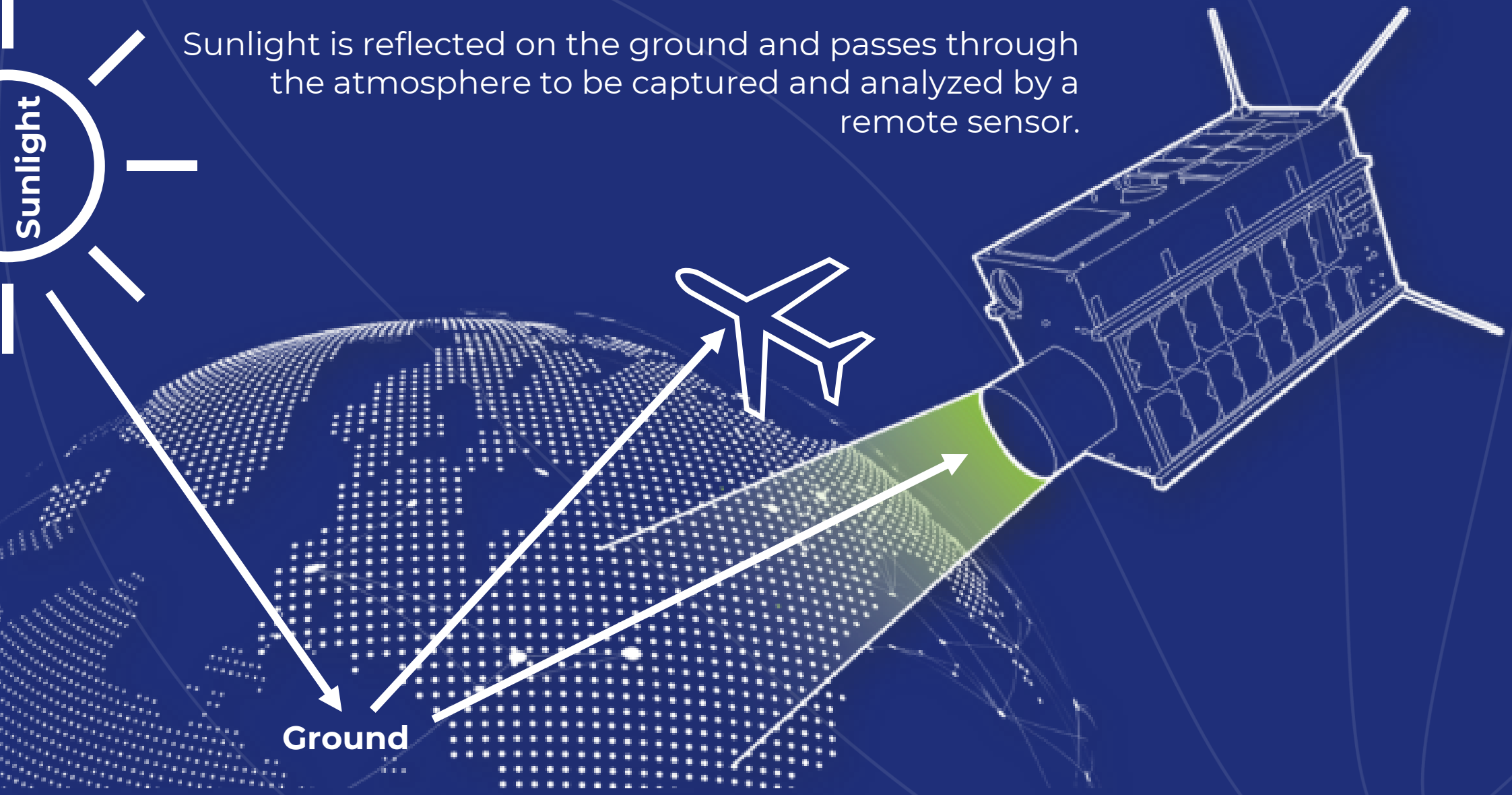
EASE OF DEPLOYMENT
Can measure any site within a few days of request, as many times as needed, with no deployment cost

CONSISTENCY, TRANSPARENCY
Same method used for all sites, everywhere, for anyone

PERFORMANCE
Can detect and quantify emissions more precisely and at lower cost

HOW ARE EMISSIONS DETECTED?

Sunlight is reflected on the ground and passes through the atmosphere to be captured and analyzed by a remote sensor.



OUR SATELLITES

10 methane detecting satellites in space!

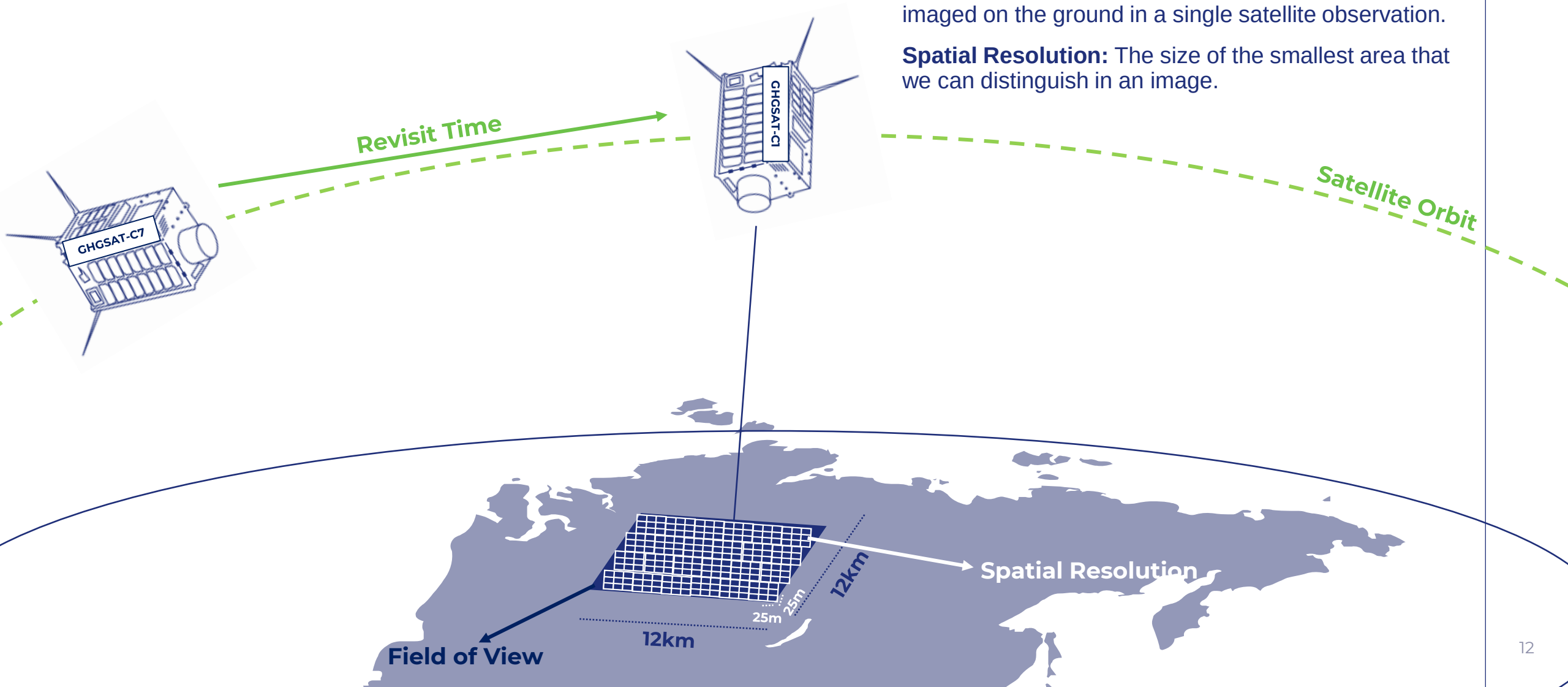
- **Spatial resolution:** 25 m
- **Spectral band:** short-wave infrared
- **Spectral resolution:** 0.3 nm (low noise level)
- **Detection threshold:** (50% PoD at 3 m/s)
- **Onshore:** 100 kg/hr
- **Offshore:** 150 – 1000 kg/hr (seasonally and latitude dependent)
- **Field of View:** 12km x 12km
- **Revisit Time:** 1-2 days with combined satellite revisit

DEFINITIONS

Revisit Time: The time that it would take for another satellite in the constellation to be overhead of the same location (or site) on the ground. The more satellites we have in orbit, the more frequently we can view a site.

Field of View: The size of the entire area that is imaged on the ground in a single satellite observation.

Spatial Resolution: The size of the smallest area that we can distinguish in an image.



FROM OBSERVATION TO METHANE QUANTIFICATION

Observation Planning

Intelligent pointing for satellites in target mode

Observation

Collect data

Data Processing & Validation

Process raw data to retrieve a map of methane concentration

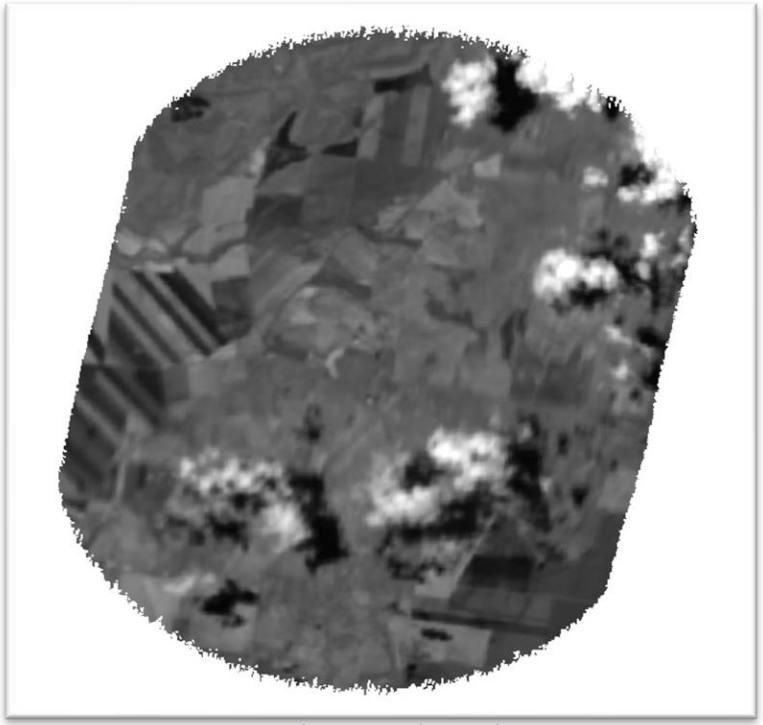
Identify Emissions

Source Rate in kg/hr

Source Location

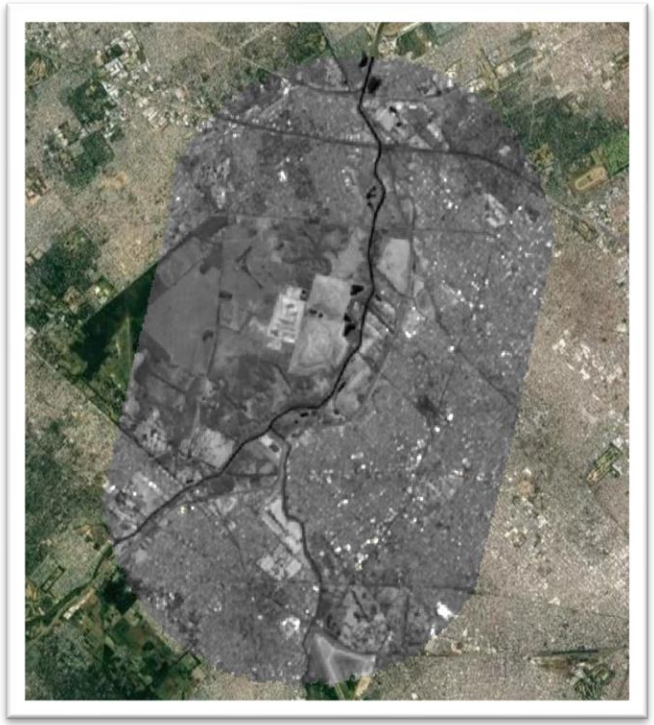
DATA PROCESSING & VALIDATION

Retrieve surface reflectance and methane concentration maps



Quality validation

Successful, marginal or unsuccessful

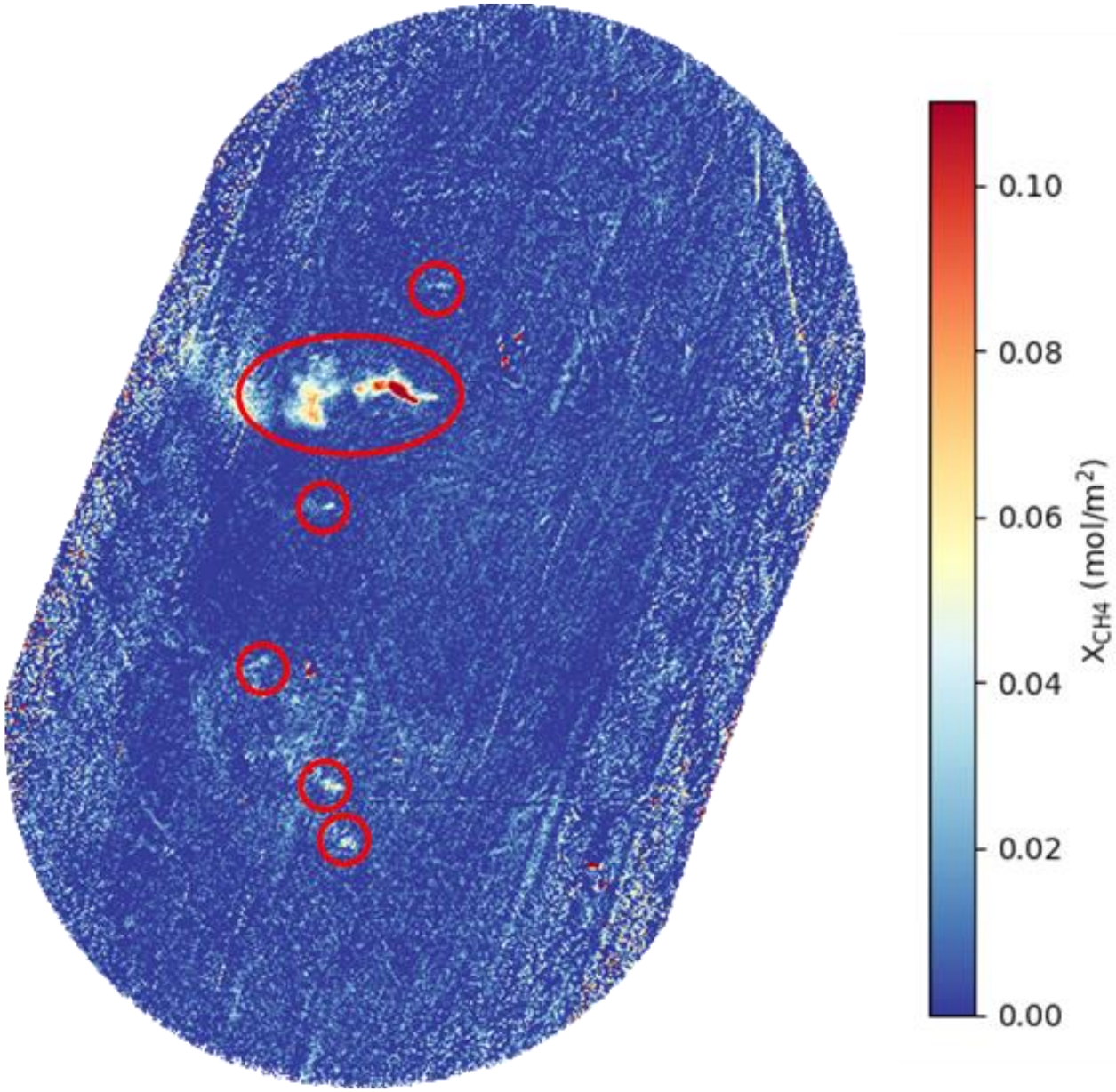


Georeferencing validation

~30 meters accuracy to real coordinates

EMISSION IDENTIFICATION

Create mask to isolate every emission



Map of methane concentration

WHAT CAN AFFECT THE ABILITY TO DETECT AND QUANTIFY METHANE?

WEATHER

Clouds and haze

SEASONAL EFFECTS

Snow cover and low solar elevation angle (especially at high latitude)

WIND SPEED

High wind speed dissipates methane emissions faster in the atmosphere. Low wind speed allows us to detect fainter emissions.

INDUSTRIAL EFFECTS

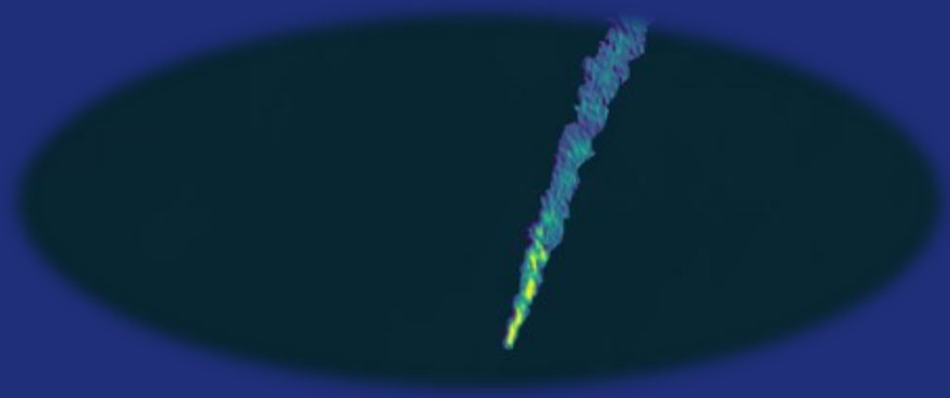
Smoke, Lit flares, Water vapor

BODY OF WATER – OCEAN & LAKES

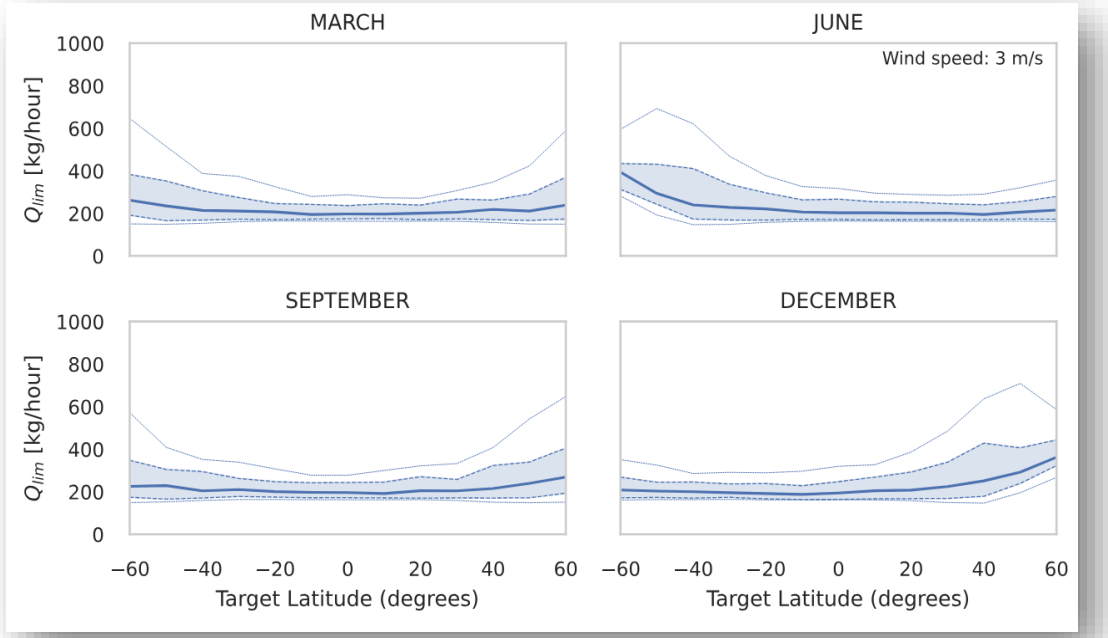
Water reflects infrared light poorly

GLOBAL MONITORING (NOW OFFSHORE)

Commercialization of glint observation mode



- GHGSAT has pioneered the use of glint observation mode for identification and quantification of methane emissions over bodies of water
- Offshore monitoring is now offered commercially
- Initial results are detailed here: https://egusphere.copernicus.org/preprints/2023/egusphere-2023-1772/egusphere-2023-1772.pdf. Notably, GHGSAT detected the smallest emission ever detected offshore (180 kg /hr).



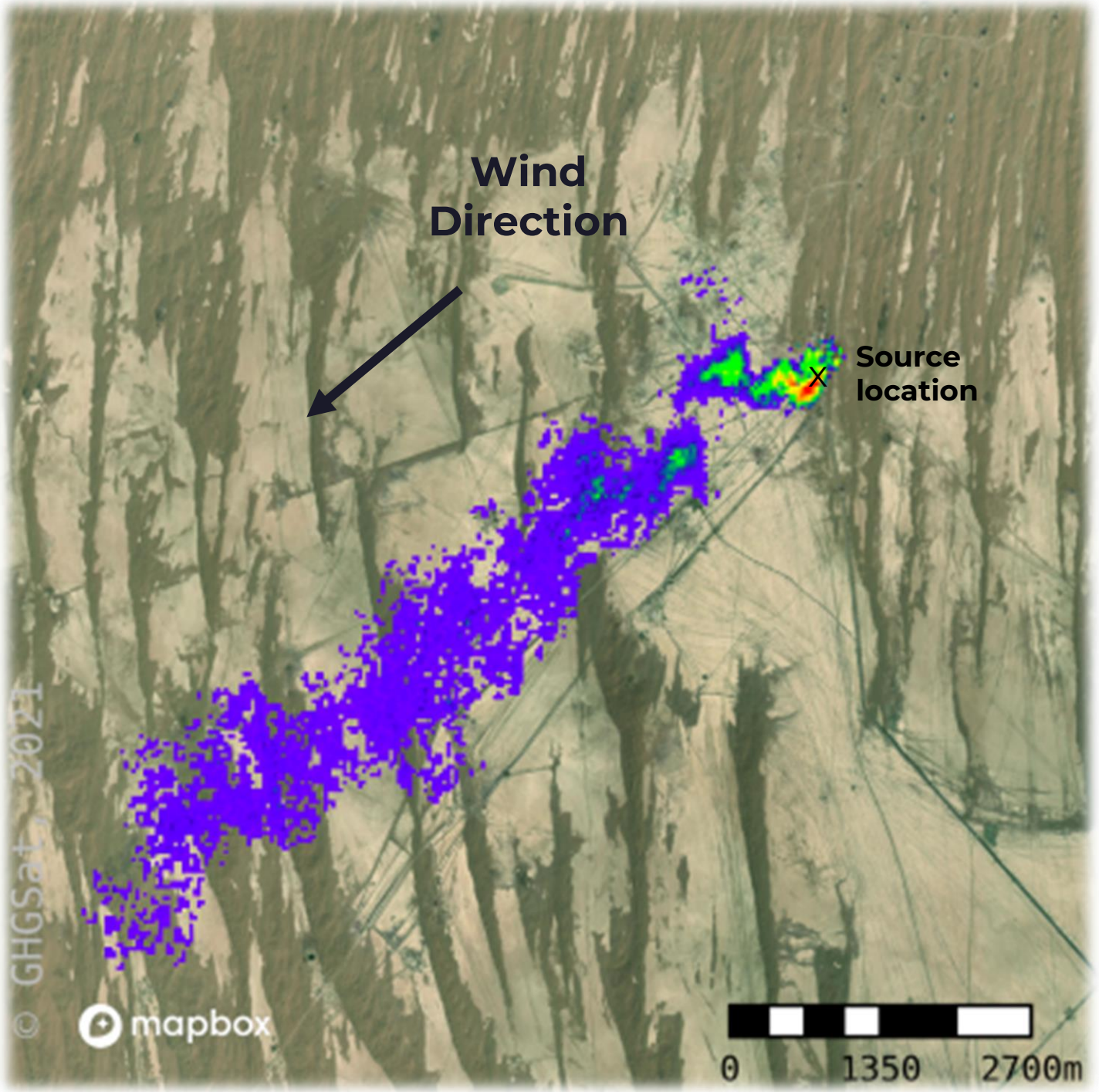
SOURCE LOCATION OF AN EMISSION

Determined using:

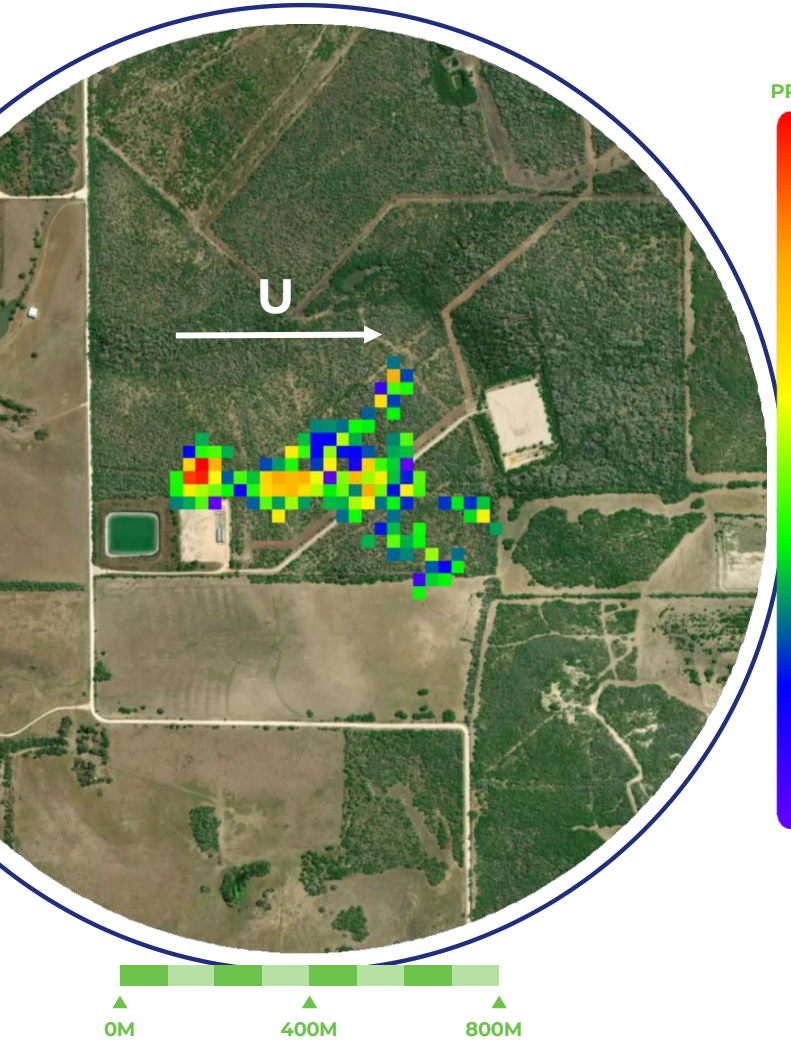
1. wind direction
2. morphology of emissions
3. location with the highest methane concentration

High source location accuracy:

- Can identify the facility
- Error of >25 m



SOURCE RATE ESTIMATION



Mass of methane (IME)

+

Length of the emission

(L)

+

Wind Speed

(U)

Source Rate Retrieval Algorithm

Example of the Integrated Mass Enhancement (IME):

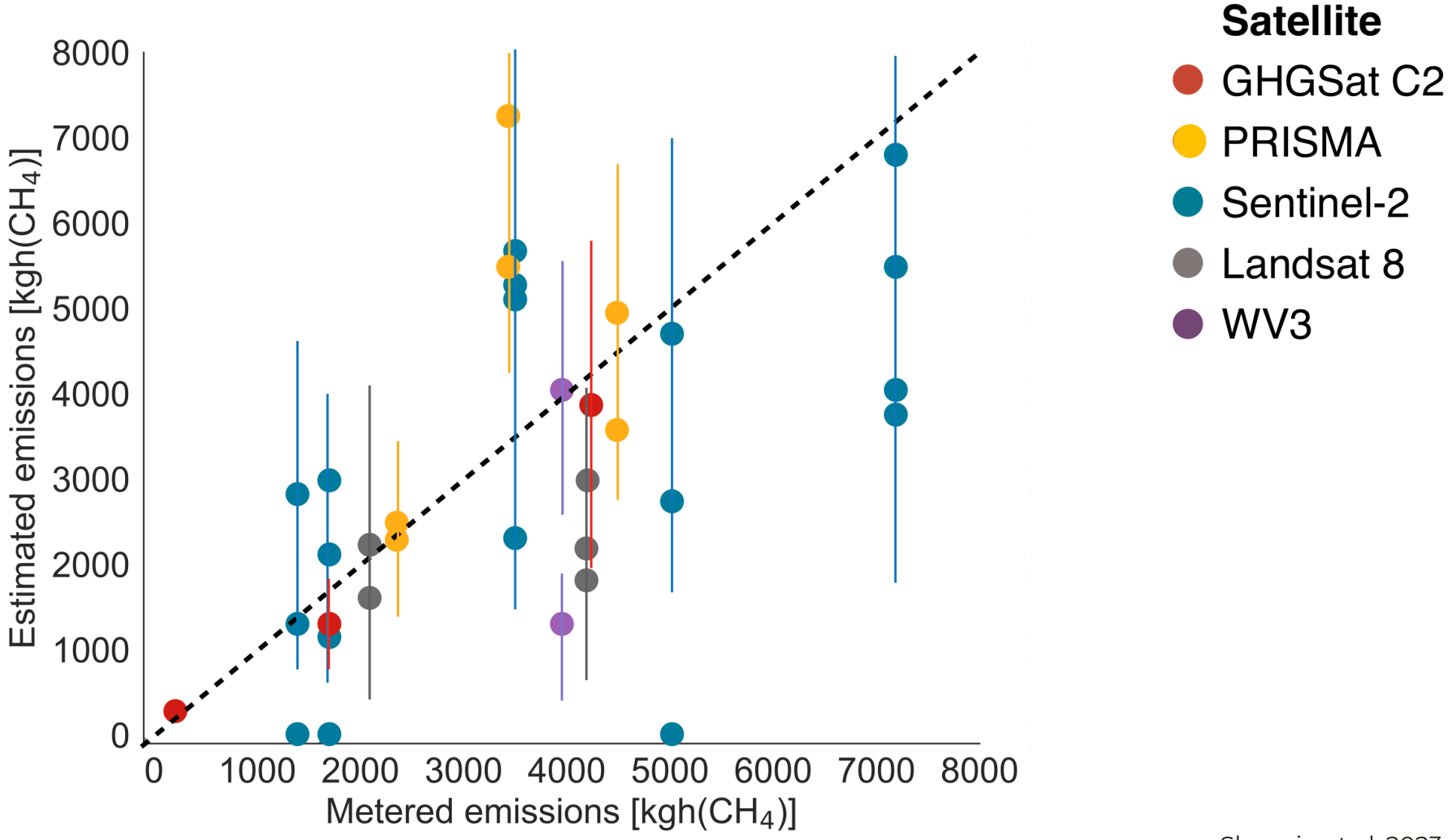
$$Q = \frac{Ueff(U) \times IME}{L}$$

Source Rate + Error (kg/hr)

e.g. Varon et al. 2018; Jacob et al 2022

EMISSION RATE – CONTROLLED RELEASES

All point source imagers currently in space



Sherwin et al. 2023

TECHNICAL ORIENTATION

Data Products - Deliverables

- **Data files:**
  - Per-pixel SWIR surface reflectance (GeoTIFF)
  - Per-pixel methane abundance and error in ppb (GeoTIFF)
  - Per-pixel quality designation flag (GeoTIFF)
  - Methane concentration map (PNG)
  - Metadata (JSON)
- **If there is an emission:**
  - Per-pixel methane abundance for isolated emission (GeoTIFF)
  - Site-attributed emission data (CSV)

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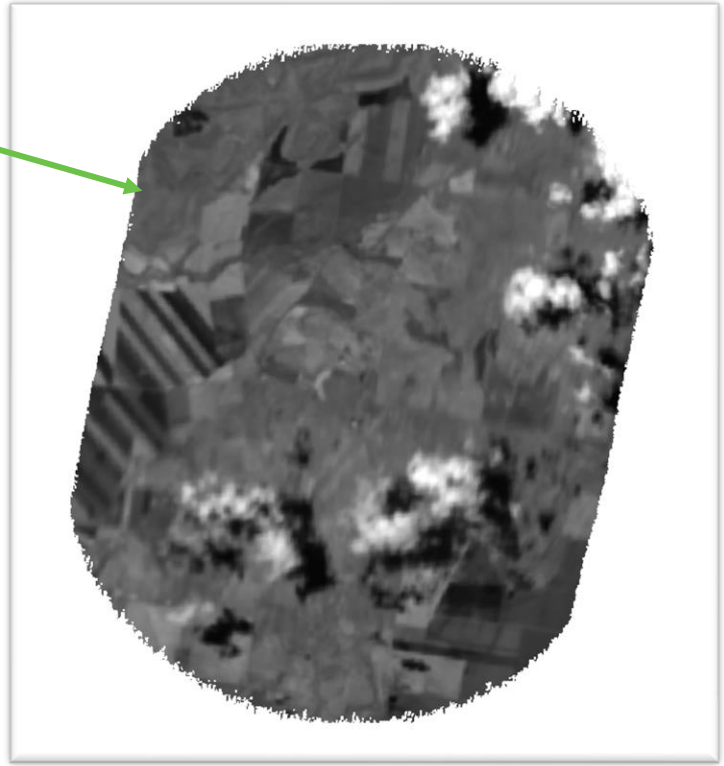

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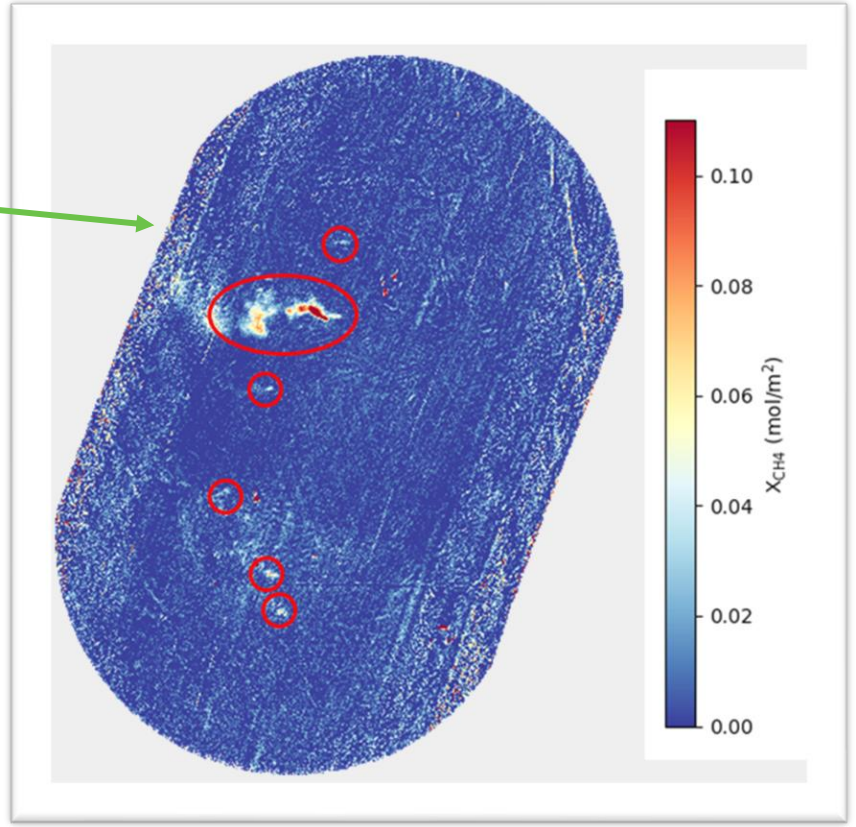

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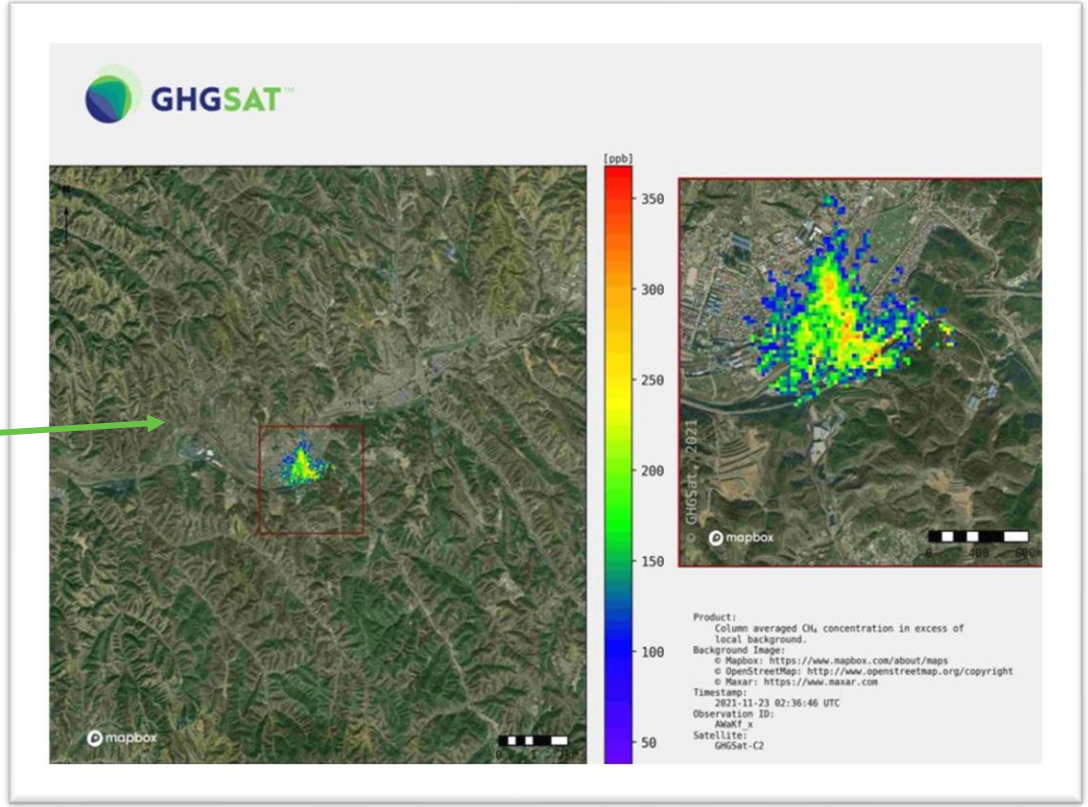

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- Per-pixel quality designation flag (GeoTIFF)
- Methane concentration map (PNG)
- Metadata (JSON)

If there is an emission:

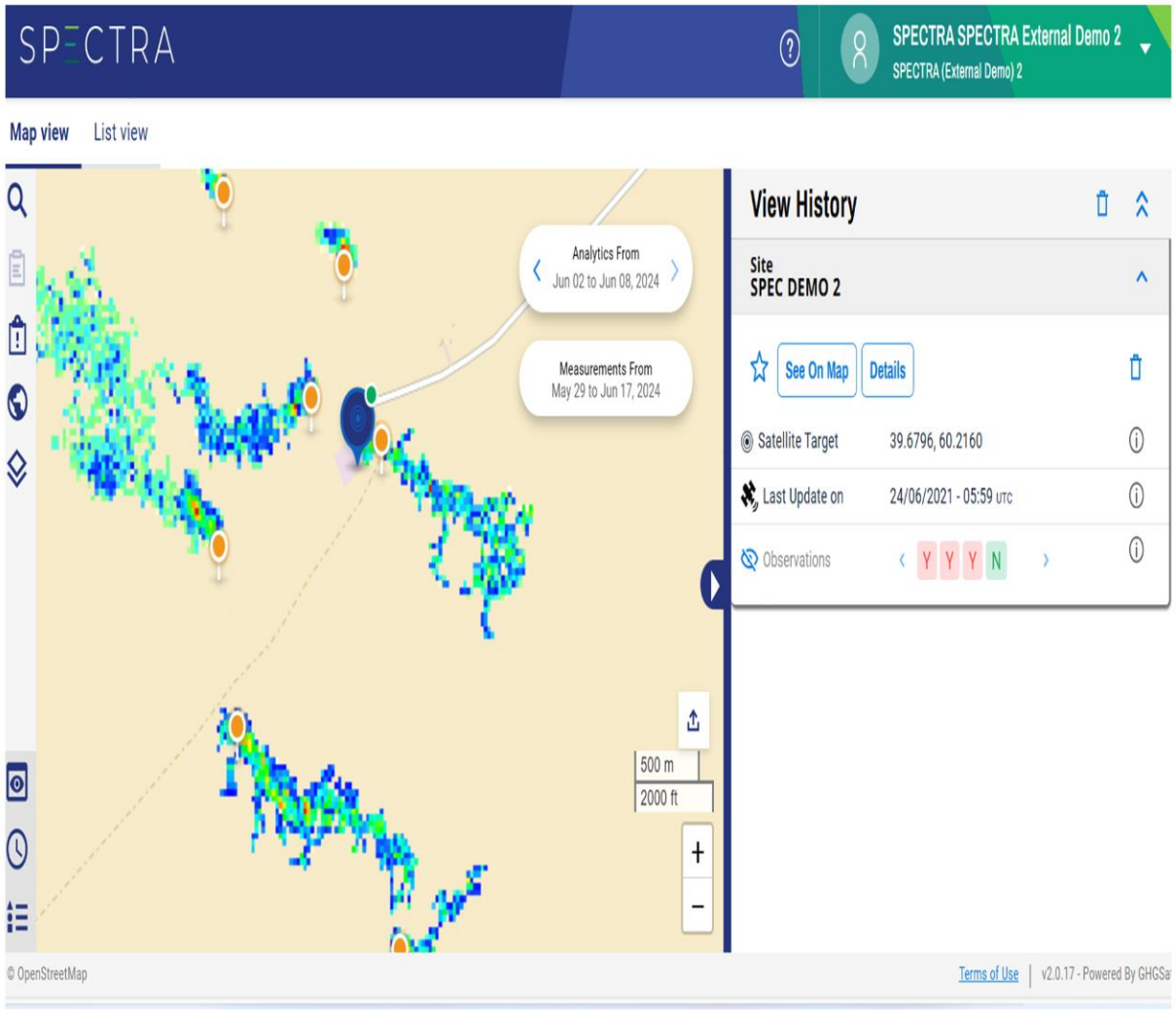
Per-pixel methane abundance for isolated emission (GeoTIFF)

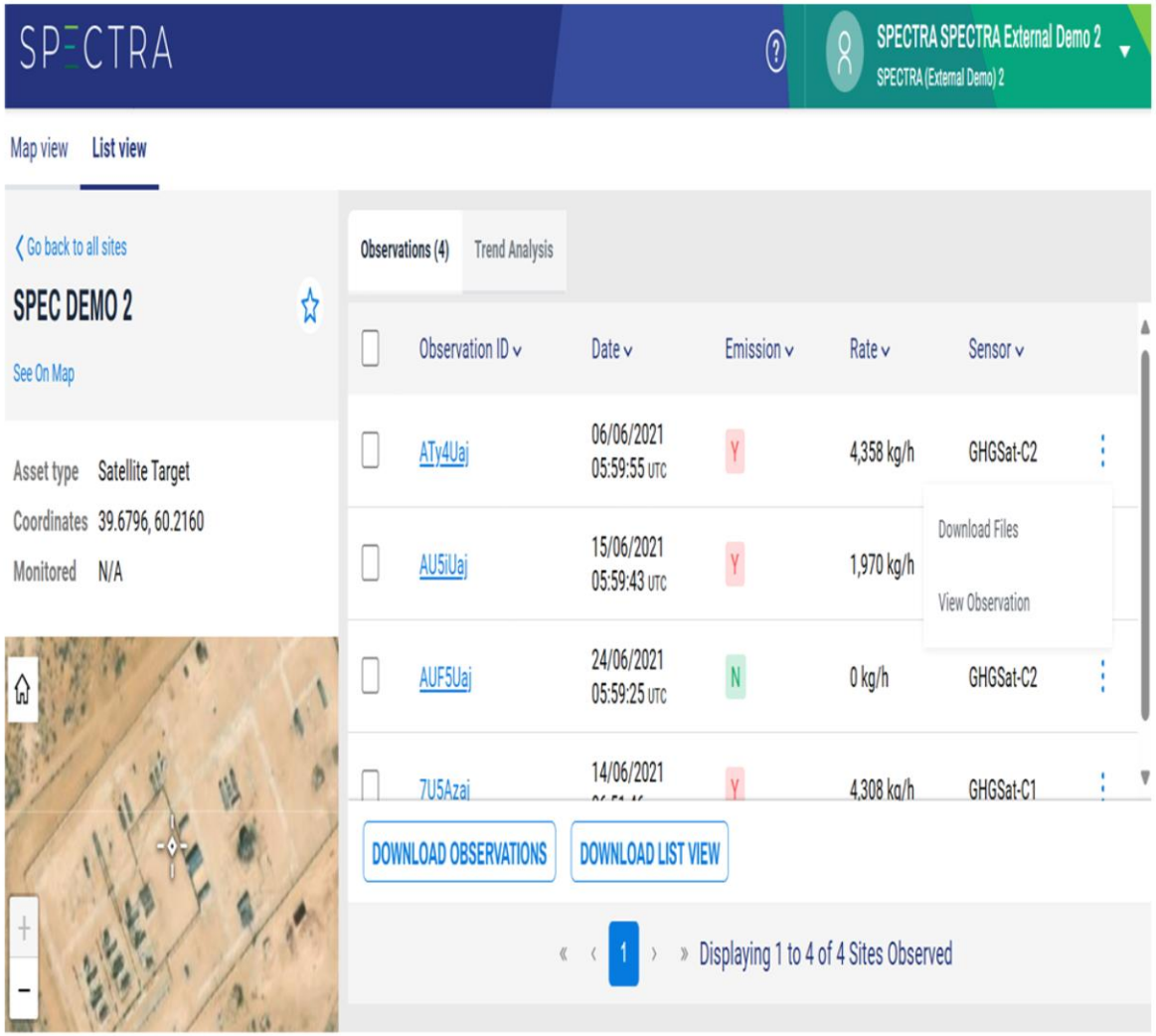
Site-attributed emission data (CSV)

Data	Description
Position	The latitude and longitude of the source of the detected emission.
Zone	The region (typically country) in which the emission was detected.
Site Name	The name of the site that the emission source is attributed to. This only applies for asset monitoring in which the customer has provided a site list.
Observation Date (UTC)	The date of the observation in which the emission was detected.
Sensor	The sensor that collected the observation with the emission (e.g. GHGSAT satellites, aircraft, third-party).
Source Rate (kg/hr)	The source rate represents the mass of methane released in the atmosphere over time. If the emission is a "maybe" for DATA.SAT or < 1000 kg/hr for Sentinel-2, then no source rate is shared.
Source Rate Error (%)	The standard deviation of the source rate calculation resulting from uncertainties in the model, methane abundance, and wind speed.
Wind Speed (m/s)	The wind speed at the source of the emission as provided by GEOS-FP, which was used to calculate the source rate.

TECHNICALORIENTATION

Data Delivery - SPECTRA



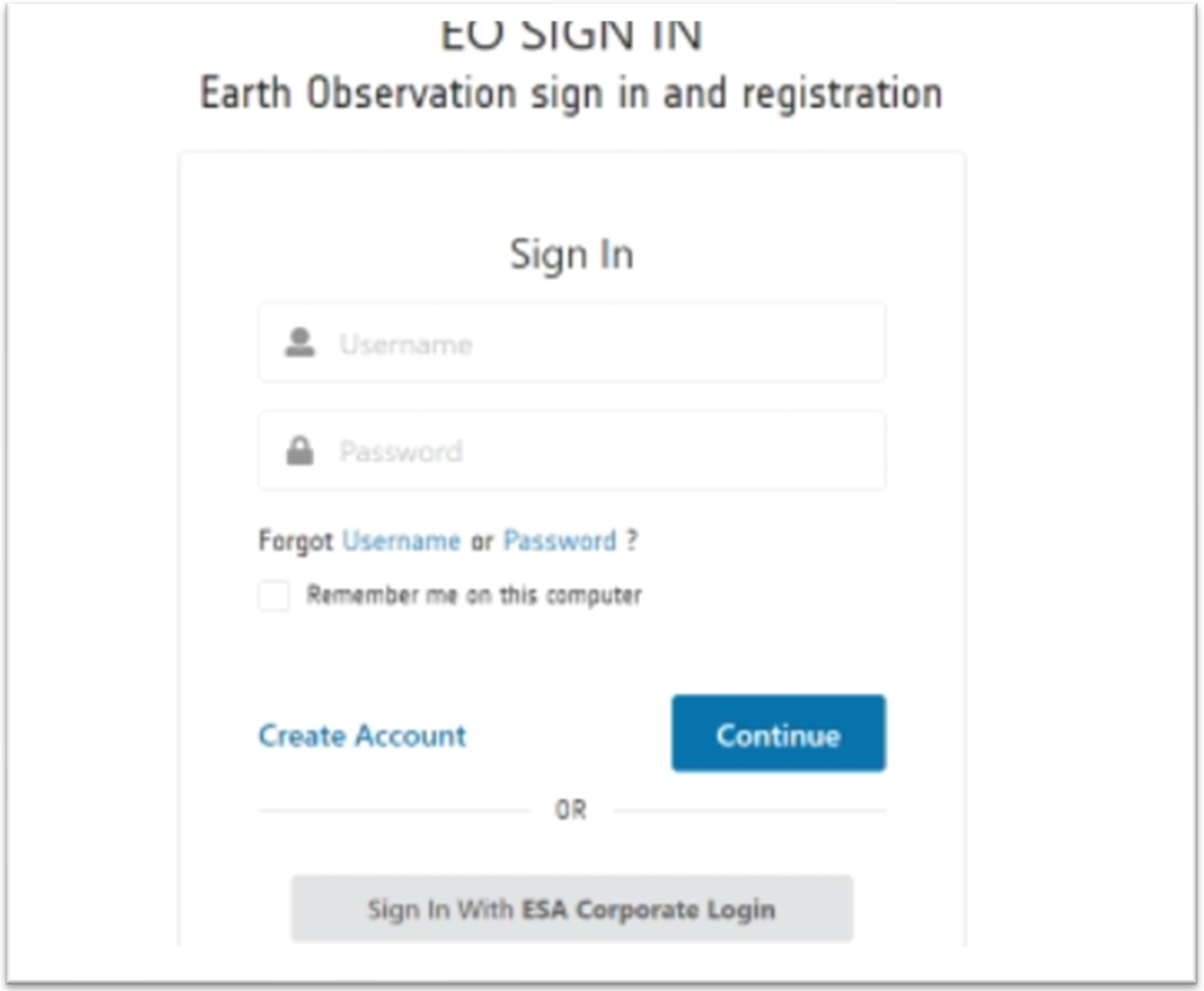


HOW TO APPLY FOR GHGSAT DATA

HOW TO SUBMIT A PROPOSAL

STEP 1: START PROJECT PROPOSAL PROCESS

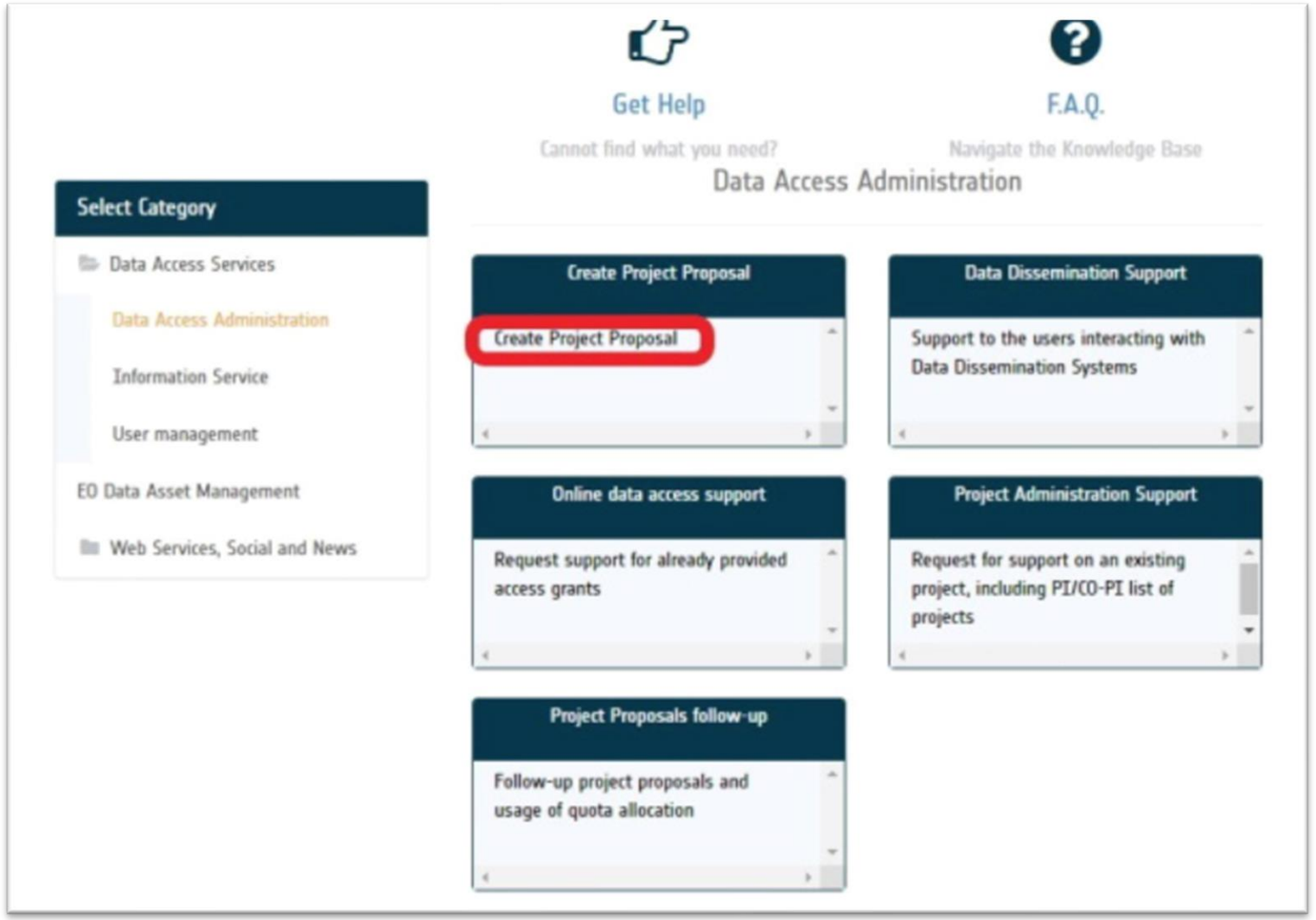
- Register in ESA EO SIGN IN Earth Observation Identity and Access Management System (esa.int)



HOW TO APPLY FOR GHGSAT DATA

HOW TO SUBMIT A PROPOSAL

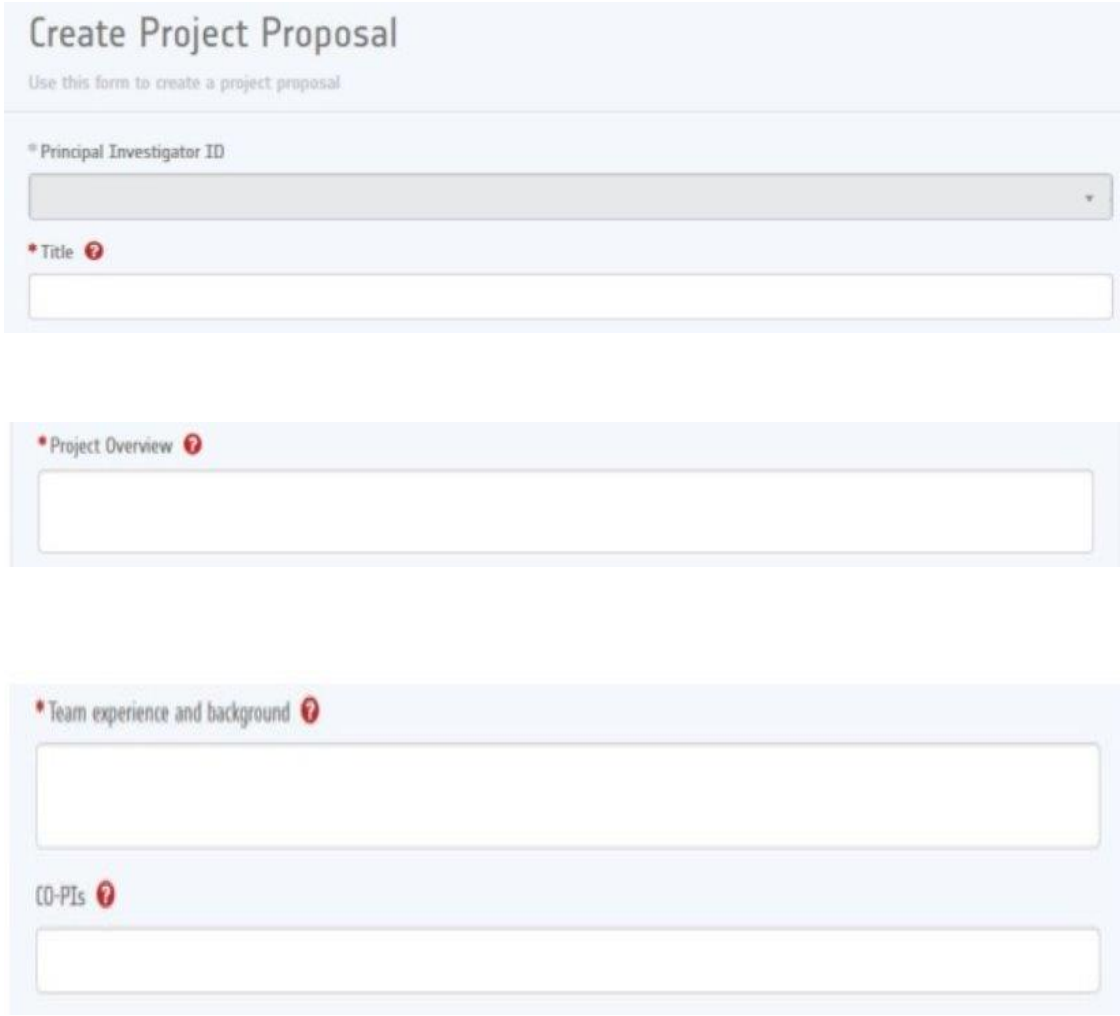
STEP 2: CREATE A PROJECT PROPOSAL



HOW TO APPLY FOR GHGSAT DATA

HOW TO SUBMIT A PROPOSAL

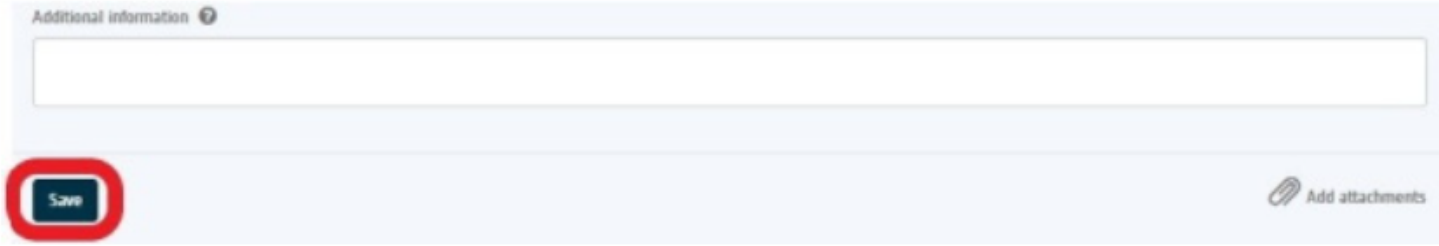
STEP 3: FILL-IN THE PROJECT PROPOSAL FORM



HOW TO APPLY FOR GHGSAT DATA

HOW TO SUBMIT A PROPOSAL

STEP 4-5: SAVE AND EDIT, SELECT DATASET



HOW TO APPLY FOR GHGSAT DATA

HOW TO SUBMIT A PROPOSAL

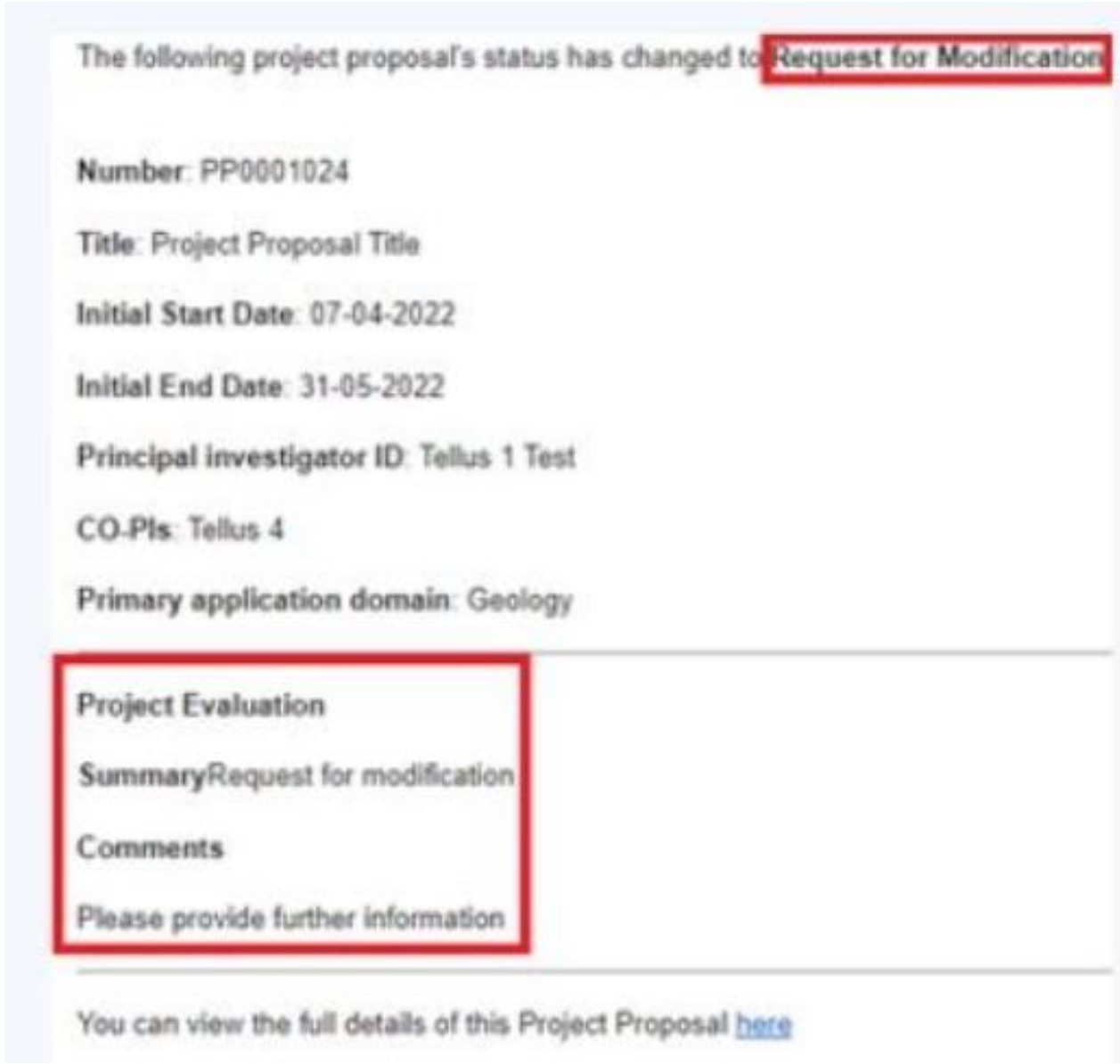
STEP 6: SUBMIT THE PROJECT PROPOSAL

HOW TO APPLY FOR GHGSAT DATA

HOW TO SUBMIT A PROPOSAL

STEP 7: EVALUATION

- By a committee of ESA experts in the topic
- Can take up to 6 weeks
- 3 different outcomes:
  - Rejected
  - Accepted
  - Asked to re-submit (requires further detail)


The following project proposal's status has changed to Request for Modification

Number: PP0001024

Title: Project Proposal Title

Initial Start Date: 07-04-2022

Initial End Date: 31-05-2022

Principal investigator ID: Tellus 1 Test

CO-PIs: Tellus 4

Primary application domain: Geology

Project Evaluation

SummaryRequest for modification

Comments

Please provide further information

You can view the full details of this Project Proposal here

HOW TO APPLY FOR GHGSAT DATA

Data Products offering – Order Details

- **What order type?**
  - **Catalogue**: Historical data that is contained in GHGSAT's archive
  - **New Tasking**: Ability to request the collection of new observations of a specific site (potentially coordinated in time)

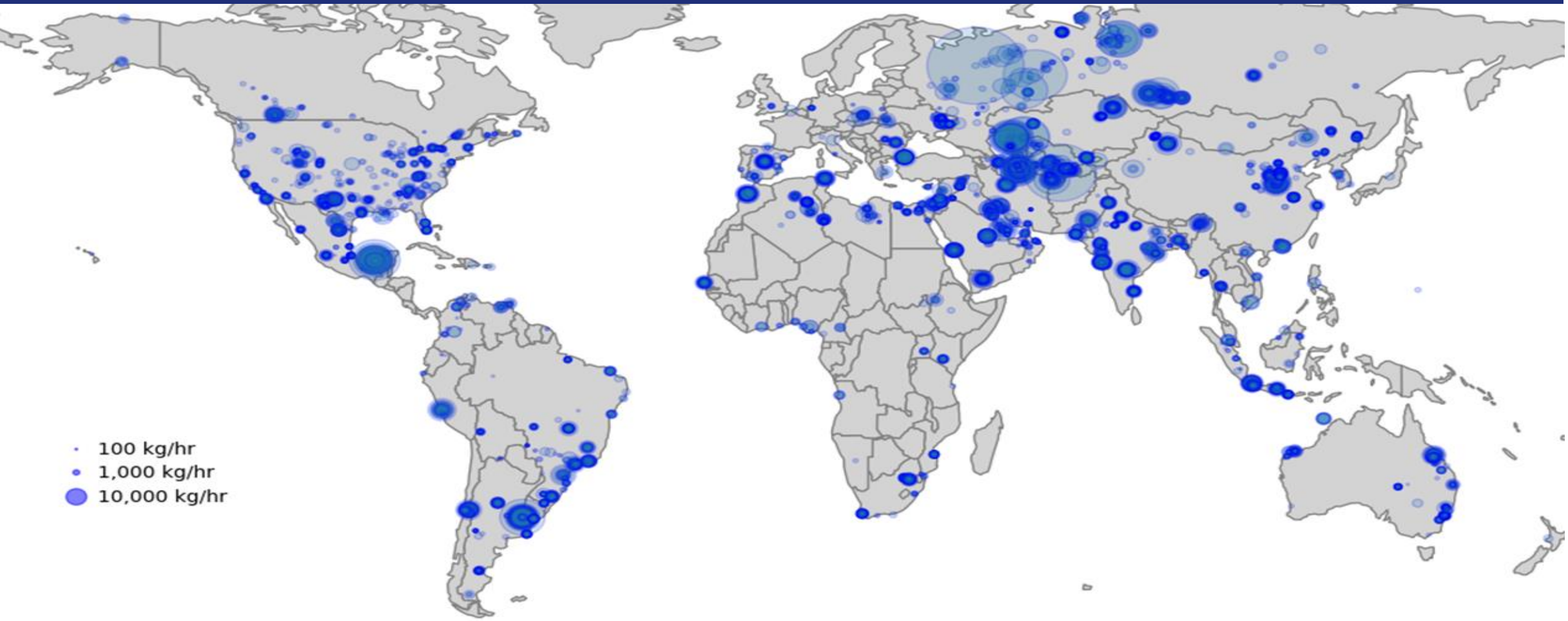
- **What frequency of monitoring?**
  - **Monthly:** 12 observations of **a single site*** over a full year
  - **Weekly**: 52 observations of **a single site*** over a full year
  - **Single**: A single observation of a requested site as a specific time

- **How much data?**
  - Number of products based on project needs, potential project impact, and remaining budget

**a change of site during a monitoring period might be allowed if properly justified*

HOW TO APPLY FOR GHGSAT DATA

Archived observations in 2023 - Catalogue



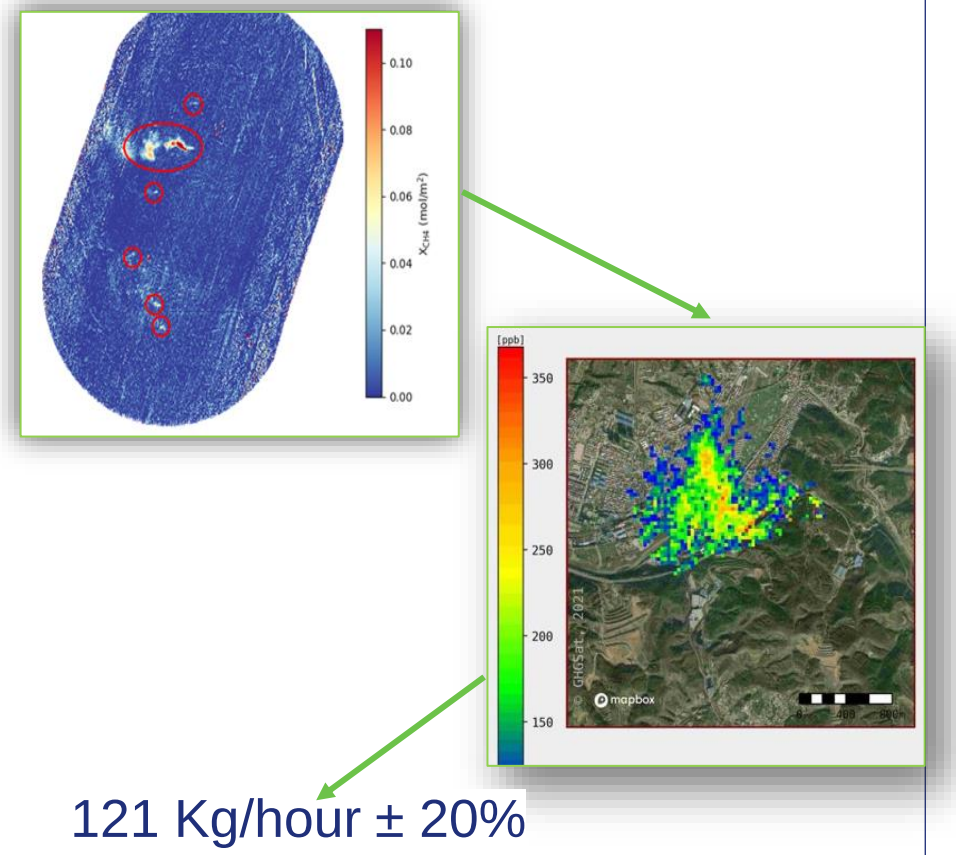
HOW TO APPLY FOR GHGSAT DATA

Data Products offering – Processing levels and data format (all included)

- **Abundance dataset (Level 2):** Set of per-pixel abundances of CH4 in excess of the local background (ppb), and per-pixel measurement error expressed as a standard deviation for a single site on a single satellite pass. Data format is 16-bit GeoTIFF.

- **Concentration Maps (Level 2):** High readability pseudocolour map combining surface reflectance, and column density expressed in ppb for a single species in PNG format.

- **Emission Rates (Level 4):** Instantaneous rate for a detected emission from a targeted source applying dispersion modelling techniques, in kg/h. The delivered product includes the emission rate estimate with uncertainty and key dispersion parameters (in CSV format).



HOW TO APPLY FOR GHGSAT DATA

Data Products offering – Single source vs Complex source

- **Single Source:** analysis of the emissions in a specific location in the image (lat/lon required)

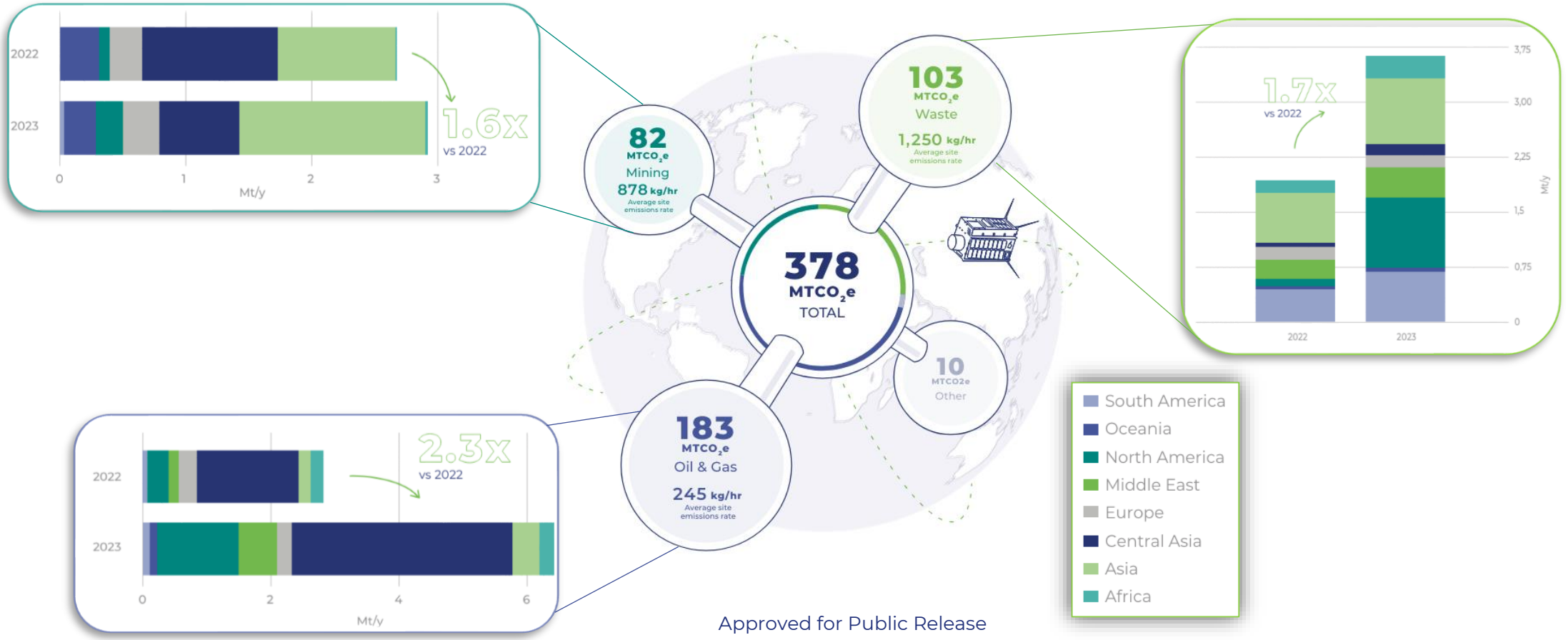
  Ex: underground coal mine shafts, O&G facility, LNG storage tank

- **Complex sources:** 3 or more individual sites to be analyzed in one image, or complex/diffused/offshore emissions.

  Ex: landfill, offshore emissions, complex O&G sites, pipeline, open-pit coal mine

IMPACT

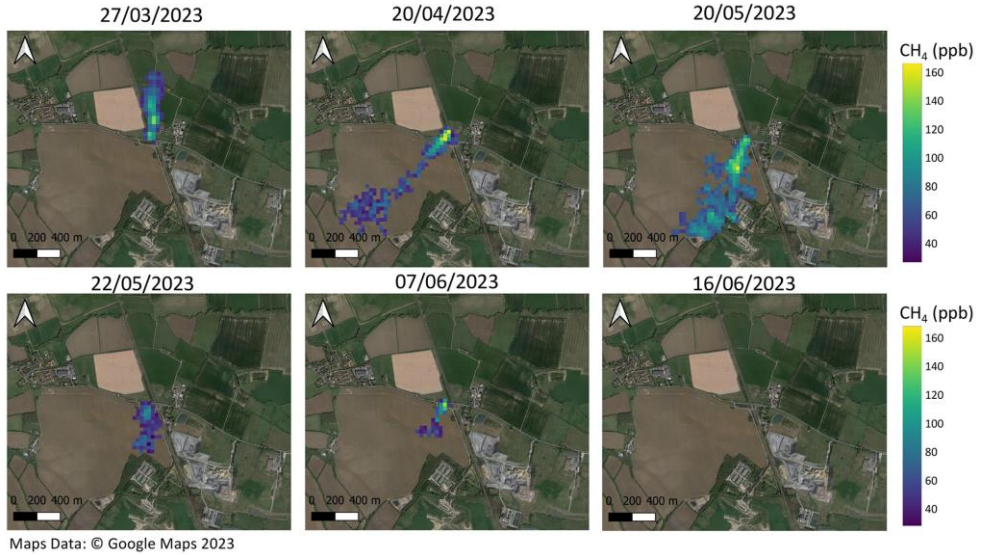
2023 Monitoring Results



IMPACT

Example Project

- **Principal Investigator:** Emily Dowd, University of Leeds
- **Period of Monitoring:** March to June 2023
- **Data Product:**
  - Number of products: 6
  - Frequency: Single
  - Source type: Complex
  - Order: New Tasking
- **Project Aims:**
  - Evaluate UK landfill emission estimates using GHGSAT emission rates and the UK National Atmospheric Emissions Inventory by comparing expected concentrations against observations at nearby tall tower sites.
  - Once a methane leak was observed from a nearby gas distribution line, project refocused on this emission with parallel ground-based measurements and modelled fluxes at the tall tower network
  - Worked with the local operator to monitor and resolve the leak
- **Research Output:** Atmospheric Measurement Techniques, Dowd et al. 2024



Dowd et al. 2024

Resources

- Sherwin, E. D. et al. Single-blind validation of space-based point-source detection and quantification of onshore methane emissions. Sci Rep 13, 3836 (2023). https://www.nature.com/articles/s41598-023-30761-2
- Maasakkers, J. D. et al. Using satellites to uncover large methane emissions from landfills. Science Advances 8, eabn9683 (2022). https://www.science.org/doi/10.1126/sciadv.abn9683
- Jacob, D. J. et al. Quantifying methane emissions from the global scale down to point sources using satellite observations of atmospheric methane. Atmospheric Chemistry and Physics 22, 9617–9646 (2022). https://acp.copernicus.org/articles/22/9617/2022/
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THANK YOU