METRICS
Methane Emissions: Testing, Reporting & Implementing Common Practises using Satellites

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Project Objectives

- **ITT**: ESA CLIMATE SPACE →*METHANE EMISSIONS: BEST PRACTICES – EXPRO*
- **Timeframe**: June 2025 – December 2026
- **Objective:** To contribute towards the ongoing development of best practices in the use of satellite-based Earth Observation for the detection and quantitative characterisation of anthropogenic (and natural) methane emissions.
    - Application of the principles of common practise methodologies to point source imager and area flux mappers

- **Policy**: COP26 Global Methane Pledge, US + EU regulations that now explicitly look to satellite-derived detection and quantification as an alert/policing mechanism for O&G sector (EPA, 2025; EU 2021/0423, 2021)
- **Wider community: UNEP IMEO, CEOS (NIST)**

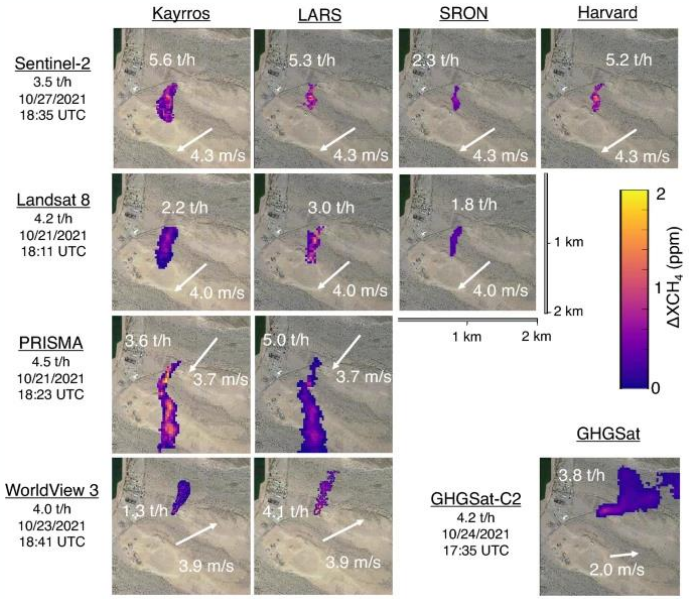
UNIVERSITY OF LEICESTER

THE UNIVERSITY of EDINBURGH

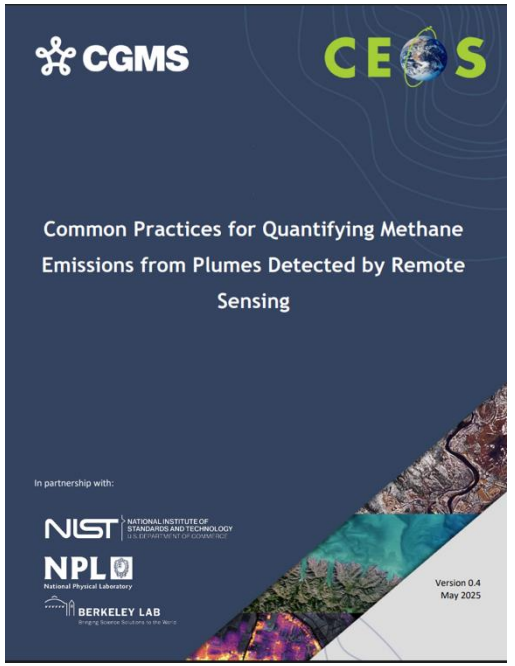
NPL National Physical Laboratory

Project Objectives

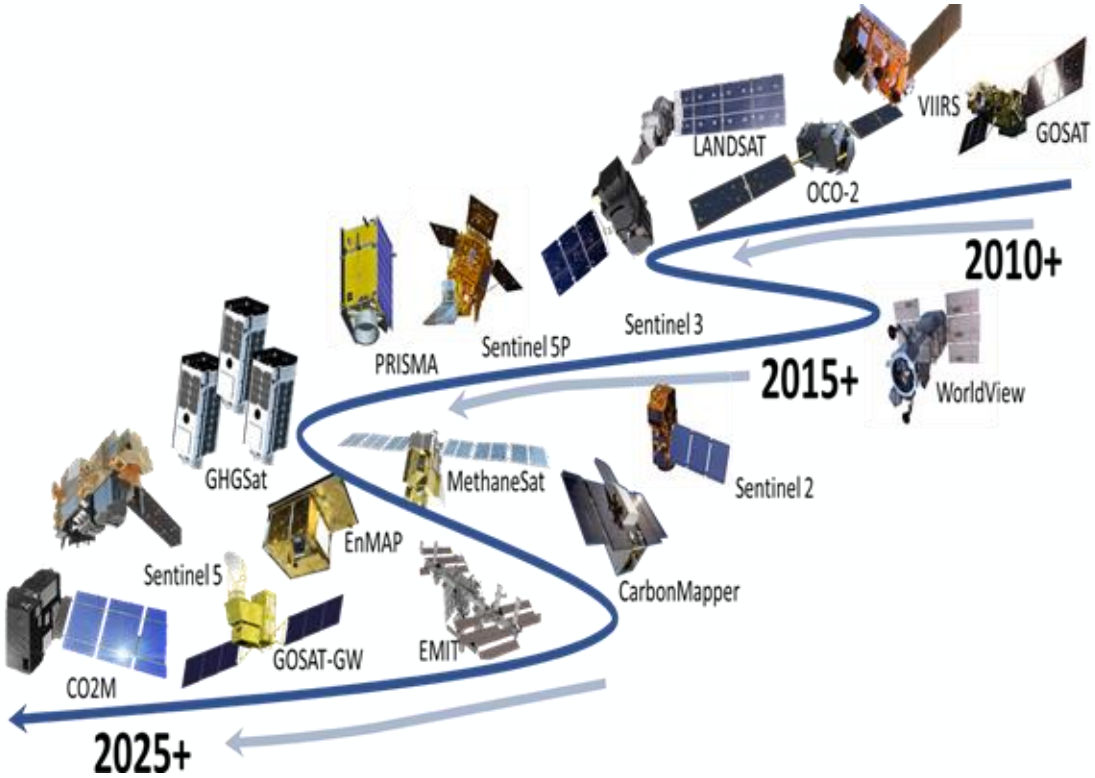
Motivation → A need for a set of "common" practices for reporting *quality assurance* for facility scale emissions so that producers of these data know what is expected by the community and (new) users know how the data should be generated and reported so that it can be trusted



Sherwin et al, 2023 - Single-blind test of nine methane-sensing satellite systems from three continents –different sensors, varying emission rates + plume structures



https://ceos.org/news/ghg-common-practices/



Wealth of CH4 data available, fast-growing capability to provide emission rates from satellite-based EO

Overview of the approach

- **WP 1 - User Requirement and Gap Analysis**
- Identify current capabilities, user needs & a framework for developing community tools and lessons learnt through user engagement

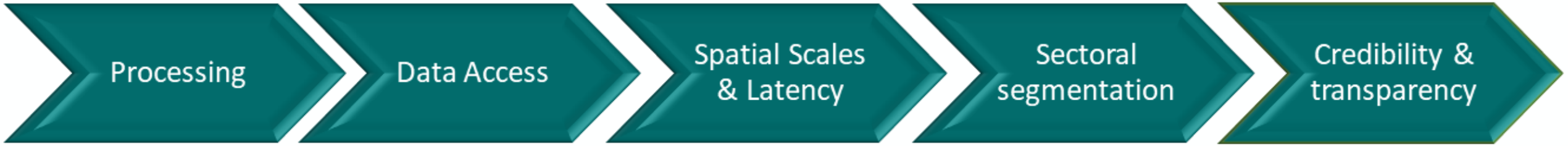
- **WP 2 – South Asia Science Study**
- Conduct a science study in South Asia using complementary satellites & modelling to better understand the uncertainties in diffuse and hotspot emissions

- **WP 3 –Common practises sensitivity study**
- Practical implementation for a comprehensive mapping of quality assessment with the aim to identifying common, good and “best” practise

User Requirements

WP1 - User engagement & gap analysis

- *General requirements*



L3/L4 products that align with bottom-up structures & inversion workflows

Reliable API access & long-term, open-access archives – transparent, reproducible & continual

Area flux mappers for regional & national trend comparisons. Tip & Cue for inventory compiling

Correct attribution, specific locations & assigning IPCC sector-specific contributions to state/national inventories

Clear documentation, uncertainty budgets & validation

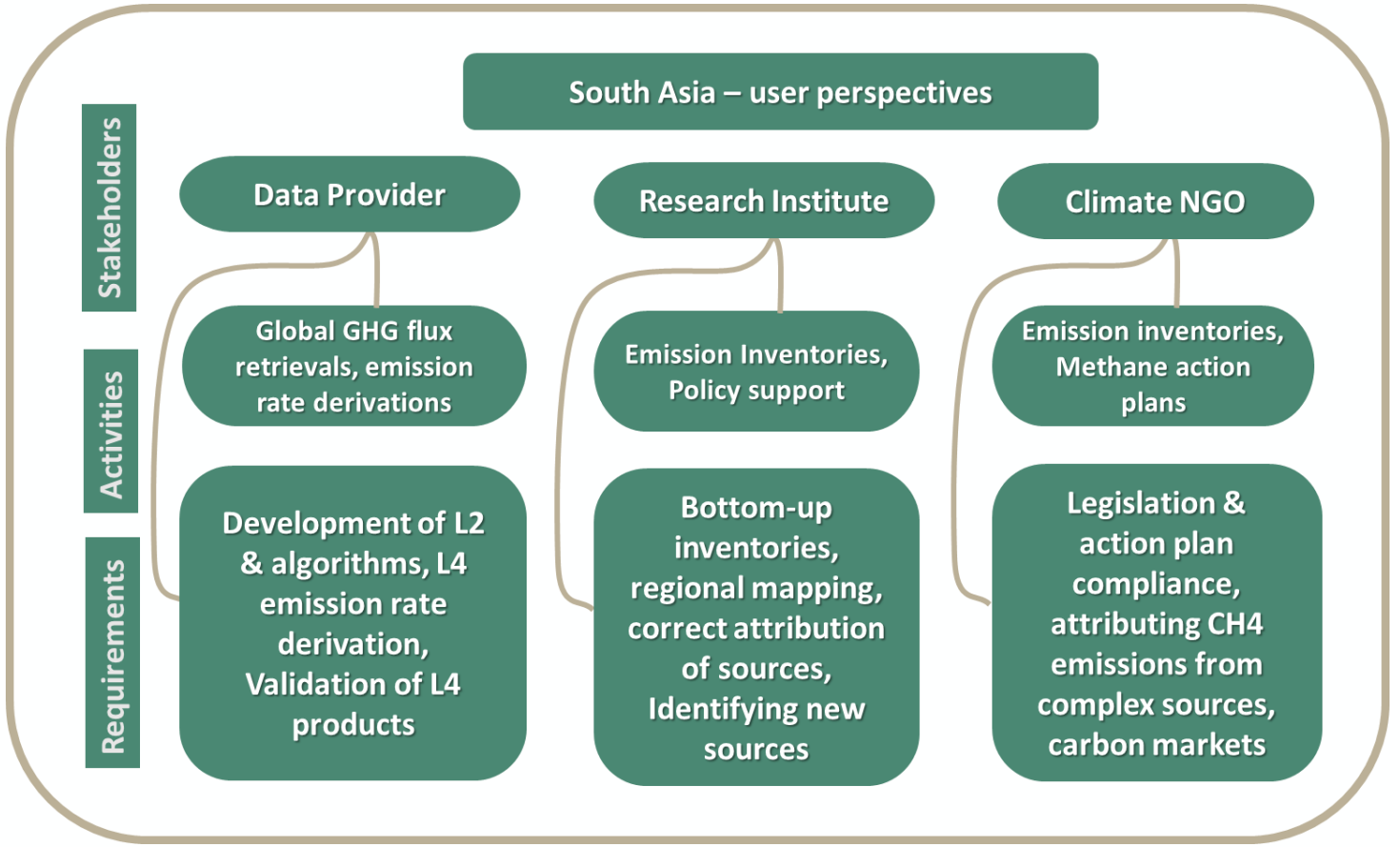
Identified issue include:

- **Detection limit:** smaller scale emissions missed
- **Spatial resolution and source location uncertainty** can be an issue in high density, urban and complex environments.
- **Latency** for leak detection and regulatory users.

User Requirements

WP1 - User engagement & gap analysis

- *South Asia requirements*



Notable considerations

- Satellite data trustworthiness → preference (as a non-scientist) is to use bottom-up approaches for inventory/policy development
- No real legislation or current need for utilisation of satellite dataset

Engagement:

teri The Energy and Resources Institute

IGSD INTERNATIONAL

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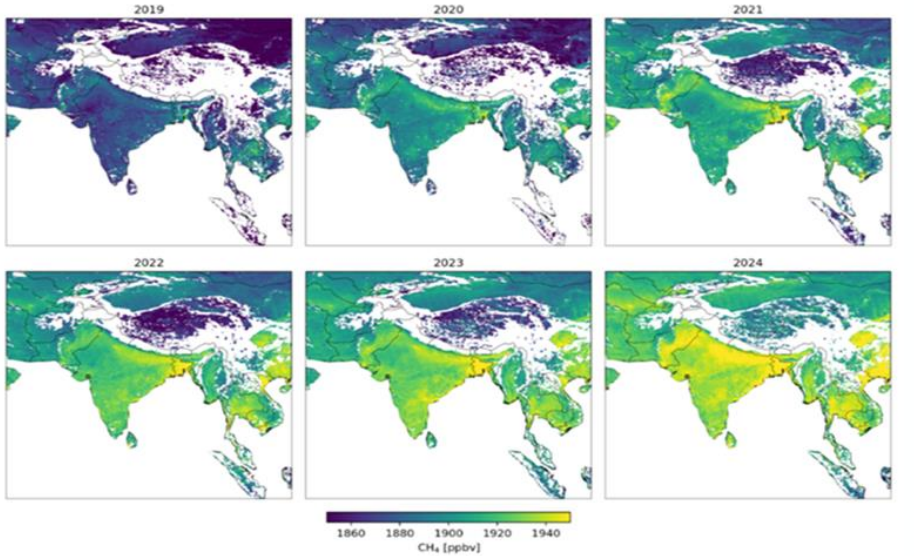
SMoG - India

South Asia Science Study

WP2 – Satellite data integration for South Asian methane inventory compilation & evaluation

- Challenging yet important region → diverse, variable, rapidly evolving sources - large-scale climate variations
- High regional emissions [India 3rd highest] + fast population growth.
- Sector specific considerations [crops, cattle, waste], often diffuse emissions, some hotspots [coal, oil, urban] → many unknowns



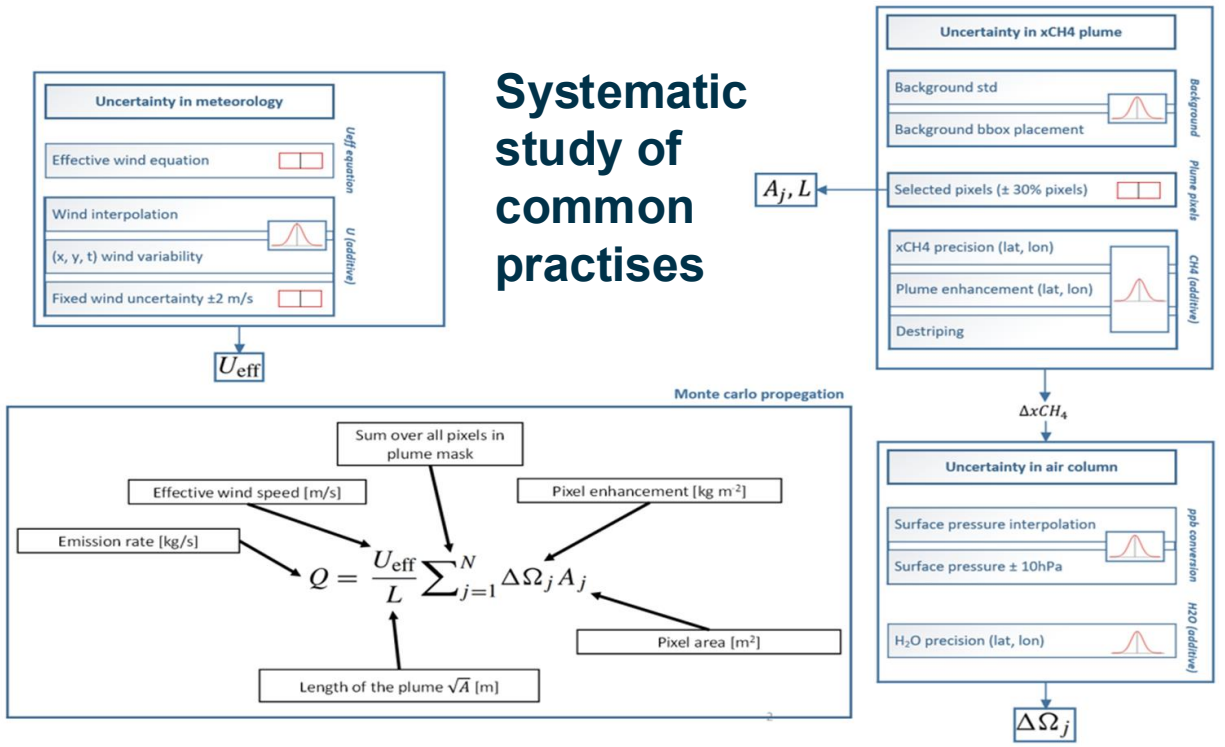
1. AI-based hotspots detect and emission estimates: efficient and robust
2. High-resolution LETKF inversion: efficient and flexible for different observation, and state vectors.
3. Harmonized point and sector source estimations: a better use of information

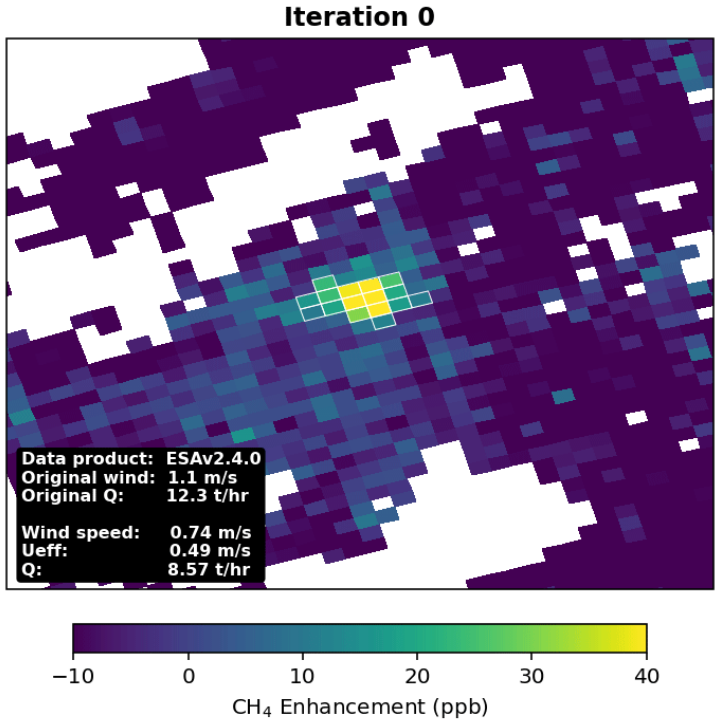
Testing common practises

WP3 - Testing community-accepted practises

Critical evaluation of current methodologies → for reliable interoperable and traceable products

Systematic study of common practises

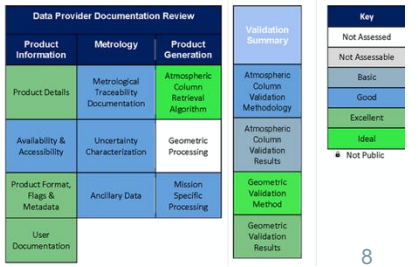




Evaluate the impact of (decisions) perturbations in isolation and in combination – Monte Carlo error propagation

Datasets & Methods : *Simulated plumes, Sentinel 5P TROPOMI, Point source imager data (EMIT/EnMAP) - Point & diffuse methane sources, varying emission quantification methods*

Product evaluation follow the EDAP & Commercial Satellite Data Evaluation (CSDA) framework



Testing common practises

WP3 - Testing community-accepted practises

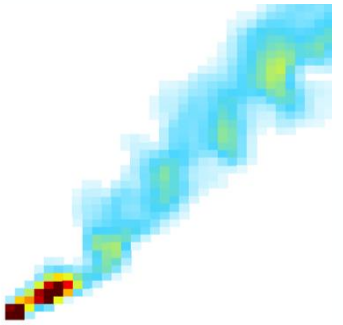
Critical evaluation of current methodologies → for reliable interoperable and traceable products

Practises

Common: defines what is generally done by experts in the field

Good: takes practises further with quantification of the merits (or inferiority) or alternative approaches

Best: more definitive → outlined as the" right" way based on quantitative analysis



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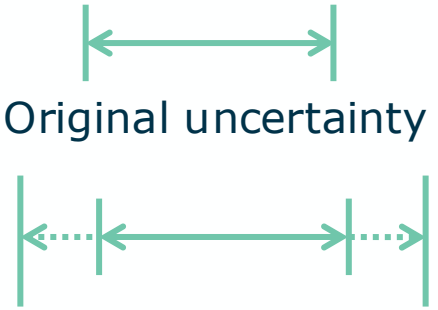


Intended users are:

- *producers of these data (to know what is expected by the community)*
- *users of these data (to understand how it should be generated and know how to use)*

Challenges

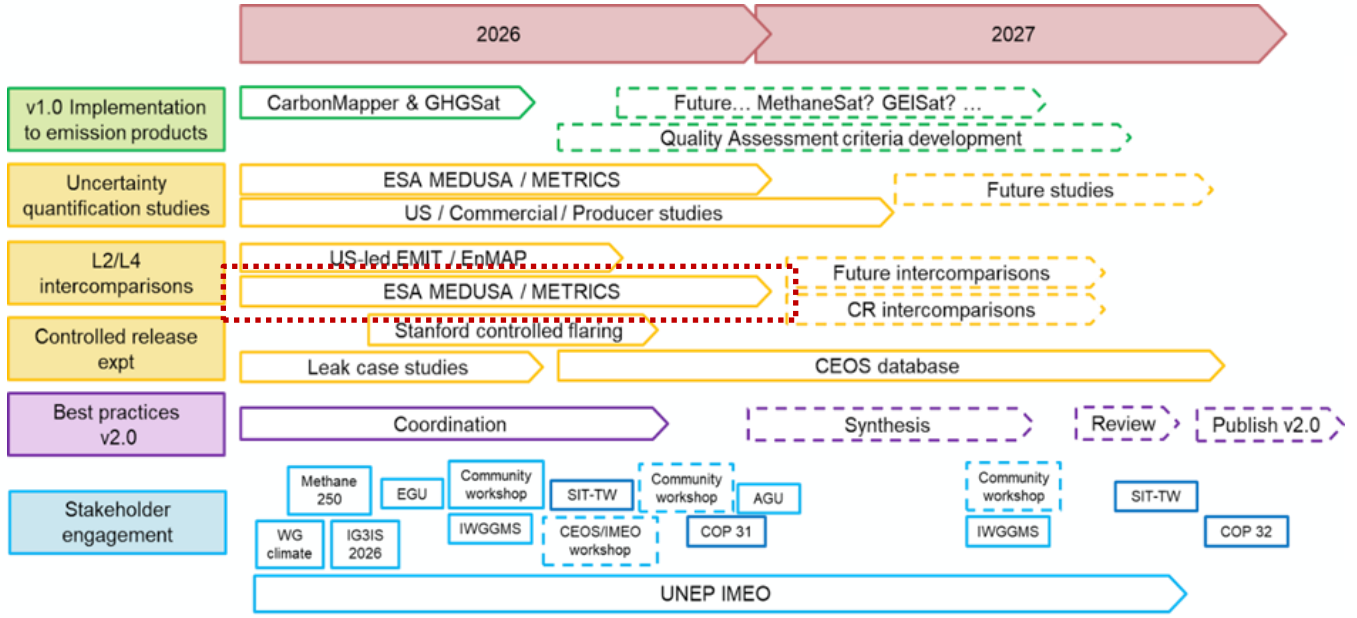
- *Are the uncertainties that we deliver with emission rates fully representative? Probably not*
- *What is the impact of a combination of decisions?*

ECVs being used

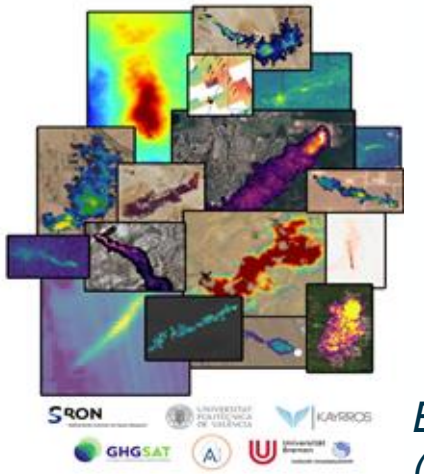
- **The following CCI ECVs are being used:**
  - CCI GHG (CH4_S5P_WFMD + ESA Operational S5P TROPOMI XCH4)
  - CCI Land Cover
- **Other data:**
  - Sentinel 2 MSI data
  - Third-party mission data (GHGSat)

- **Wishlist**
  - Broad range of EO data are used at different points of analysis. Many users use combination of ECVS (wind, aerosol loading, XCH4...) and mix in bottom up inventories, so uses DEM, SAR data, flood, burn area, smoke, aerosol etc
  - More alignment between datasets to ensure consistency in their use (spatial grids, temporal product delivery etc)

Results & relevance to the CCI community



ESA community



ESA EDAP (NASA CSDA) program aligned quantity matrix development (JPL, BIRA, ESA)

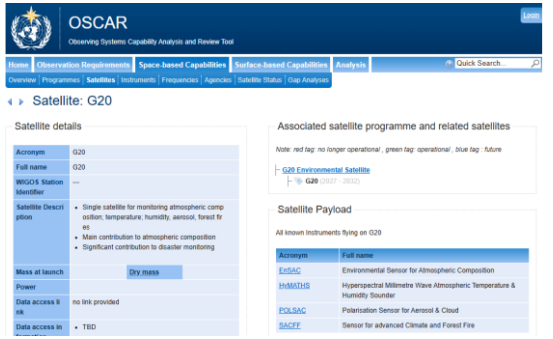
ESA MEDUSA - UPV, SRON (WP420 uncertainty framework), IUP (other products, retrievals)

Other communities

GHG task team - roadmap 2.0 best practices extension beyond plume mappers to area flux mappers

US-led intercomparison exercises

Atmosphere Monitoring Service
atmosphere.copernicus.eu



ISRO G20 Environmental Satellite –emerging GHG sensors

UN environment programme | International Methane Emissions Observatory

Accurate tracking & reporting of emissions