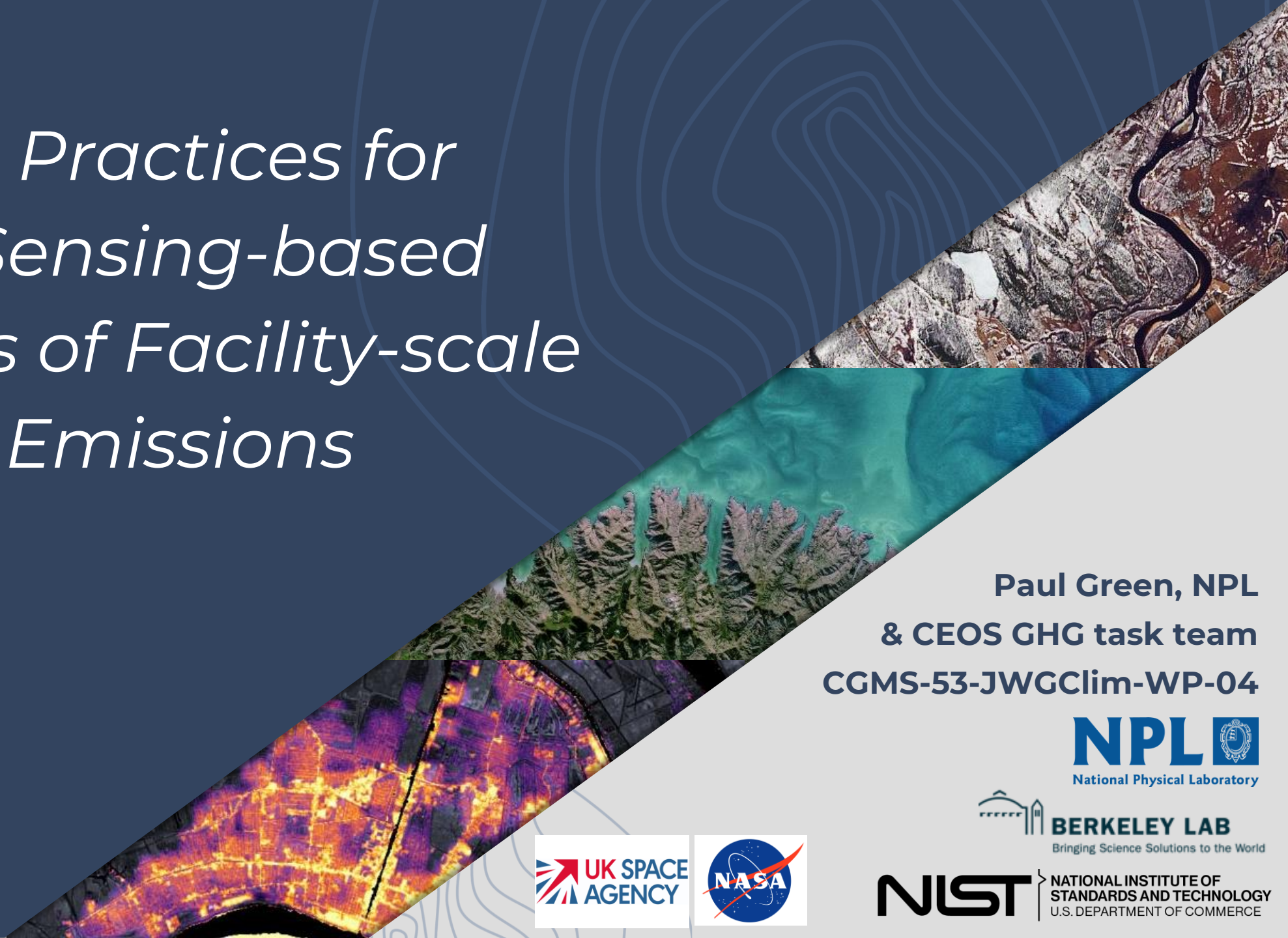
Common Practices for Remote Sensing-based Estimates of Facility-scale Methane Emissions



Paul Green, NPL
& CEOS GHG task team

CGMS-53-JWGClim-WP-04

CGMS

CEOS
Committee on
Earth Observation Satellites

NPL
National Physical Laboratory

BERKELEY LAB
Bringing Science Solutions to the World

UK SPACE AGENCY

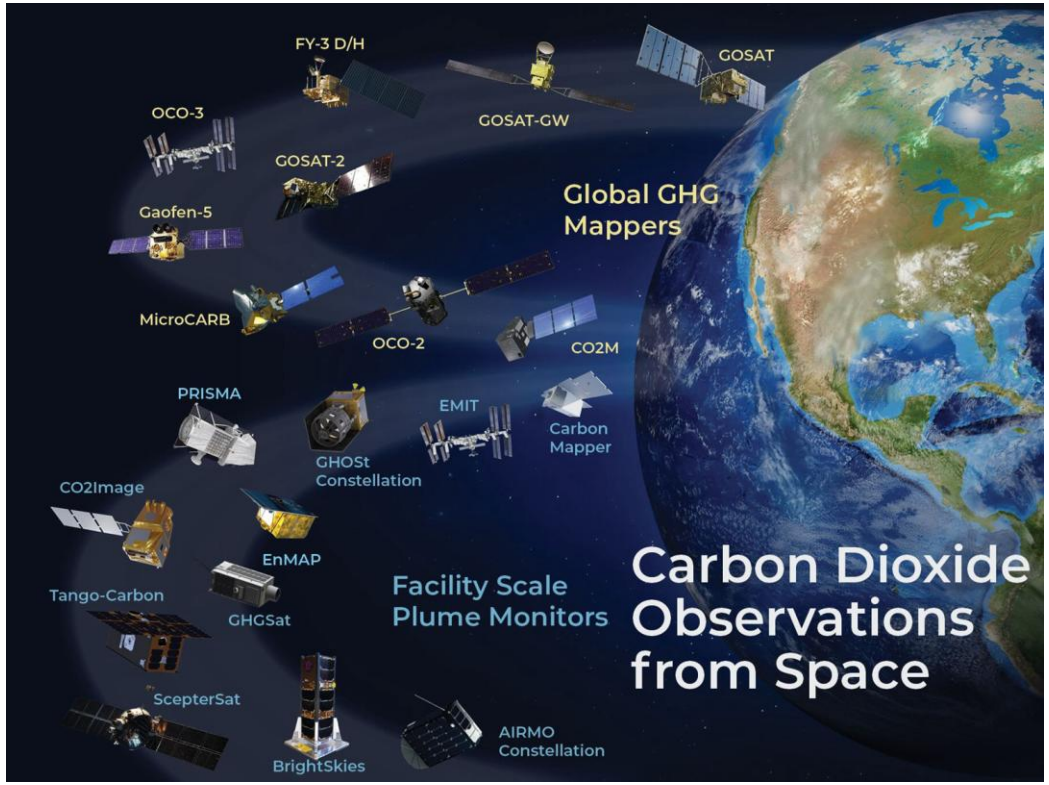
NASA

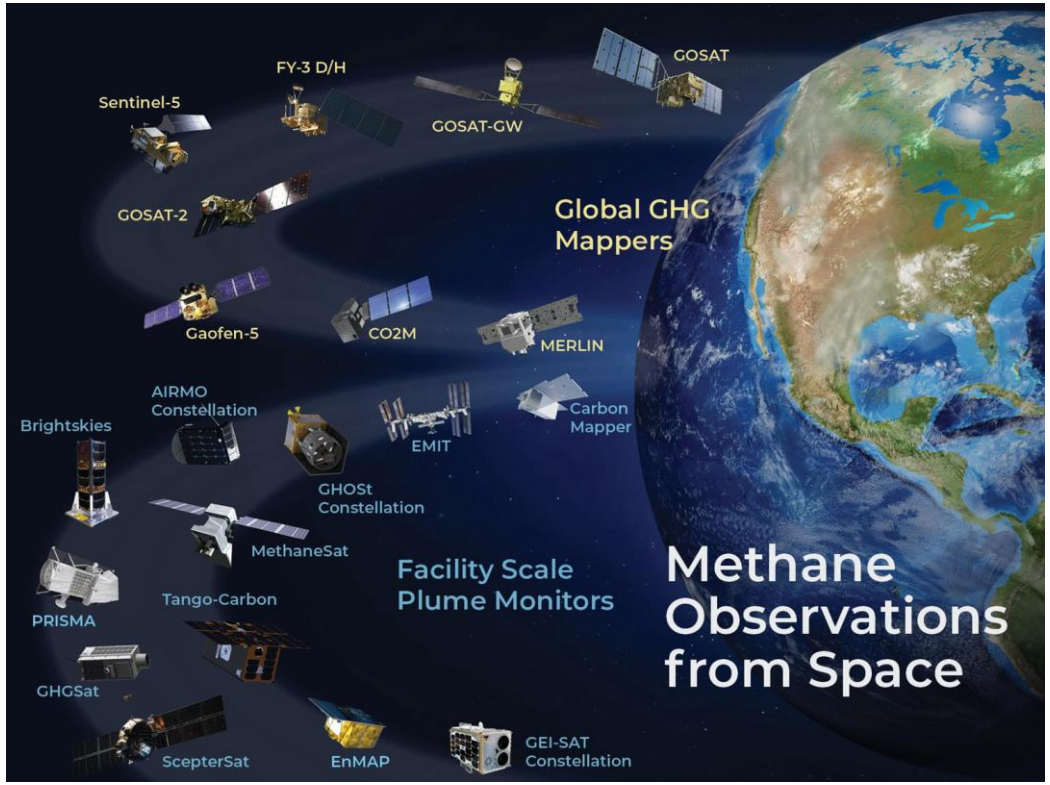
NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Motivation

- The Global Methane Pledge (now signed by 159 countries) seeks to reduce methane emissions by 30% between 2020 and 2030
- Fugitive emissions / high emitters (emissions t> 100 kg/hr) represent a substantial fraction of fossil and waste emissions. Estimated between 30% and 75% of O&G emissions in some US production basins.
- Public and New Space observations of CO_2 and CH_4 are increasingly being used to identify high emitters to improve production efficiency, reduce GHG emissions, support regulation, and are likely needed for a functioning reporting obligations and carbon market
- Currently there are 3 missions dedicated to facility scale emissions monitoring, with another 10 expected in few years – in addition to the products generated from public data.
- We need a set of “common” practices for reporting VVUQ and QA 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 transparent and trusted.

Growing constellation of GHG observations from the global to the facility scale





These are now being used to derive carbon dioxide and methane emission (flux) estimates on a range of spatial and temporal scales

Jacobs 2022

New rules on Energy sector

EU agrees law to curb methane emissions from fossil fuel industry

Rules would require firms to report emissions, find and fix leaks, and limit wasteful venting and flaring

Flares burn off hydrocarbons such as methane at an oil and gas facility. Methane has more than 80 times the heating power of CO2 over a 20-year timespan. Photograph: David Goldman/AP

https://oeil.secure.europarl.europa.eu/oeil/popups/ficheprocedure.do?reference=2021/0423(COD)&l=en

EPA United States Environmental Protection Agency

Search EPA.gov

Environmental Topics | Laws & Regulations | Report a Violation | About EPA

Controlling Air Pollution from the Oil and Natural Gas Operations

CONTACT US

- Oil and Natural Gas Air Standards Home
- Basic Information
- Actions and Notices
- Implementation

EPA's Final Rule for Oil and Natural Gas Operations Will Sharply Reduce Methane and Other Harmful Pollution.

December 2, 2023 -- EPA has issued a final rule that will sharply reduce emissions of methane and other harmful air pollution from oil and natural gas operations — including, for the first time, from existing sources nationwide. The final action includes New Source Performance Standards to reduce methane and smog-forming volatile organic compounds from new, modified and reconstructed sources. It also includes Emissions Guidelines, which set procedures for states to follow as they develop plans to limit methane from existing sources. Oil and natural gas operations are the largest industrial source of methane pollution in the U.S.

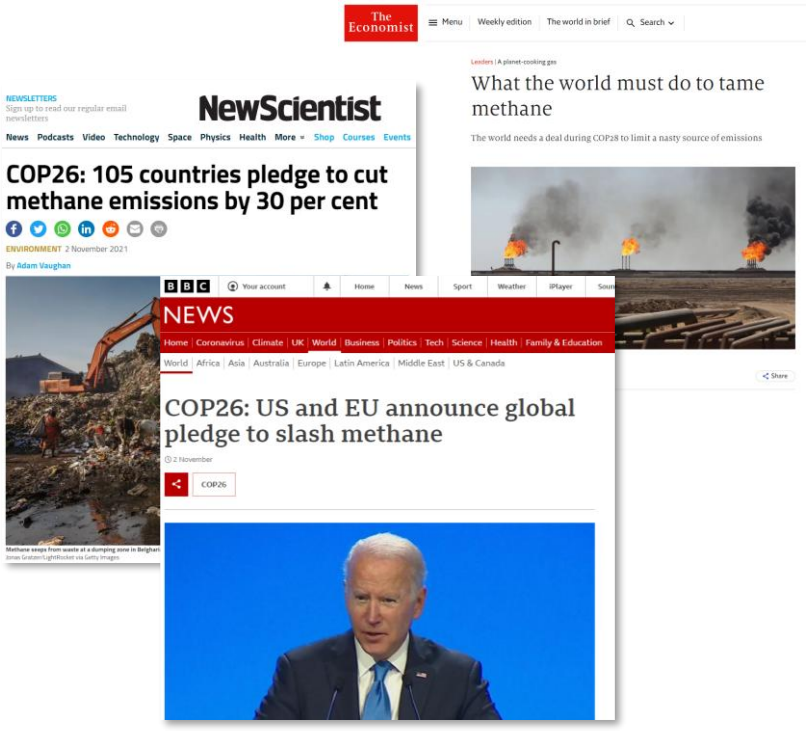
Methane is a climate "super pollutant" that is more potent than carbon dioxide and is responsible for approximately one third of current warming resulting from human activities. Rapid, sharp cuts in methane can generate near-immediate climate benefits and are a crucial addition to cutting carbon dioxide in slowing the rate of warming of Earth's atmosphere.

Regulatory Documents

- Final Rule and Regulatory Text (pdf) (5.9 MB)
- Regulatory Impact Analysis (pdf) (3.3 MB)
  - Supplementary Material for the Regulatory Impact Analysis: Report on the Social Cost of Greenhouse Gases (pdf) (8.8 MB)

https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-operations/epas-final-rule-oil-and-natural-gas

Corporate emissions and climate risk reporting

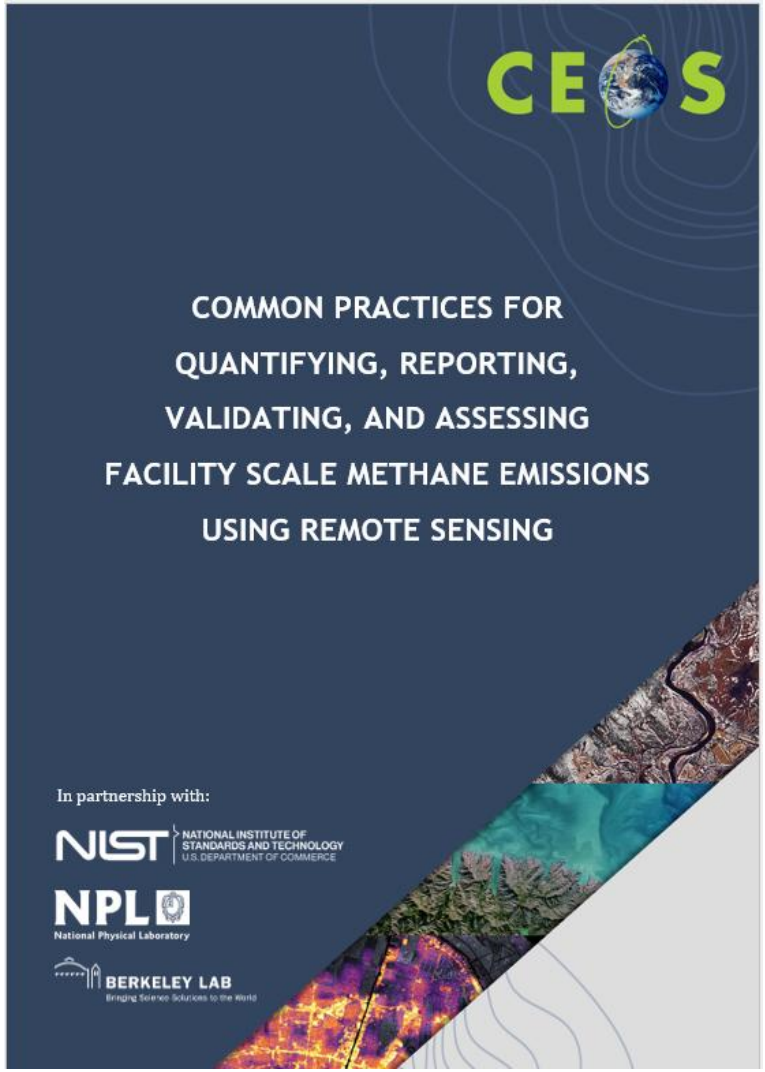


TCFD

Compulsory emissions & climate risk reporting for listed companies in US and UK, together with voluntary schemes to maintain market competitiveness aligned with customer climate expectations

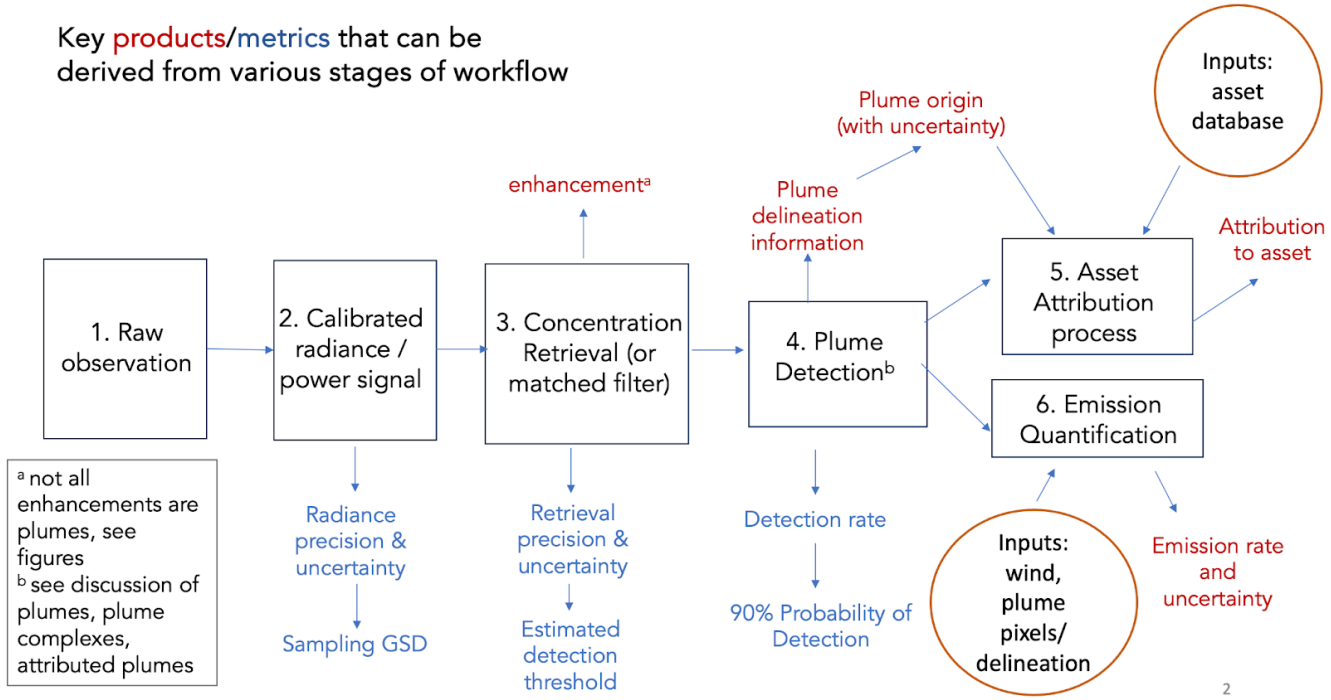
Common practice structure & contributors

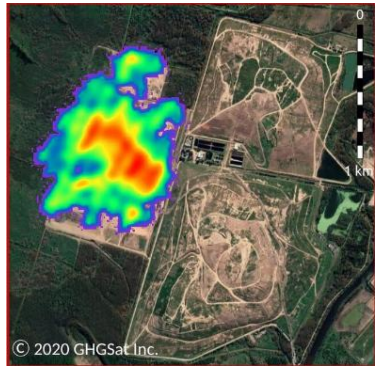
- Common practices intended users are
  - producers of these data (to know what is expected by the community)
  - users of these data (to understand how it should be generated and know how to use)
- Overall structure
  - Motivation, remit and timeliness
  - Common practice for L0 to L4
  - Validation current art
  - Quality assessment framework
- Integrates efforts across multiple agencies

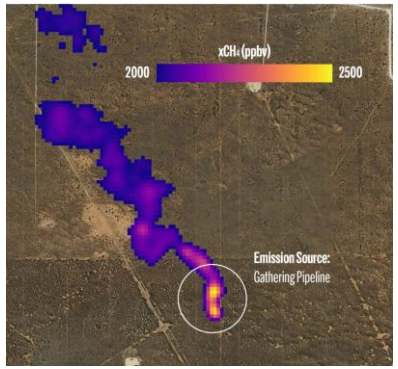


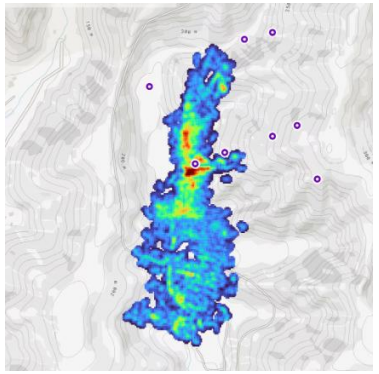
Workflow Common Practice

- At a high level, all practitioners use the same sequence of steps in their workflows
- The details of implementation vary, increasingly later in the process (from concentration/enhancement to emissions estimates)
- Later plume detection, delineation and emission quantification steps require a human in the loop









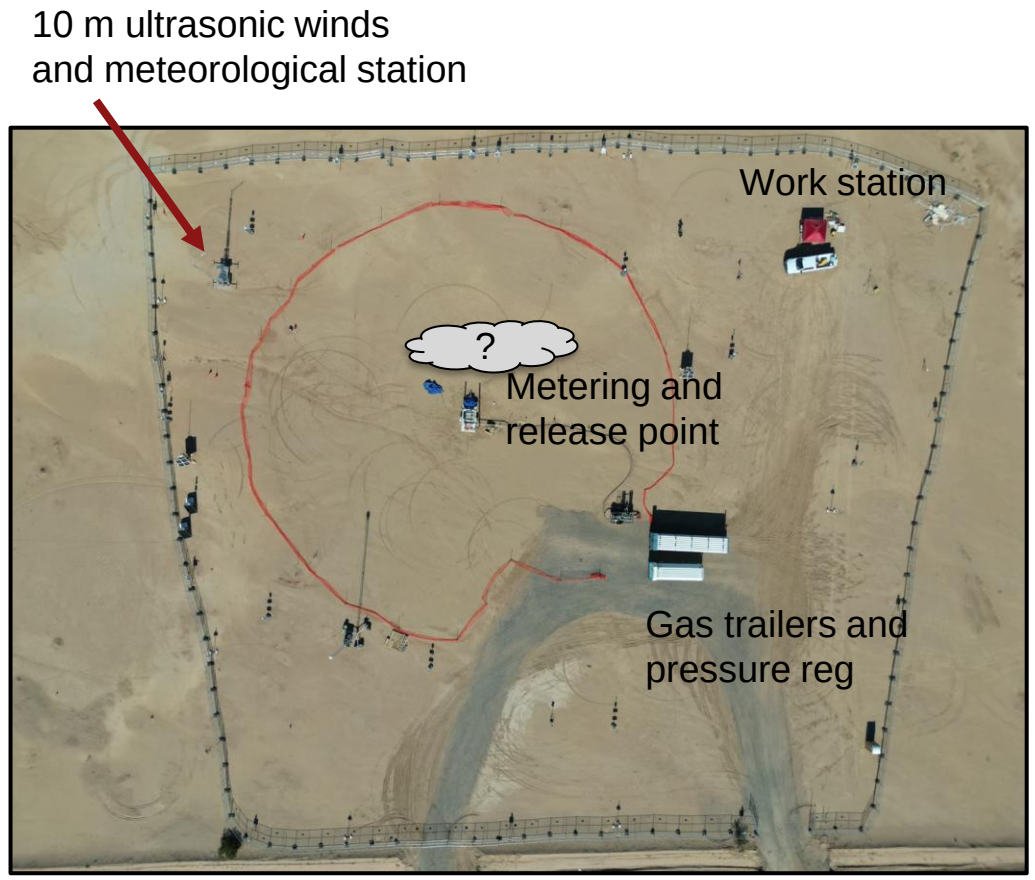
Credit (L-R):
GHGSat
MethaneSat
CarbonMapper

State of Practice for Validation – controlled release

- Independent testing of space-based methane detection needed, including several new satellite programs launched last year
- Cooperative and single-blind controlled release tests, building on 5+ years of satellite, airplane and ground sensor tests
- Expanded participation to 12+ methane satellite platforms and 15 analysis teams

2024-2025

- 150 release (10-1500 kg/h) cooperative stage being analysed
- First single-blind stage “Phase 1” is ongoing in Q1 2025, data to be unblinded on May 1
- Subsequent phases to follow with alternate testing configurations



Credit: A Brandt Stanford tinyurl.com/stanford-methane
*Participants know location but not [on/off] or volume flow rate. Coriolis flow metering for leaks between 3 kg/h and 1500 kg/h

Quality Assessment framework

- Quality Assessment framework aligned with that developed within EDAP / CSDA for consistency across GHGs and other ECVs

Data Provider Documentation Review			Validation Summary
Product Information	**Metrology**	**Product Generation**	
Product Details	Metrological Traceability Documentation	Atmospheric Column Retrieval Algorithm	Atmospheric Column Validation Methodology
Availability & Accessibility	Uncertainty Characterization	Geometric Processing	Atmospheric Column Validation Results
Product Format, Flags & Metadata	Ancillary Data	Mission Specific Processing	Geometric Validation Method
User Documentation			Geometric Validation Results

Key
Not Assessed
Not Assessable
Basic
Good
Excellent
Ideal
Not Public

Column Enhancement

Product Evaluation Matrix			
Data Provider Documentation Review			Validation Summary
Product Information	Metrology	Product Generation	
Product Details	Metrological Traceability Documentation	Emission Quantification Method	Emission Validation Methodology
Availability & Accessibility	Uncertainty Characterisation	Mission-Specific Processing	Emission Validation Results
Product Format, Flags & Metadata	Ancillary Data		
User Documentation			

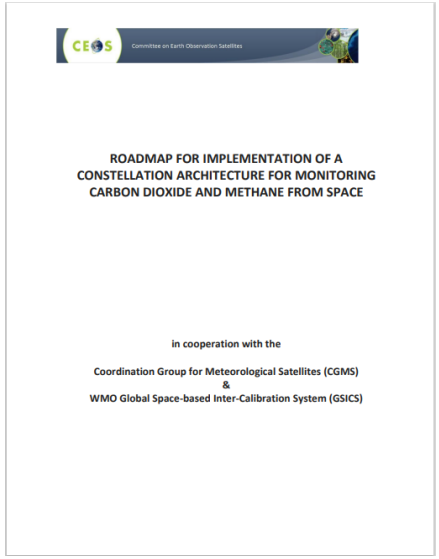
Key
Not Assessed
Not Assessable
Basic
Good
Excellent
Ideal
Not Public

Emissions

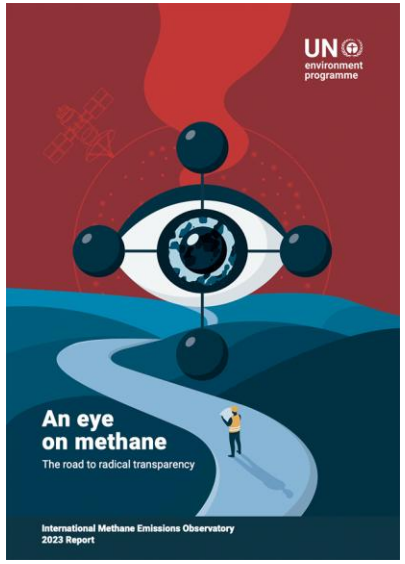
Best practice as an enabler

- Build on previous CEOS work on best practises in the public and new space domains and want to partner with key parallel programmes and stakeholders to add value as an underpinning framework to enable reporting in the public and commercial sectors

Draft scheme

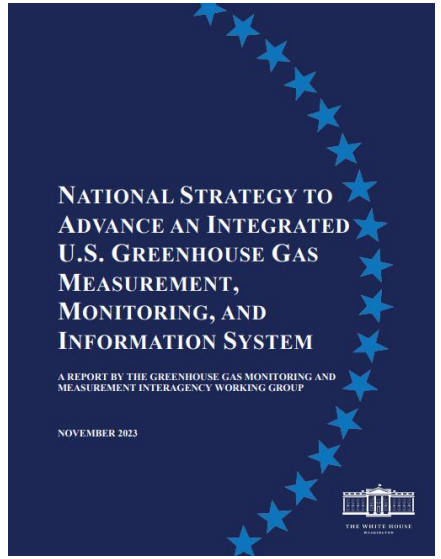


CEOS roadmap



UNEP IMEO

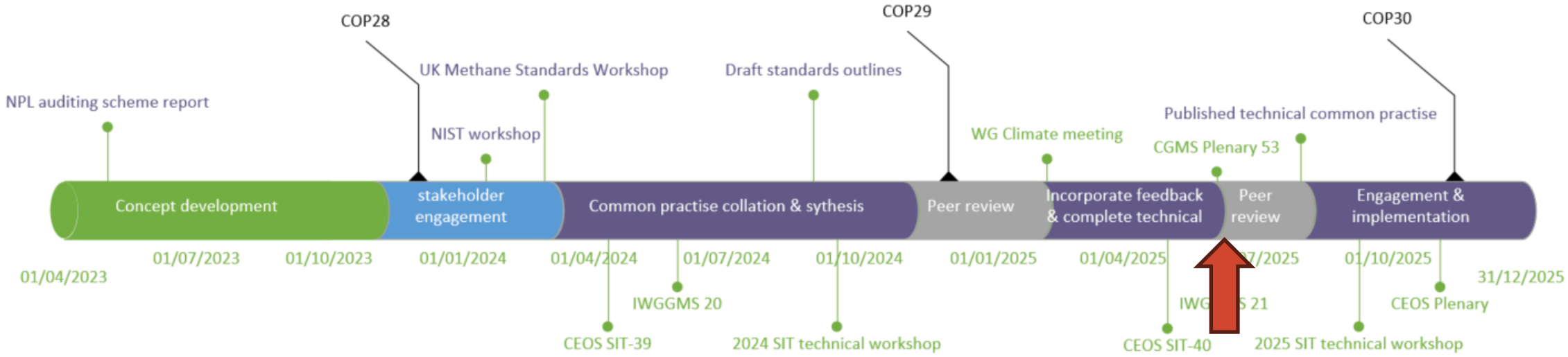
WMO G3W



US GHG Centre

Progress and timeline

- 2024 – outline development & peer review
- 2025 – detailed completion, peer review & v1 finalization for end 2025
  - now v0.4 out for CGMS & CEOS final review
  - Final community review in June 2025 leading to static v1.0 July 2025.
  - Case study development over Summer 2025.



Summary & CGMS ask

- Public and New Space observations of CO_2 and CH_4 are increasingly being used to identify high emitters for regulation (in addition to science) and are likely needed for a functioning reporting obligations and carbon market
- Currently there are 3 dedicated to facility scale emissions monitoring, with another 10 expected in few years – in addition to the products generated from public data.
- We need define the common practices for reporting VVUQ and QA 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
- Document shared with CGMS member consideration in preparation for Plenary 53. Will submitted for endorsement in Q3 2025 to align with CEOS endorsement, followed by key stakeholder engagement (IMEO/GMP/CCAC) and implementation (inc. case study) towards COP 30
- The authors welcome your comment & feedback