# TROPOMI-BASED WORLDWIDE CHARACTERIZATION OF EMISSIONS

Leveraging satellite data to quantify regional and national methane emissions and identify critical gaps in current UNFCCC reporting and NDCs.



DONOR:
**United States**

BENEFITTING COUNTRIES OR REGIONS:
**Worldwide**

SECTOR:
**Multisector**

Subsector, if applicable:
**Oil and gas, coal**

STATUS:
**Published**

TIMELINE:
**Measurements 2023; published in 2025.**

IMEO SCIENCE OBJECTIVE:

→ **Validation of measurement-based approaches.**

## KEY FINDINGS

This study quantified regional (national and basin scale) methane emissions from oil and gas production worldwide by time-dependent inversion of TROPOMI observations at a high, 25-50 km resolution, allowing emissions to be separated by country and sector. The results, including error characterization, were used to evaluate national emission reports to the UNFCCC. The study found global emissions are 15 per cent higher than what is reported to the UNFCCC, with significant variations in individual countries and sectors.

## RATIONALE

Individual countries report their emissions to the United Nations Framework Convention on Climate Change (UNFCCC), and these provide targets for Nationally Determined Contributions (NDCs) to mitigate climate change under the Paris Agreement. However, these inventories have high uncertainty in assessing emissions at the regional and national scale.

Satellites can decrease this uncertainty by providing global monitoring of emissions, which can be used to evaluate national emission inventories. But global evaluations have so far been limited by coarse resolution, due to computational limitations. This study presents a global system for estimating methane emissions at up to 25-km resolution by inversion of 2023 TROPOMI observations with prior point source and infrastructure information.



United Nations Environment Programme | International Methane Emissions Observatory
1 rue Miollis 75015 Paris, France | www.unep.org/methane
For more information, please contact unep-methanescience@un.org

## RELATED PUBLICATIONS

- Worldwide inference of national methane emissions (East et al., 2025)

## SIGNIFICANCE FOR DECISIONMAKERS

The TROPOMI-guided corrections enhance prior bottom-up emission estimates. These corrections directly contribute to improving national emission reports to the UNFCCC inventories and NDCs for mitigating methane emissions.

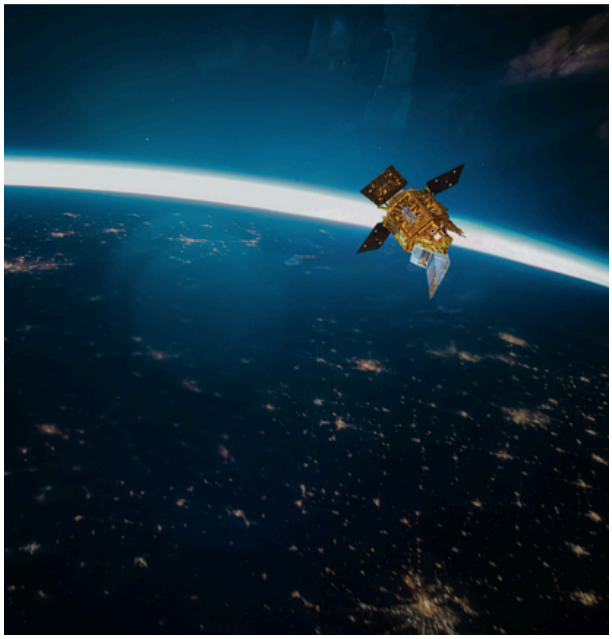

Photo Attribution: Canva

## STUDY APPROACH/ACTIVITIES

The TROPOMI satellite instrument has been reporting global daily methane columns at 5.5-7x7 km2 pixel resolution since 2018, and retrievals have been steadily increasing in quality. These observations can be inverted with a chemical transport model to infer emissions.
The study presents a new global system based on the open-source Integrated Methane Inversion (IMI) model. It used TROPOMI observations from 2023 and previous UNFCCC reporting in an ensemble of high-resolution regional inversions covering all sectors for 161 countries worldwide. It also improved the global inventory with information about source location and magnitude from satellite point-source imagers. The system can also be used to explore uncertainties related to different inversion parameters.

## CATALYZING ACTION

The study will help improve a global gridded bottom-up inventory for fossil fuel emissions, in which emissions are broken down into a grid based on UNFCCC totals. By comparing the inferred emissions with reported figures in national inventories, the study supports the identification of discrepancies and assessment of the accuracy of data provided by different countries.

## OTHER SUPPORTERS/STAKEHOLDERS

Principal Investigator:
**Harvard University, USA**

Revision History: **10/09/2025**

The UN Environment Programme's International Methane Emissions Observatory (IMEO) exists to provide open, reliable, and actionable data to the individuals with the agency to reduce methane emissions. IMEO does this by integrating and reconciling data across sources, including its global methane science studies. IMEO supports measurement and research studies around the world to close the knowledge gap on methane emissions and provide policy-relevant insights to decisionmakers.