TROPOMI-BASED WORLDWIDE CHARACTERIZATION OF EMISSIONS

Leveraging satellite data to quantify national and regional methane emissions while identifying 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:
Analysis Ongoing

TIMELINE:
Measurements 2023 to present

IMEO SCIENCE OBJECTIVE:

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

KEY FINDINGS

This study will quantify regional (national and basin scale) methane emissions from oil and gas production worldwide by time-dependent inversion of TROPOMI observations at 25-50 km resolution. The results (including error characterization) will be used to evaluate the national emission reports to the UNFCCC, thereby enabling the formulation of improved NDCs.

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 climate change mitigation under the Paris Agreement. However, these inventories have high uncertainty in assessing emissions at the regional/national scale.

Satellites can decrease this uncertainty by providing global monitoring of emissions. This study will generate a worldwide quantification of total methane emissions from oil, gas, and coal production on national and basin scales by inversion of multi-year 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/imeo
For more information, please contact imeo@un.org

UN environment programme

RELATED PUBLICATIONS

- The first study quantifying 2021 methane emissions in South America at up to 25 km × 25 km resolution using satellite methane observations is currently under review in EGU Sphere (Hancock et al., 2024)

SIGNIFICANCE FOR DECISIONMAKERS

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

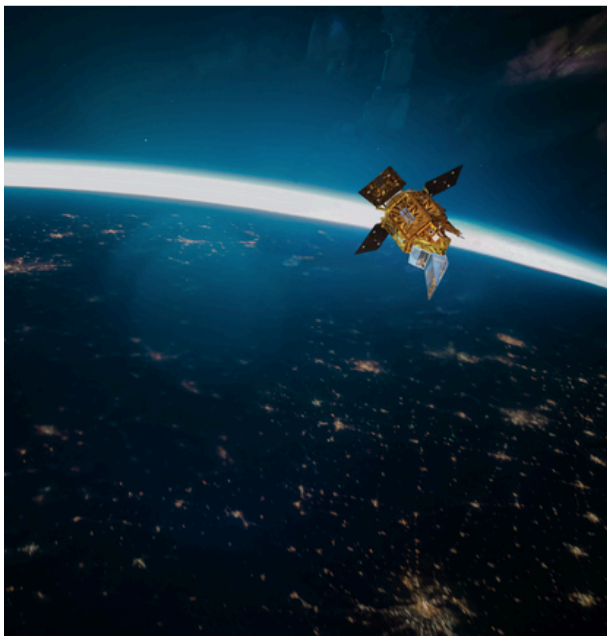

Photo Attribution: Canva

STUDY APPROACH/ACTIVITIES

The TROPOMI satellite instrument has been reporting global daily methane columns at 5.5-7x7 km2 pixel resolution since 2018, and the retrievals have been steadily increasing in quality. Here we propose to use the TROPOMI observations in an ensemble of high-resolution (0.25x0.3125 degree grid (≈25x25 km2)) regional inversions covering major oil and gas production regions worldwide. The approach is to infer posterior emission estimates by analytical solution to Bayesian optimization using the GEOS-Chem chemical transport model as forward model. Analytical solution requires explicit construction of the model Jacobian matrix relating emissions to concentrations on the optimization grid. A major advantage of the analytical solution (as opposed to a variational solution) is that it provides closed forms of error statistics and information content on the posterior estimates. Once the Jacobian matrix has been constructed, it can be used to readily produce an ensemble of sensitivity inversions to explore uncertainties related to different inversion parameters.

CATALYZING ACTION

The study will support improvement of global gridded bottom-up inventory for fossil fuel emissions. The improvements will involve information from new infrastructure databases for emission allocation including from Environmental Defense Fund (oil and gas), Global Energy Monitor (coal, oil and gas), and satellite point source imagers. These improvements will be applied to updated versions of the UNFCCC national reports. By comparing the observed emissions with the reported figures in national inventories, the study will support the identification of discrepancies and assess the accuracy of the data provided by different countries.

OTHER SUPPORTERS/STAKEHOLDERS

Principal Investigator:
Harvard University, US

Revision History: **10/15/2024**

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.