

# Integrated Methane Inversion (IMI):

A tool for stakeholders to infer total methane emissions from satellite data

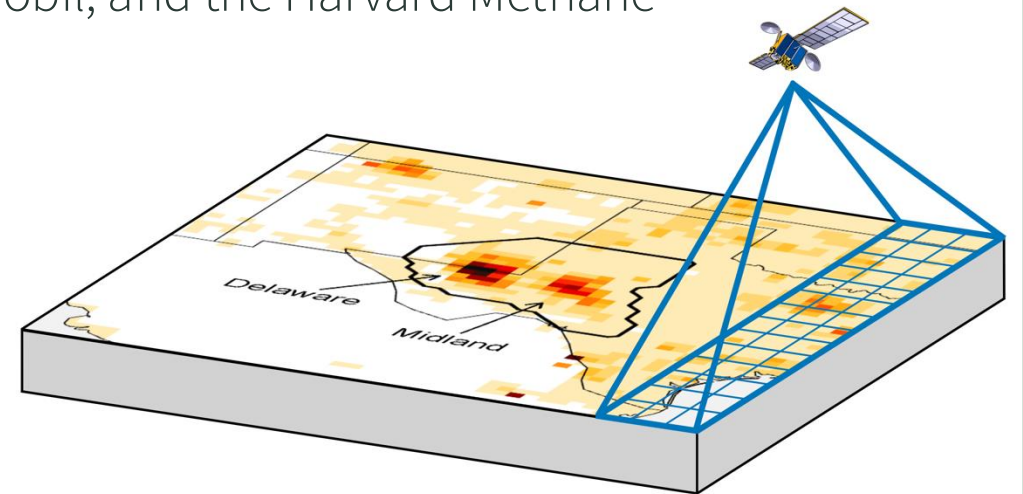
## What IMI users can do:

- Quantify methane emissions from any region at 25-km resolution with accounting of uncertainties
- Compare their results to bottom-up emission inventories
- Set up near-real-time continuous monitoring for their region
- Run the IMI freely on the AWS cloud or with the user-friendly Integral Earth dashboard

## What is under the IMI hood:

- Advanced inverse methods documented in the scientific literature and made easy to use
- A team of Harvard developers supported by NASA, Exxon-Mobil, and the Harvard Methane Initiative
- An open-source code for transparency of results

Varon, D.J., et al., Integrated Methane Inversion (IMI 1.0): a user-friendly, cloud-based facility for inferring high-resolution methane emissions from TROPOMI satellite observations, *Geosci. Model Dev.* 15, 5787-5805, <https://doi.org/10.5194/gmd-15-5787-2022>, 2022

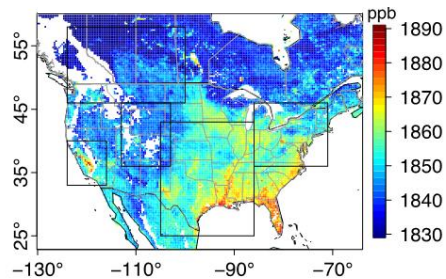


# Why the IMI?

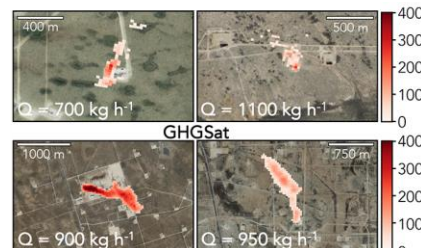
Satellites observe atmospheric methane worldwide, but calculating emission rates (through “inversions” of the satellite data) requires advanced computational resources and scientific expertise.

Satellites observe methane concentrations

TROPOMI



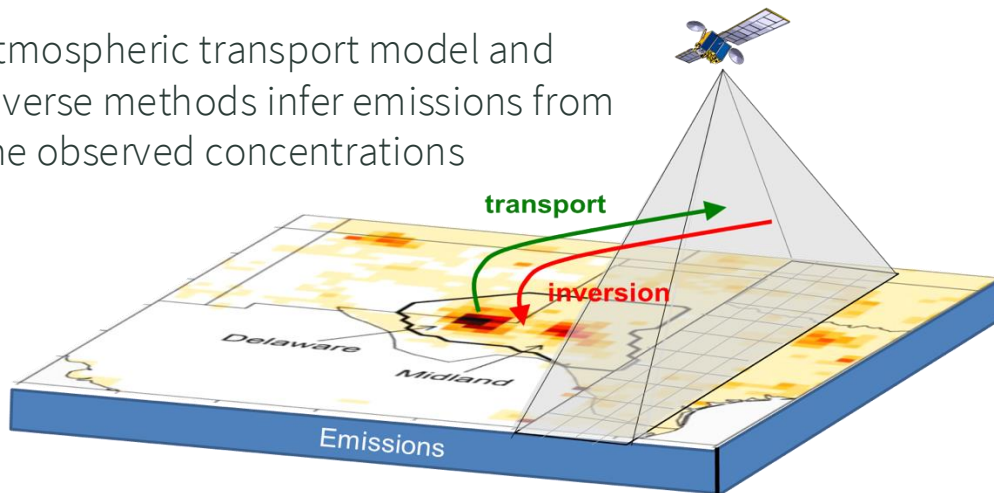
Point sources



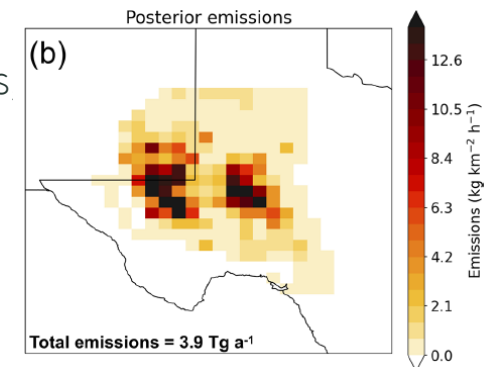
Terabytes  
of data

- IMI uses an analytical Bayesian inverse method backed up by a large body of scientific literature
- It exploits data from TROPOMI and point source satellite instruments
- All data processing is done on the cloud and is transparent to the user

Atmospheric transport model and inverse methods infer emissions from the observed concentrations



IMI output includes calculated emissions and their uncertainties, breakdown by sectors, comparison to previous inventories point source information, etc.



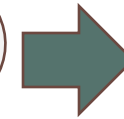
# The IMI puts the power of satellite data in the hands of non-expert stakeholders

Sustained R&D by  
Harvard group



**Stakeholders**

- National, state, local govt agencies worldwide
- International organizations
- Industry
- NGOs and advocacy groups



Actionable, total emissions  
data

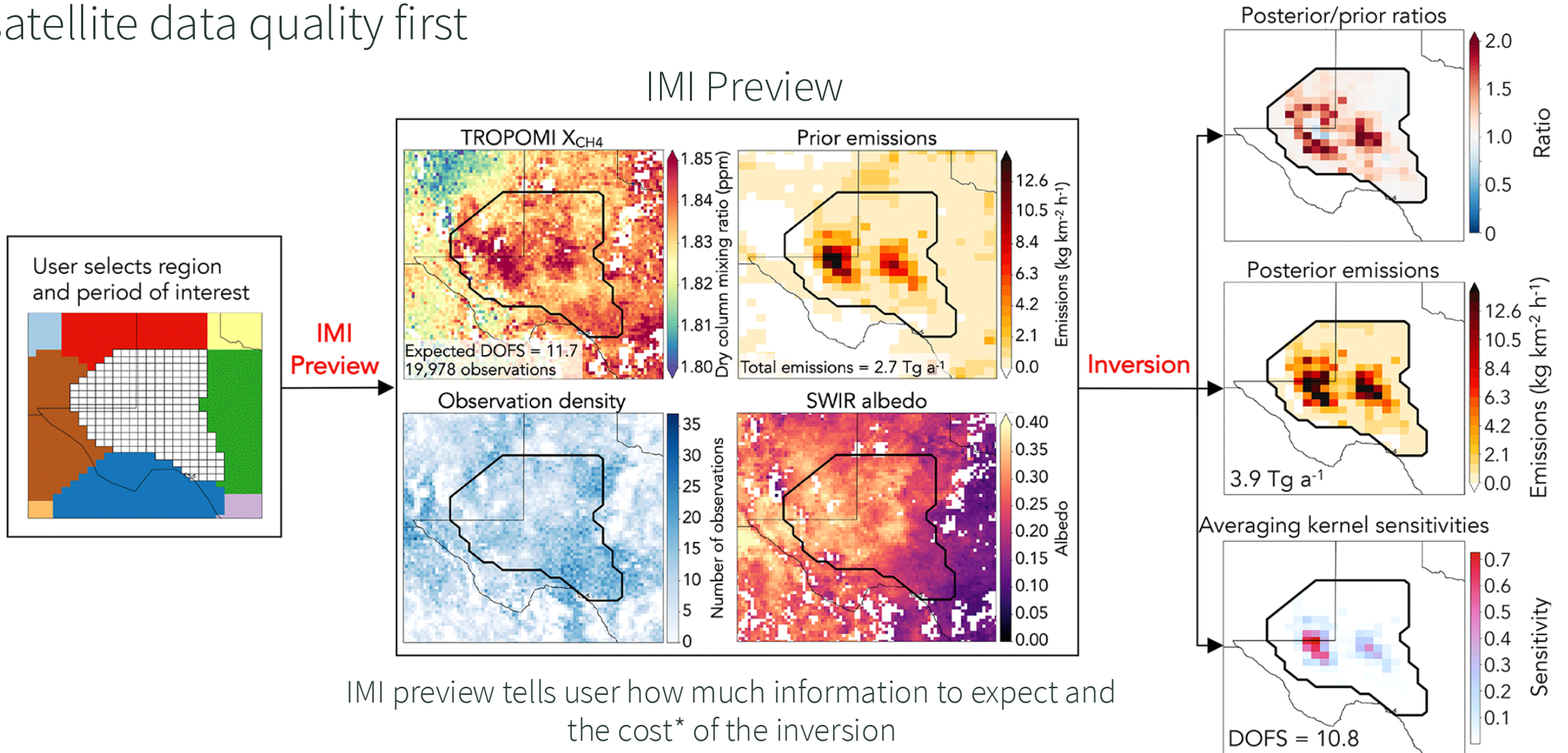
Select region and period of interest  
with simple configuration file

Open-source data and  
code on the cloud ensure

- Transparency
- Reproducibility
- Credibility

Free IMI preview lets user check satellite data quality first

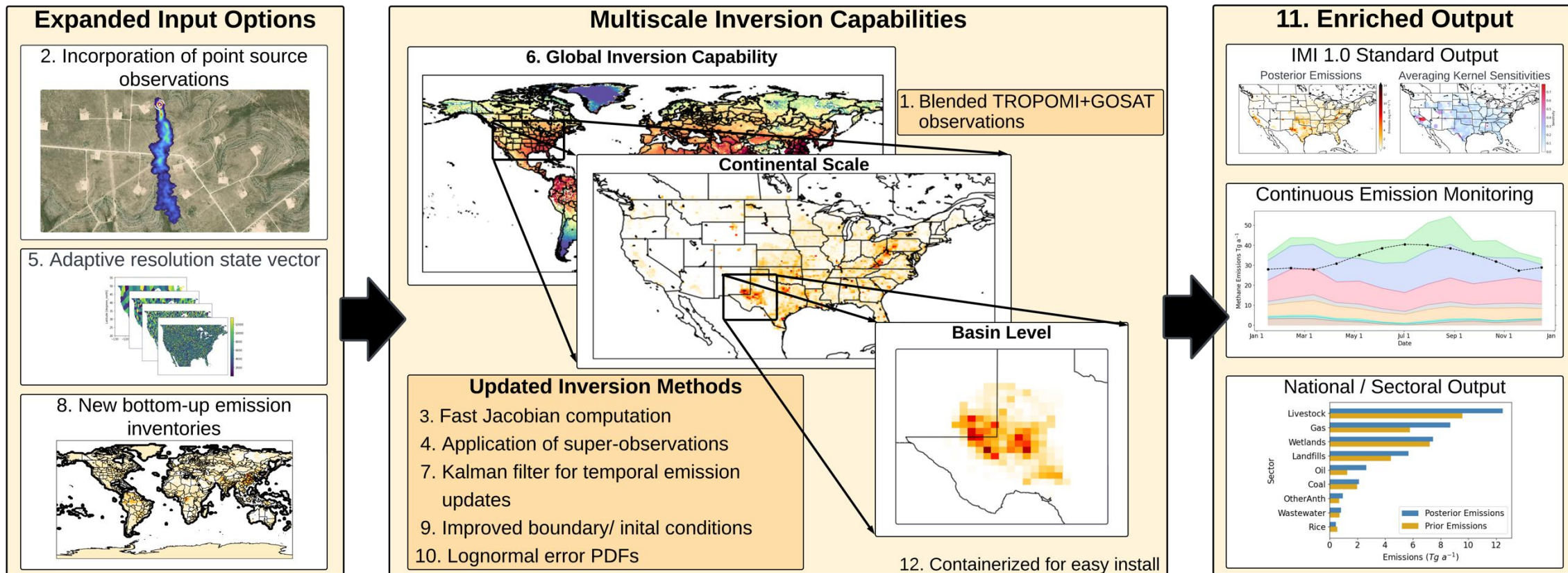
## IMI Preview



IMI preview tells user how much information to expect and the cost\* of the inversion

\*Reach out for accurate estimates. Costs range from \$10 to \$100+ per request depending on the region and period of interest.

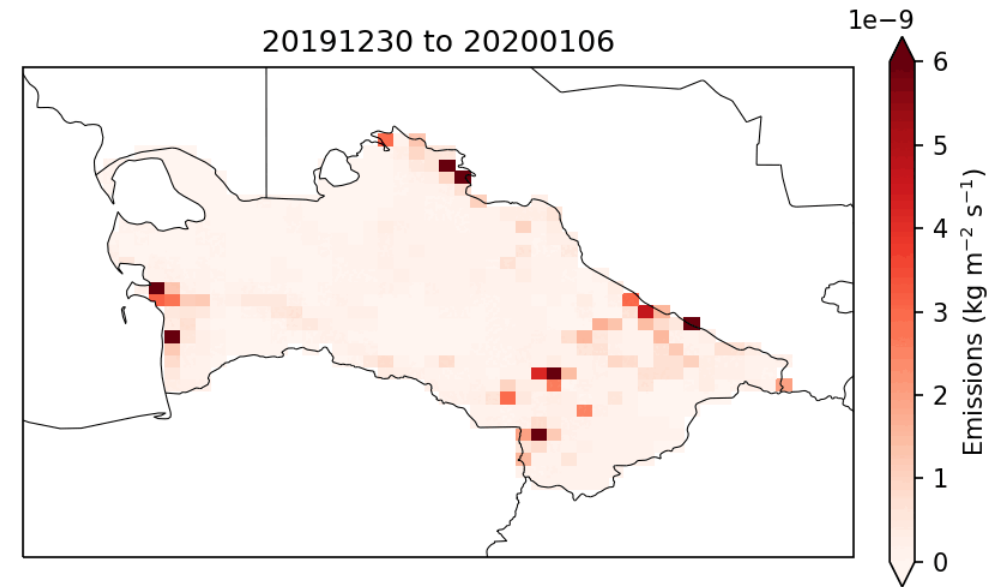
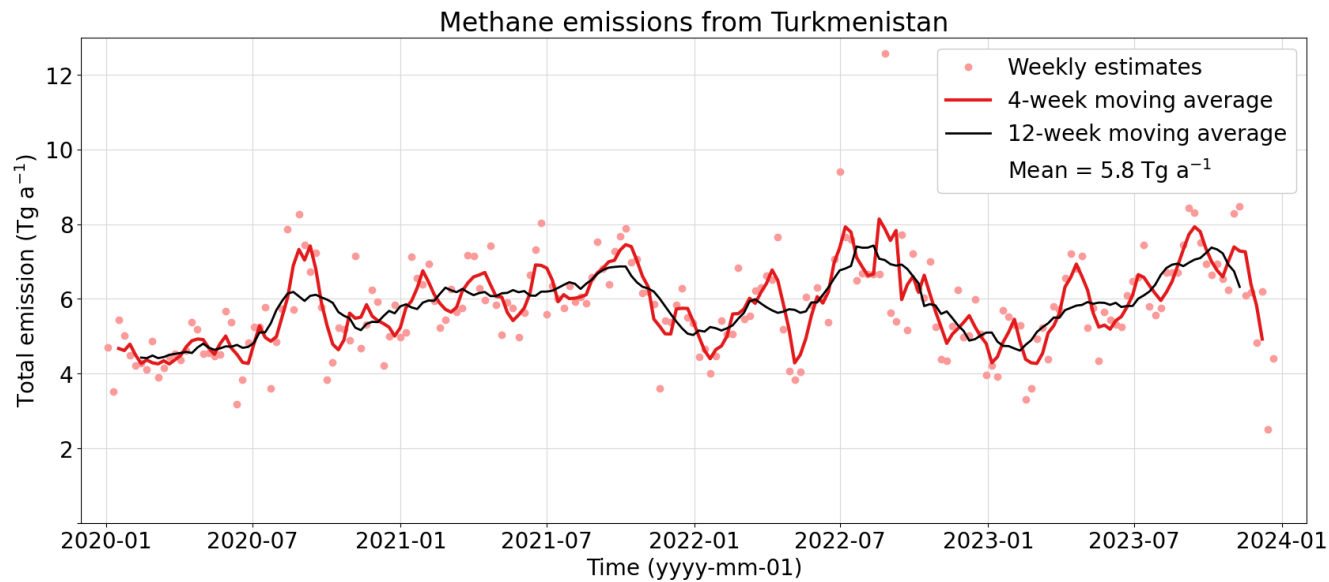
# New IMI 2.0 released in June 2024 features greatly expanded capabilities



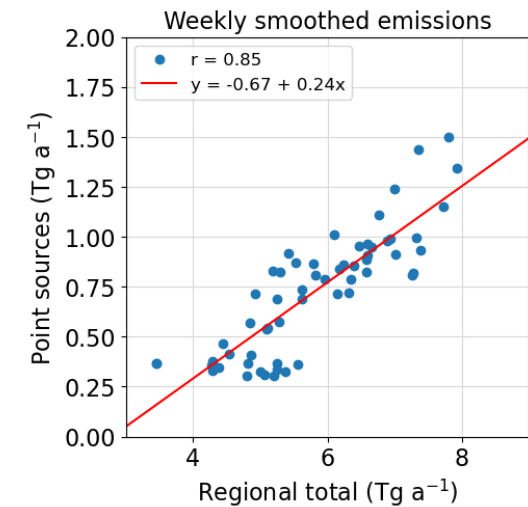
## Future Developments:

- Improve user dashboard for ease of input and output management
- Exploit new satellite datasets (MethaneSAT, Carbon Mapper, ...)
- Increase resolution to 12 km
- Extend capability to CO<sub>2</sub>

# Continuous weekly monitoring of Turkmenistan's methane emissions with IMI 2.0

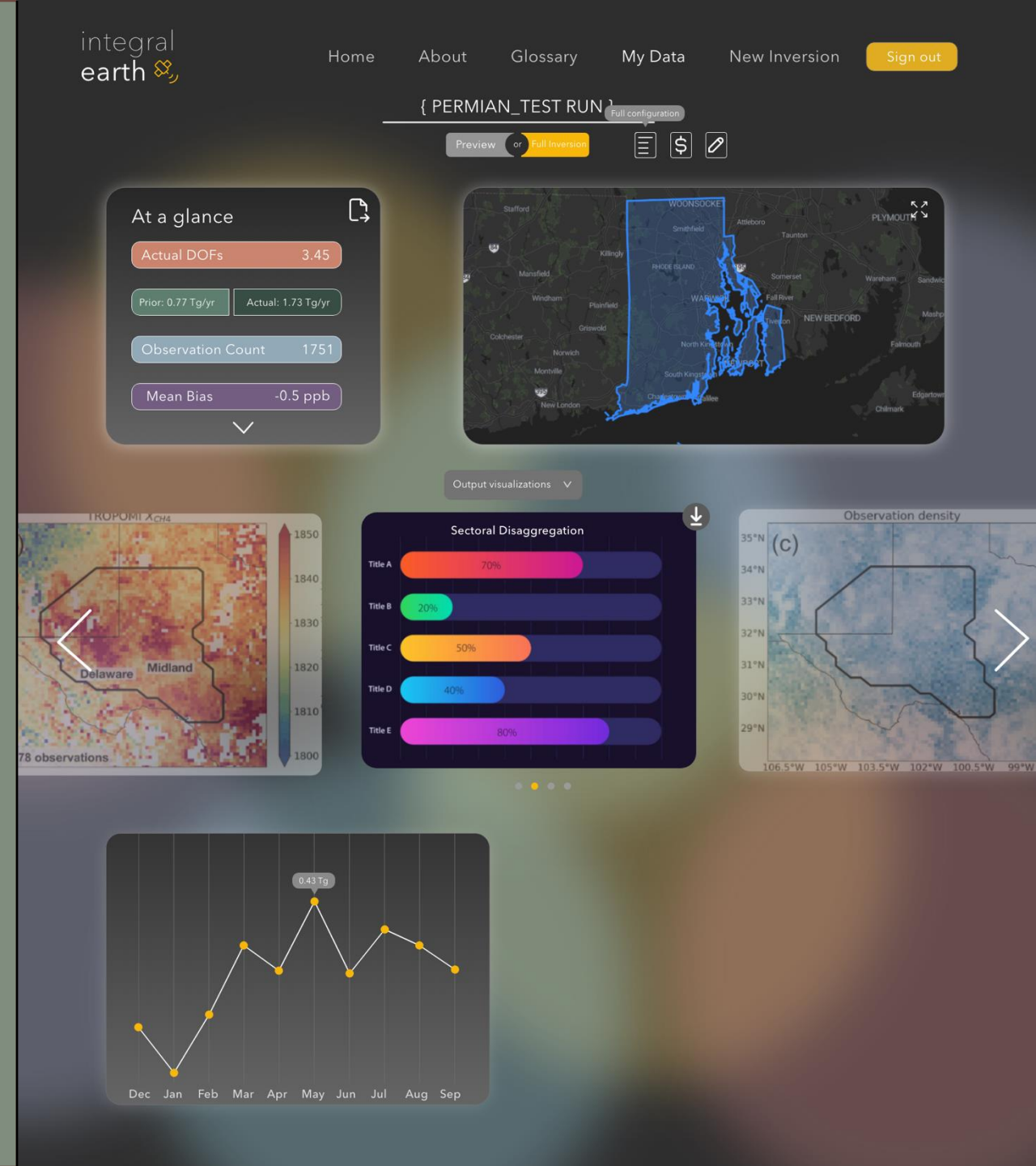


- IMI 2.0 enables continuous monitoring (e.g., weekly, monthly) of methane emissions from any region of interest
- Example: Continuous weekly monitoring of Turkmenistan's methane emissions supports diplomatic activities of the UNEP International Methane Emissions Observatory (IMEO)
- National total methane emissions are highly correlated with sums of point source detections in Turkmenistan (bottom right figure)



# Coming soon... Integral Earth

- Managed emission monitoring for easy stakeholder access via web UI
- Expert evaluation of results
- Customized emissions intelligence dashboards



# To get more information and access the IMI:

- The IMI is openly accessible on the AWS Marketplace.  
All you need is an AWS account: read the documentation at <https://imi.readthedocs.io/en/dev/>
- Visit the IMI website: <https://www.imi.seas.harvard.edu>
- Contact the IMI team:
  - Lucas Estrada ([lestrada@g.harvard.edu](mailto:lestrada@g.harvard.edu), Lead Developer)
  - Melissa Sulprizio ([mpayer@seas.harvard.edu](mailto:mpayer@seas.harvard.edu), Software Engineer)
  - John Thomas ([johnthomas@g.harvard.edu](mailto:johnthomas@g.harvard.edu), Web Developer)
  - Alex Goodman ([agoodman@mba2025.hbs.edu](mailto:agoodman@mba2025.hbs.edu), Marketing Director)
  - Daniel Varon ([danielvaron@g.harvard.edu](mailto:danielvaron@g.harvard.edu), Lead Developer)
  - Daniel Jacob ([djacob@fas.harvard.edu](mailto:djacob@fas.harvard.edu), Lab Director)
- Attend virtual user workshop on **15 October 2024 at 11-13 eastern US time** – contact Melissa Sulprizio to get on email list for updates