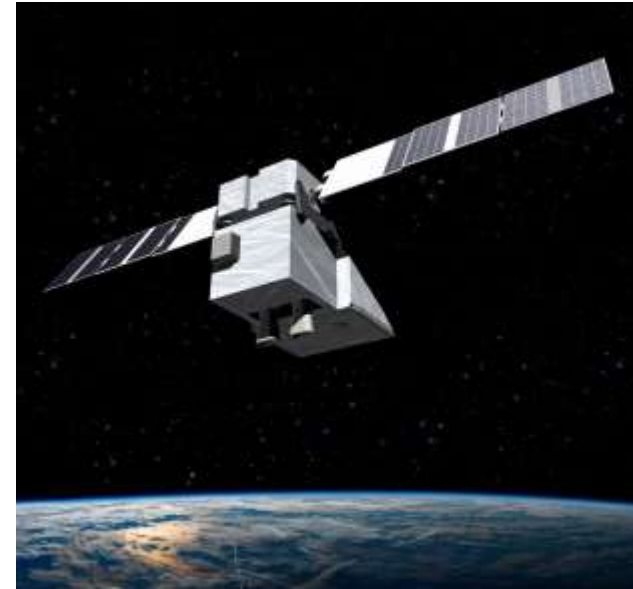


Reducing Methane Emissions

Steven Hamburg

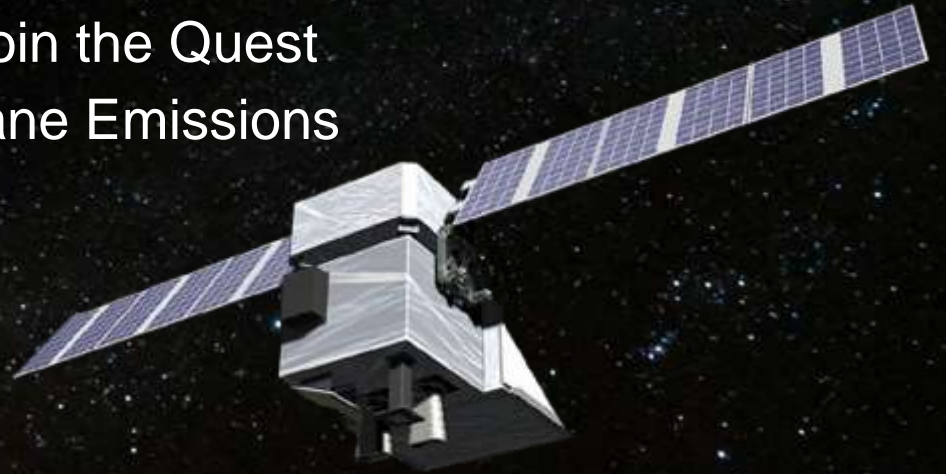
Chief Scientist - Environmental Defense Fund


Executive Manager - MethaneSAT LLC (non-profit)



New Satellites Unlock Crucial Climate Opportunity

Ecosystem of Orbital Sensors Join the Quest to Find, Measure and Cut Methane Emissions





Methane from fossil fuel value chains, agriculture and the waste industry is causing more than 25% of current temperature increases.

The fastest way to slow the increase in warming over the next few decades is to reduce methane emissions.

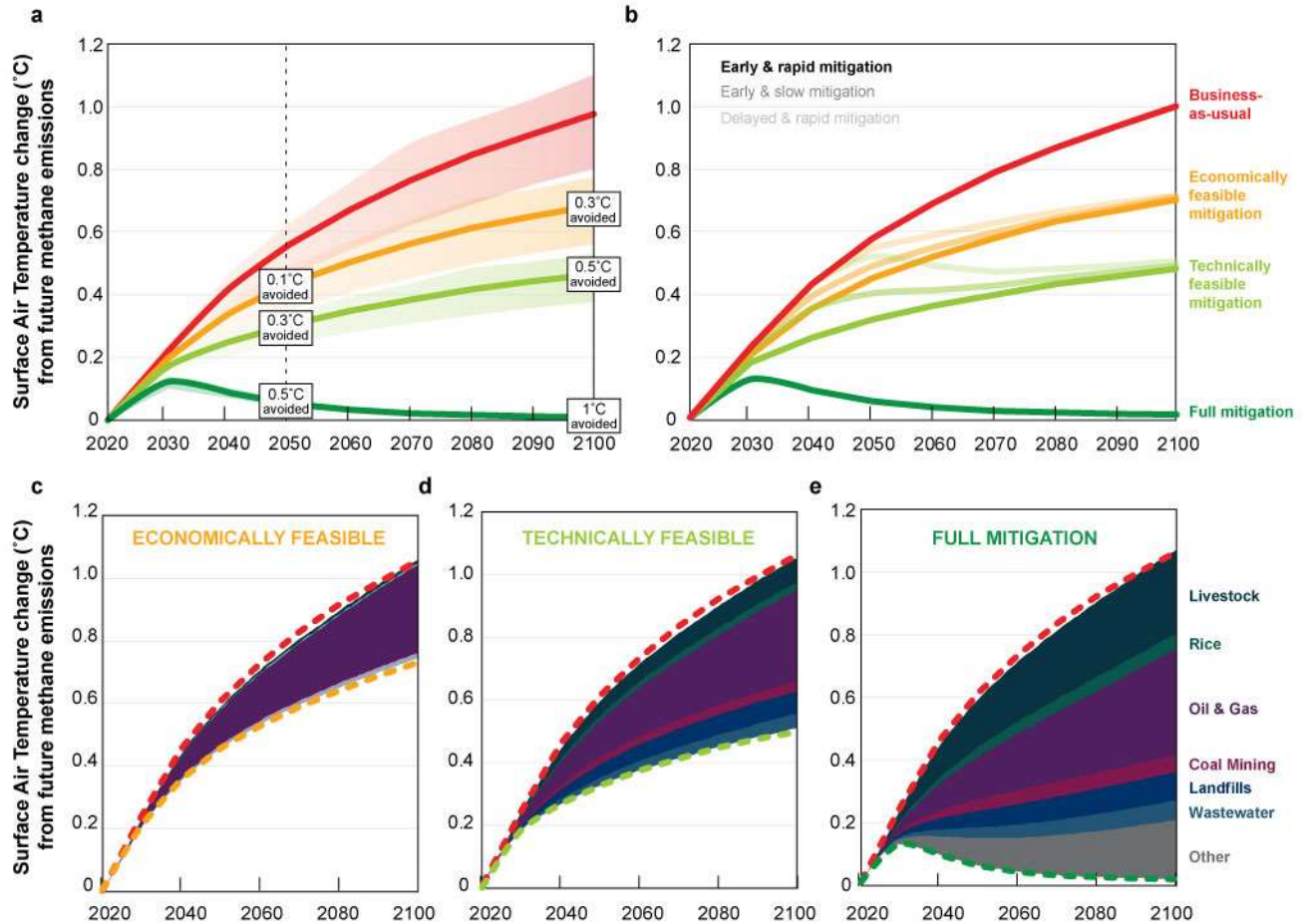
EDF ENVIRONMENTAL DEFENSE FUND
Feeding the world that works

We have tools to cut global methane emissions in half within 10 years.

Do we have the necessary

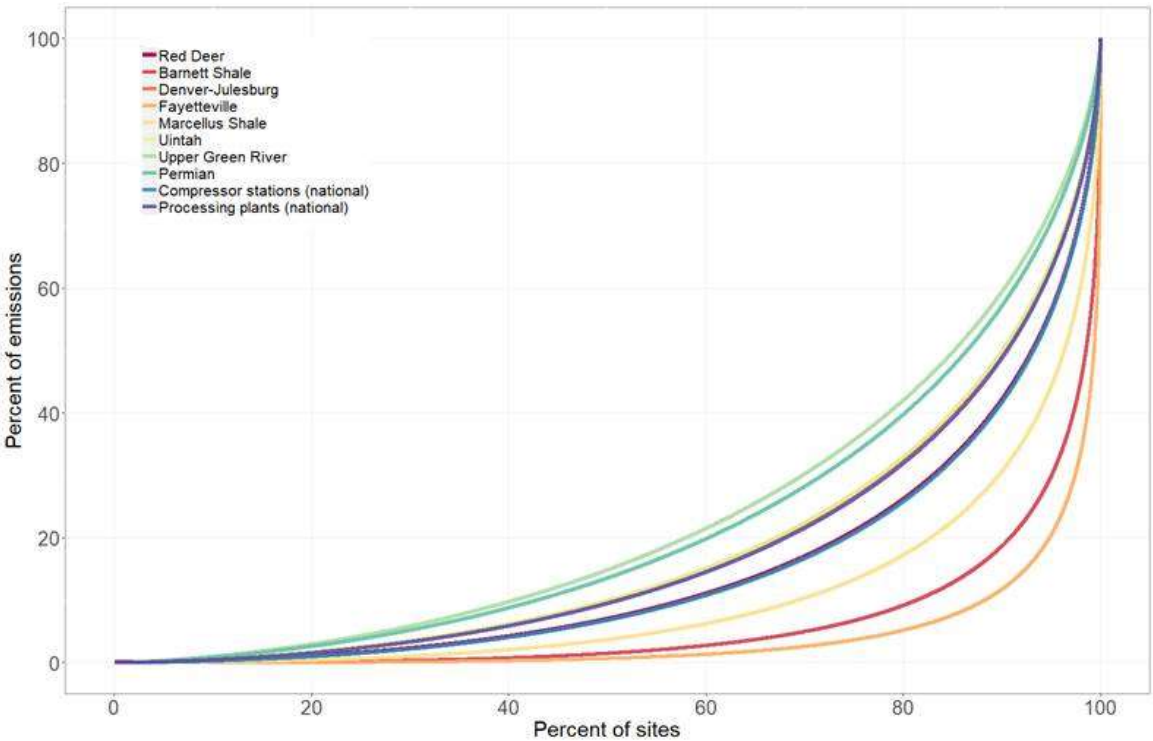


Reducing methane emissions has the potential to reduce the rate of warming significantly

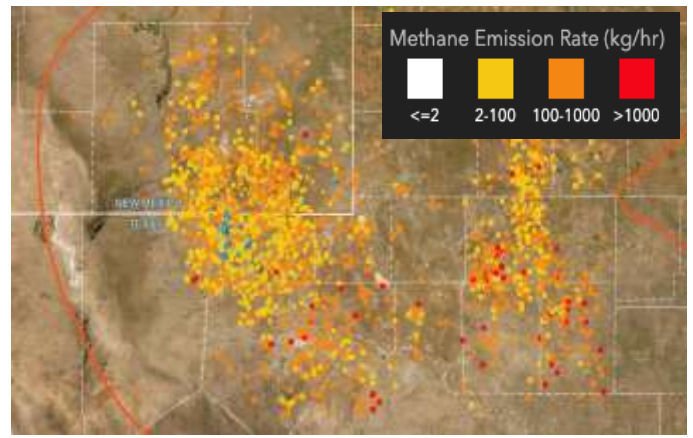


Characterizing (and mitigation of) super-emitters is necessary but not sufficient

Emissions distributions site-level measurements



All facilities (Permian)



Lower detection thresholds of current satellite instruments:

Understanding contribution of fat tail to total emissions is essential

Accelerating emissions reductions requires knowing:

- **What** is being emitted?
- **Where** are the emissions, what are the sources?
- **How much** is being emitted?
- Are emissions **changing** over time?

Thus, we need fine spatial and temporal scale satellite remote sensing data.

An ecosystem of methane-detecting satellites is emerging, each with distinct capabilities and purpose.

They're giving companies, regulators, investors, and the public a new level of transparency and insight for tackling an urgent climate challenge.



Different Platforms Offer Different Capabilities

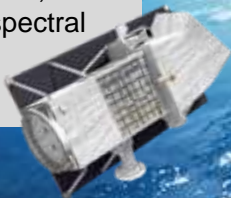
GHGSat

An industry-oriented constellation of commercial point-source satellites.



PRISMA

Launched by the Italian Space Agency in 2019; combines a hyper-spectral sensor with a high-resolution camera.



MethaneSAT will be the most advanced methane-tracker in space, monitoring emissions almost anywhere on Earth with greater precision than any other satellite, measuring large sources as well as sources too small for other instruments to see.

DATA PROVIDERS

KAYRROS

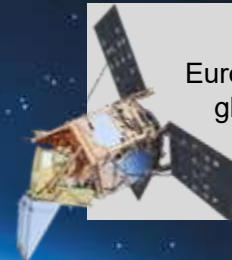
Data analytics company serving traders, investors, operators and governments using observations from assortment of satellite sources.

IMEO

Created by the UN Environment Programme and the European Commission, IMEO will aggregate and analyze emissions data from government, industry, and satellite sources.

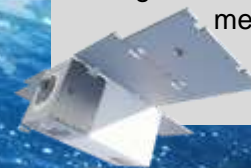
TROPOMI

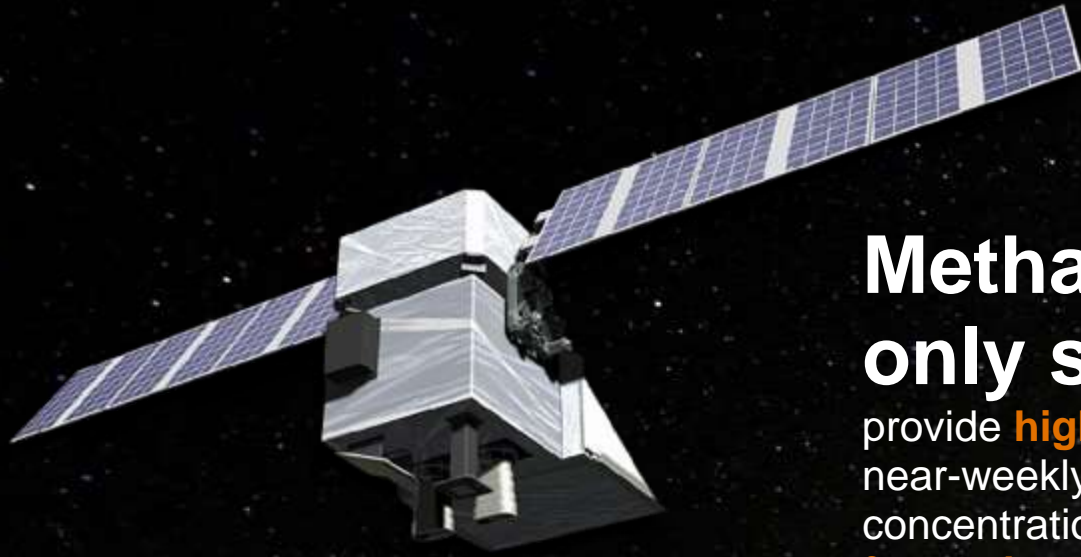
European Space Agency's global-mapper launched in 2017 on the Sentinel-5P satellite.



CARBON MAPPER

A point-source instrument announced in 2021 by coalition of organizations together with commercial satellite provider Planet, planned for launch in 2023.



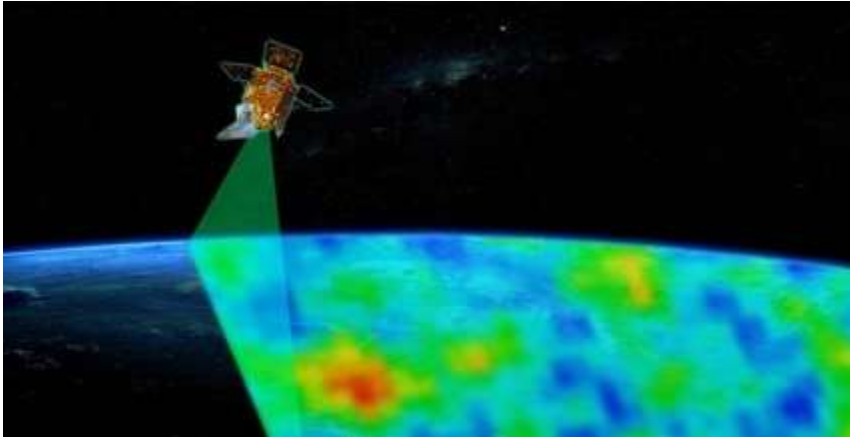


MethaneSAT is the only satellite that will

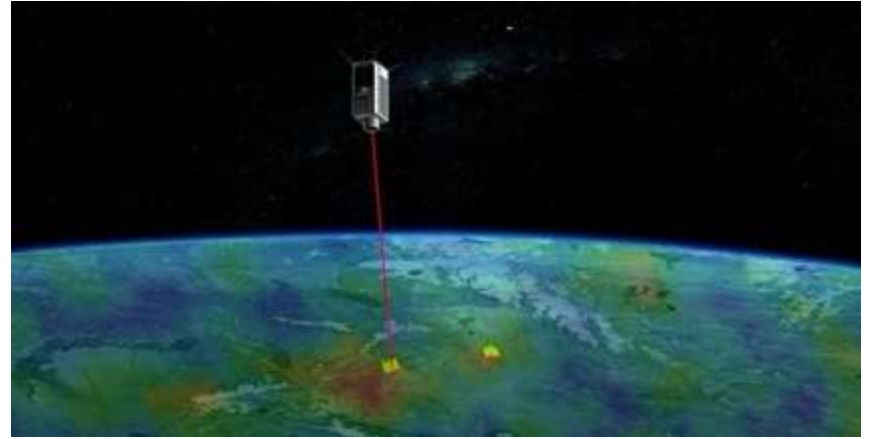
provide **high-precision** global coverage on a near-weekly basis, measuring not just methane concentrations but **the rate** it's escaping **from where**, and **who is responsible**.

It will quantify large emissions as well as **sources too small for other satellites to see**, but which make up a significant share of the world total.

Global Mappers vs. Point-Source Detectors



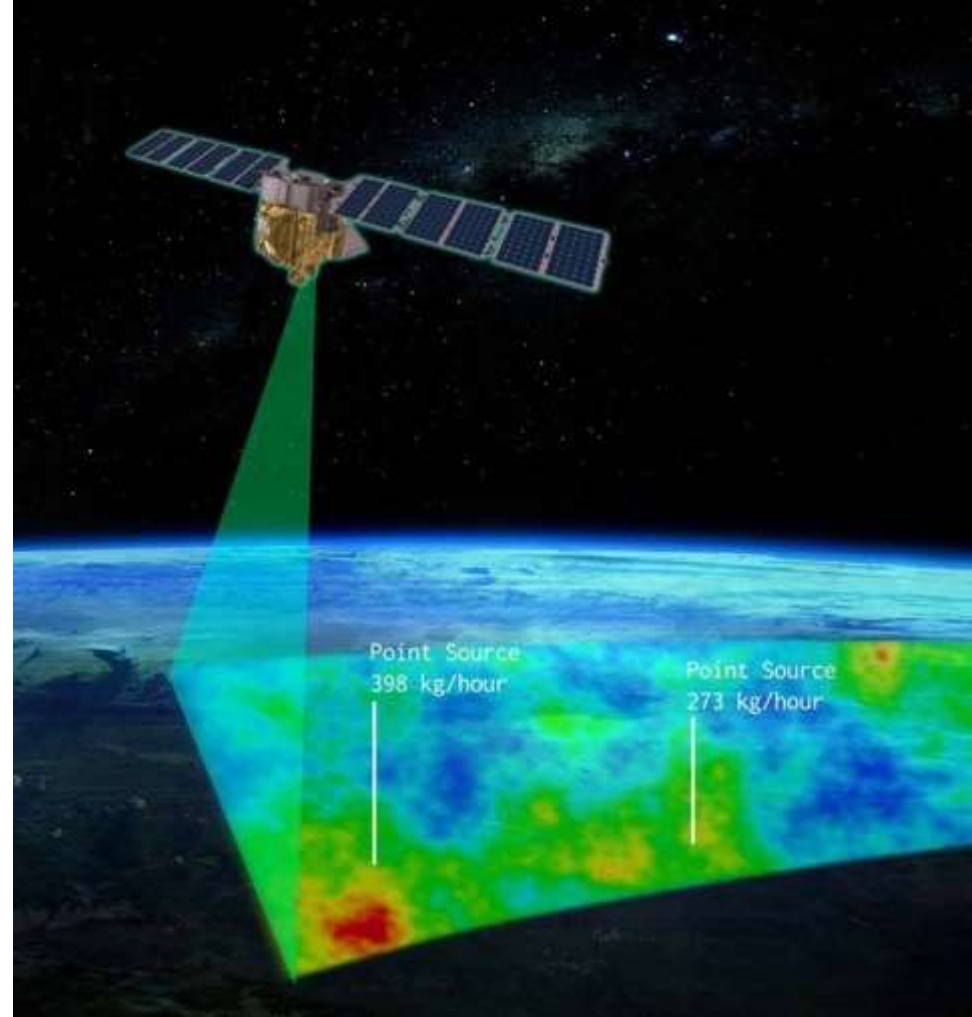
Global Mappers offer more precise measurement. They can track methane over very wide areas but can see only very large emissions and lack the resolution to identify sources.



Point-Source Detectors have fine-grained spatial resolution for targeting known sites but lack sensitivity to detect the vast number of smaller emissions responsible for a substantial share of the everyday total.

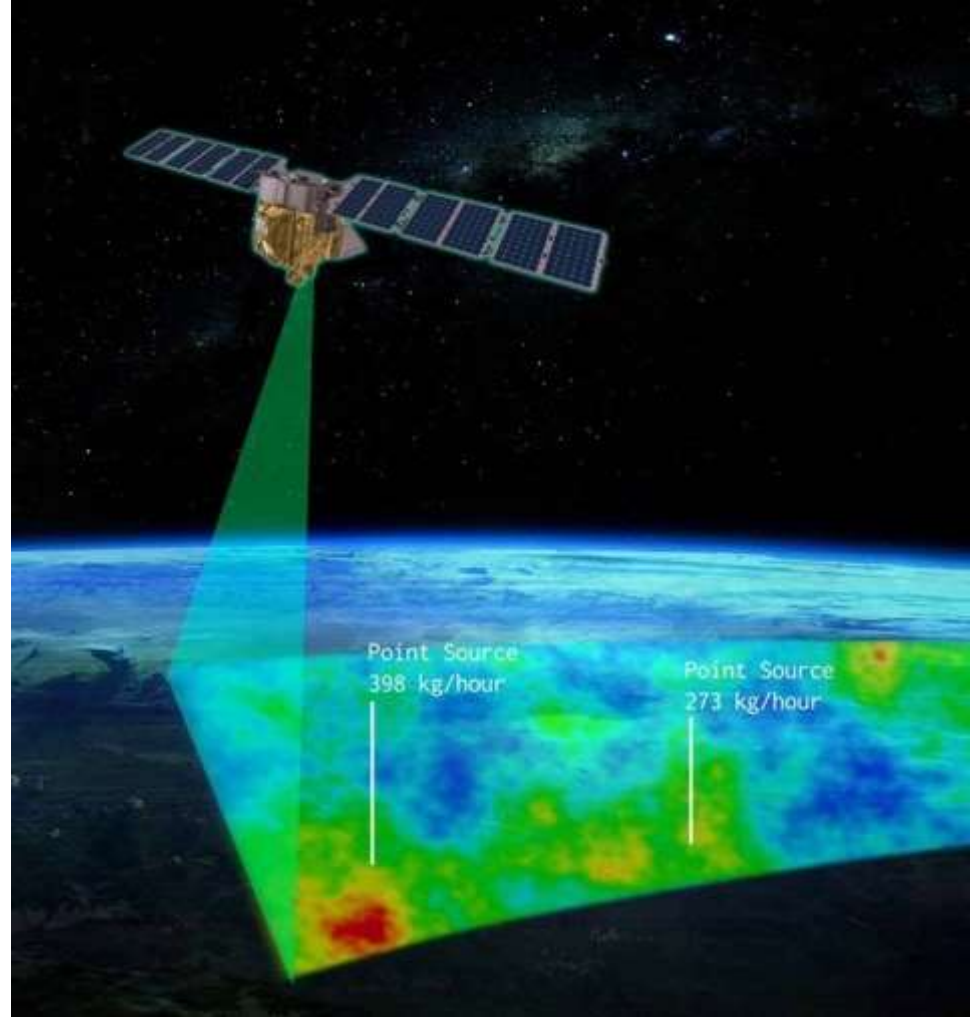
MethaneSAT combines the capabilities of today's global mappers and point-source satellites into a single platform.

It has a wide field of view to find and measure even the smallest amounts of methane across wide areas with exceptional precision – detecting concentrations as small as **just 3 parts per billion.**



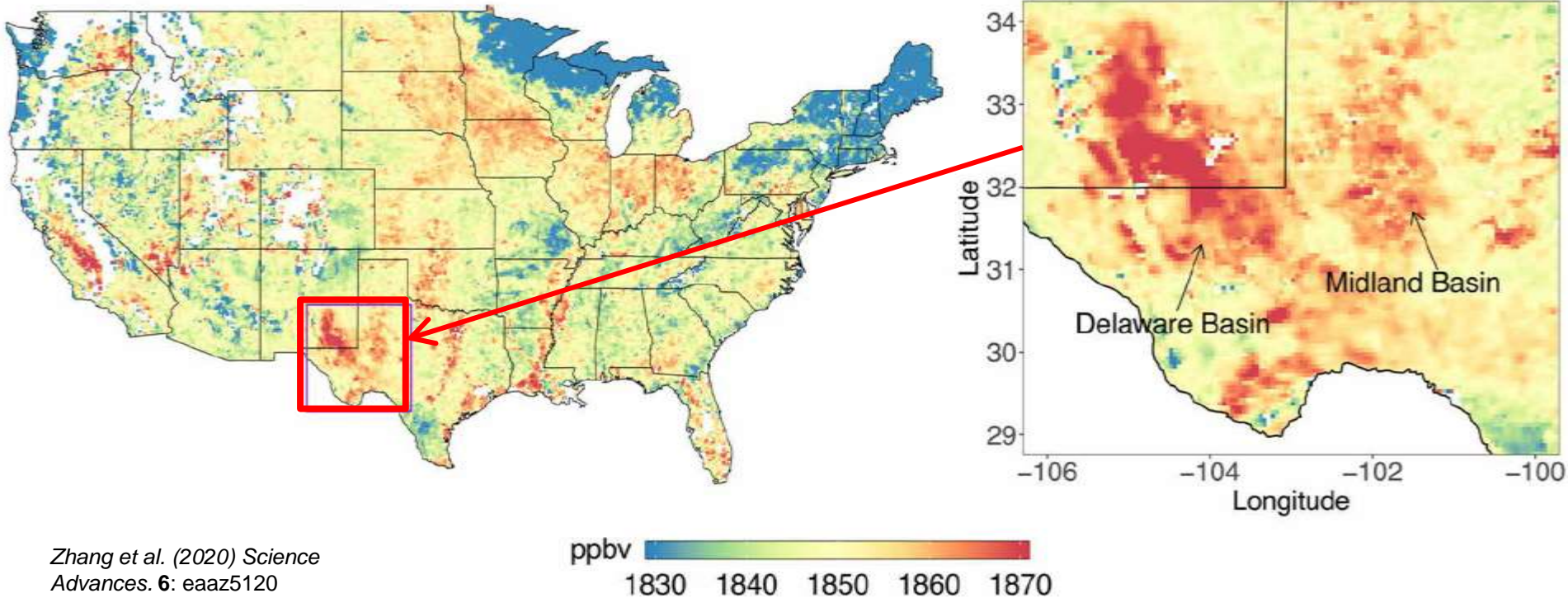
MethaneSAT will:

- Track emissions **back to their origin**
- Accurately measure not only methane concentrations but **emissions rate**
- Provide data for companies or regulators to **find the biggest reductions fast**
- Cover the globe every **3 to 4 days**
- **Automate calculations** done by scientists today, cutting a process that can take months down to just days

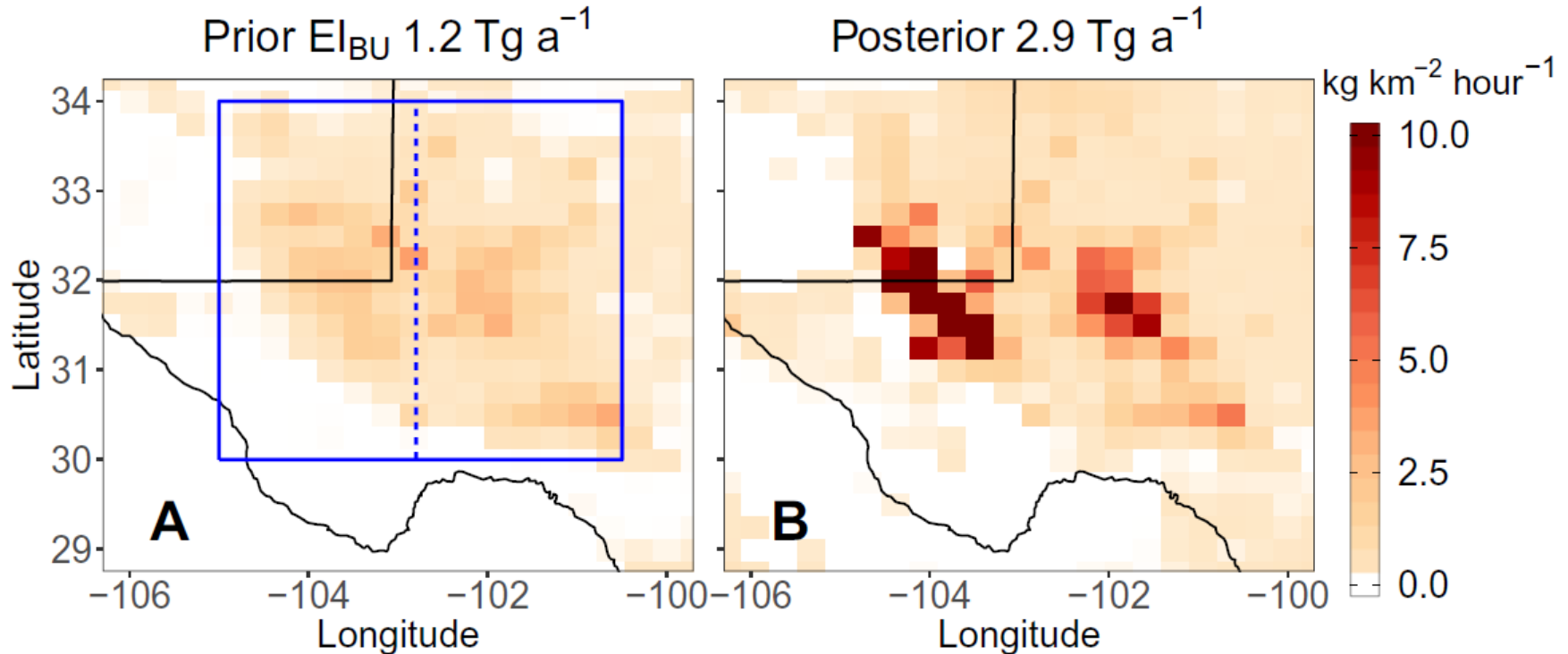


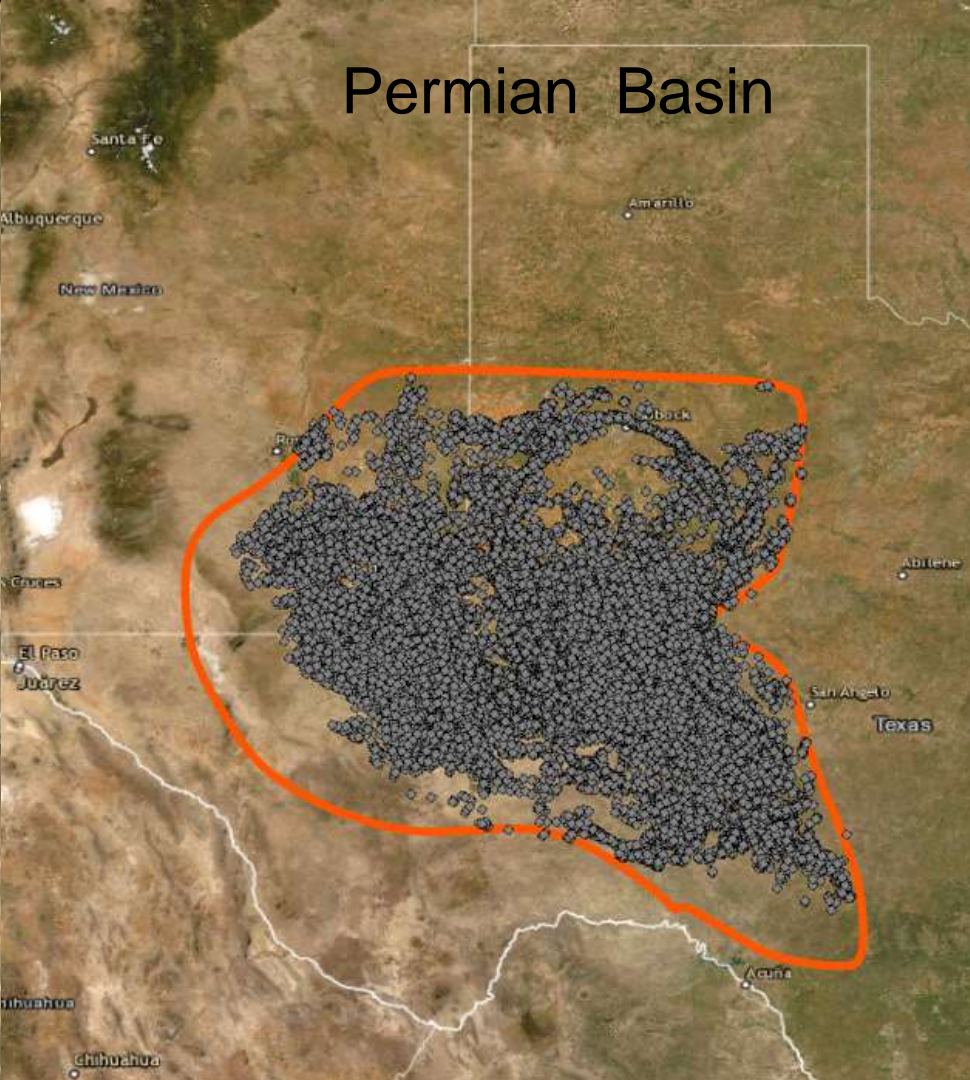
Satellite observations reveal high Permian methane emissions

TROPOMI (Sentinel 5-P) methane data averaged from May 2018 – March 2019

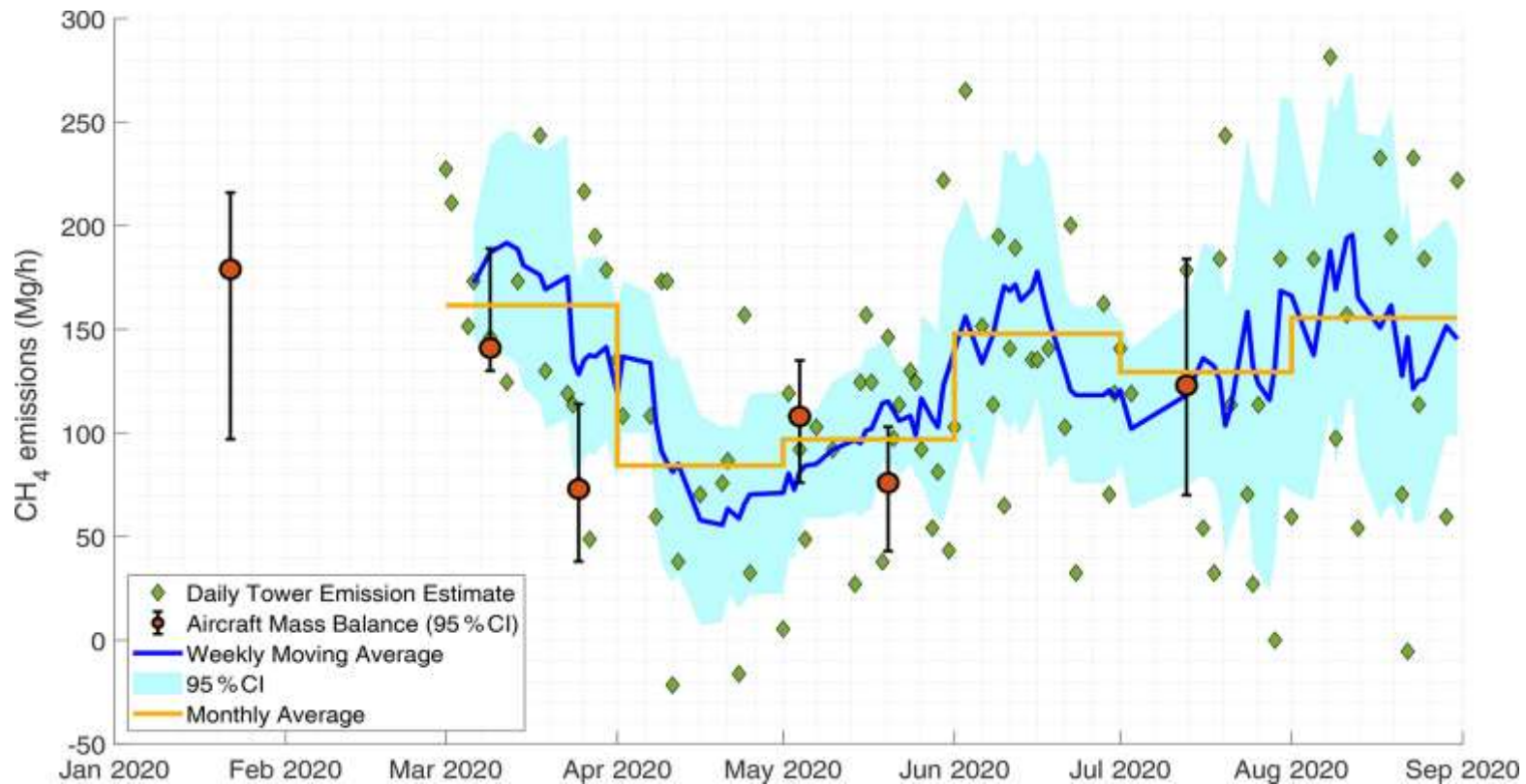


TROPOMI data reveal highest methane emissions from the Permian Basin ever measured from any U.S. oil and gas basin





Permian Basin Methane Emissions Trends in 2020



Lyon et al. 2021. Concurrent variation in oil and gas methane emissions and oil price during the COVID-19 pandemic. *Atmospheric Chemistry and Physics* 21: 6605–6626, <https://doi.org/10.5194/acp-21-6605-2021>

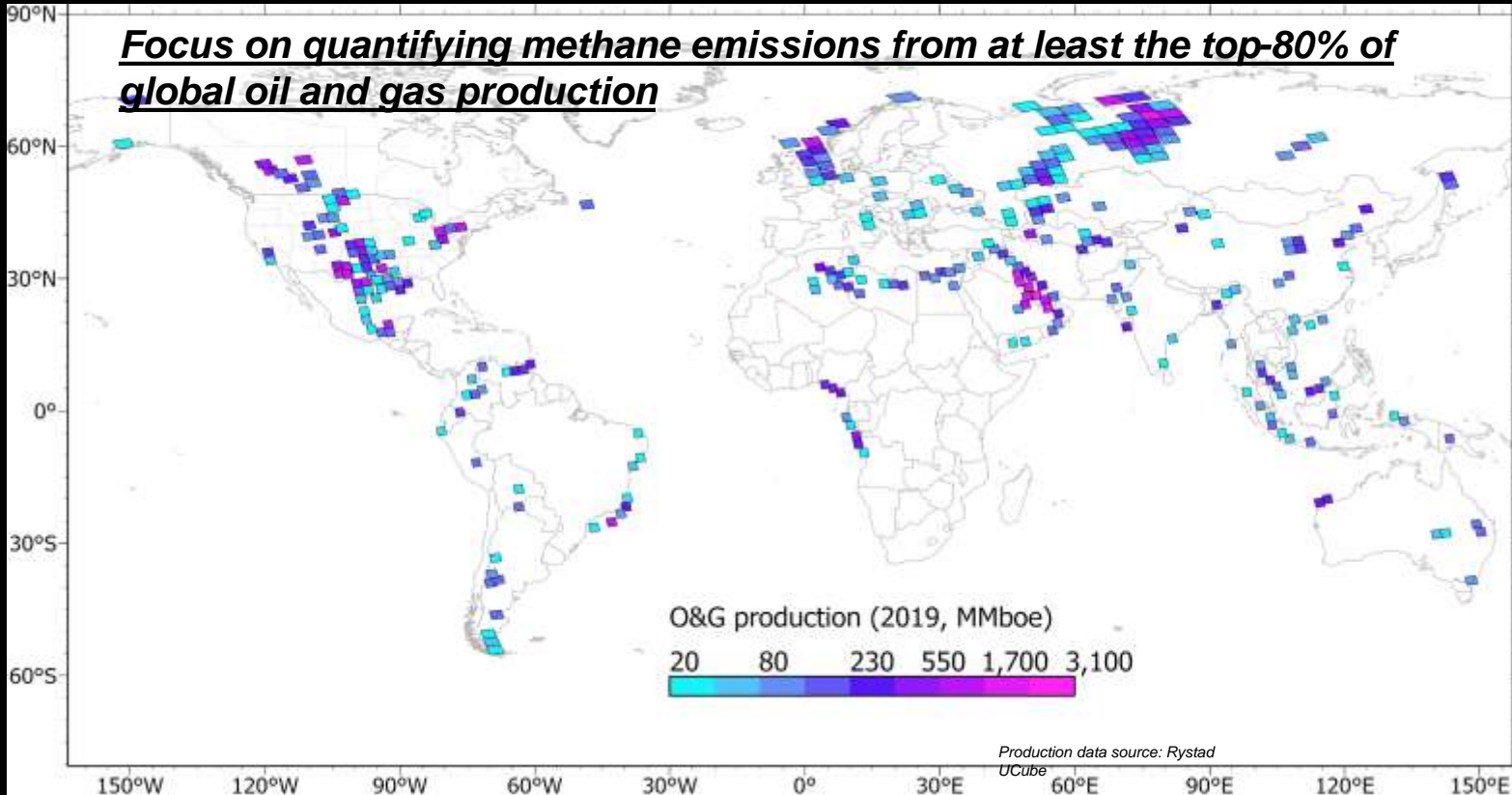
MethaneSAT data will be public, free of charge.

It will enable stakeholders of all kinds to compare emissions performance by country or company, virtually anywhere on Earth.



MethaneSAT oil and gas target areas

Focus on quantifying methane emissions from at least the top-80% of global oil and gas production



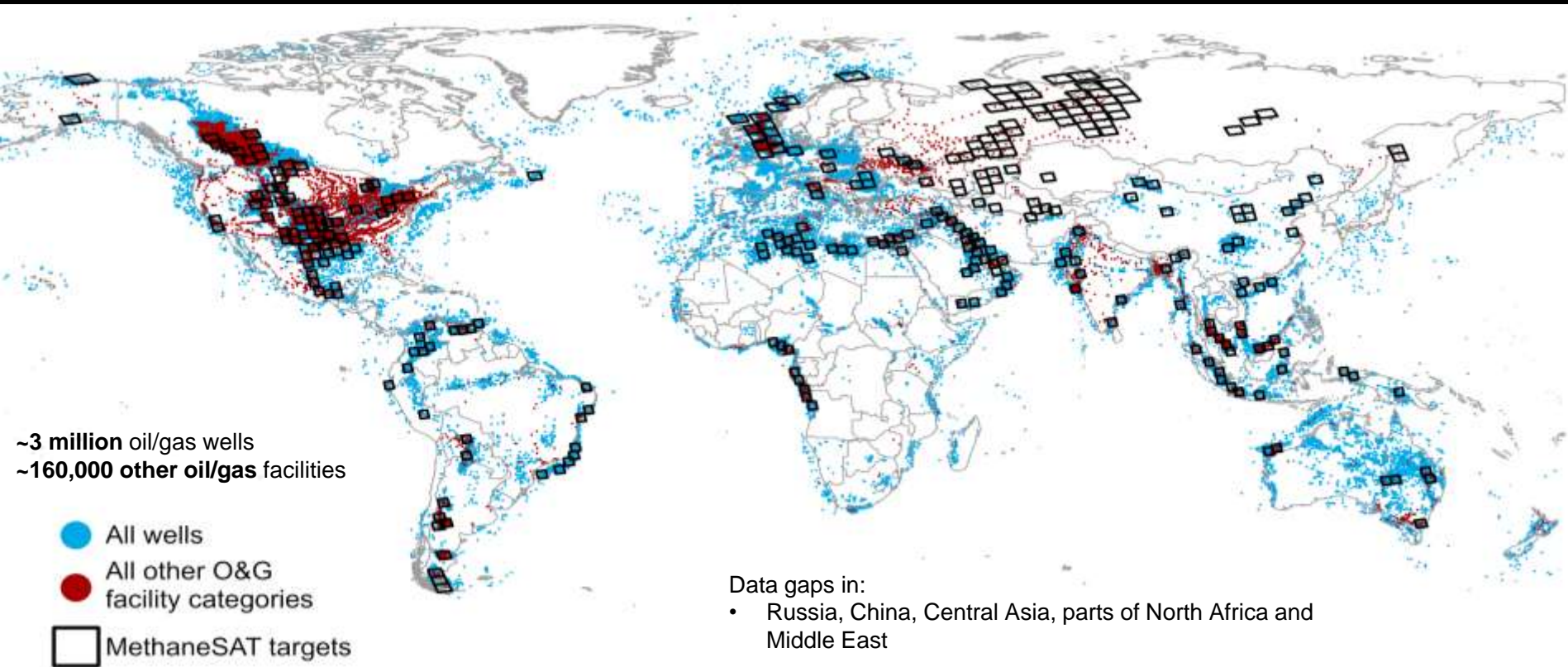
Each MethaneSAT target is ~200 km x 200 km

Total area covered is ~13 million sq. km.

Top-80% global production correspond to ~150 targets.

Top-90% global production correspond to ~300 targets

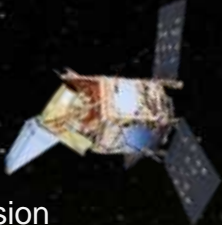


Current global oil/gas infrastructure data coverage

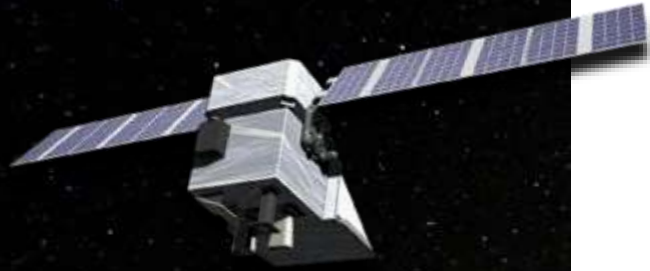


Basins within or surrounding Europe

Basin_Name	Oil & Gas production (kboed_2020)	%_Global_Producti on	Top 50%	Top 80%	Top 90%	Country	Onshore_Offsho re
Northern North Sea	3035.14672	1.80%	No	Yes	Yes	Norway; United Kingdom	Offshore
Precaspian	2526.361011	1.50%	No	Yes	Yes	Kazakhstan; Russian Federation	Offshore; Onshore
Volga - Urals	1931.898553	1.20%	No	Yes	Yes	Kazakhstan; Russian Federation	Onshore
Central Graben	949.1984809	0.60%	No	Yes	Yes	Denmark; Germany; Netherlands; Norway; United Kingdom	Offshore
Nile Delta	943.0573018	0.60%	No	Yes	Yes	Cyprus; Egypt; Greece	Offshore; Onshore
Voring	831.6748054	0.50%	No	Yes	Yes	Norway	Offshore
Southern North Sea - Anglo-Dutch	620.0651226	0.40%	No	No	Yes	Belgium; Germany; Netherlands; United Kingdom	Offshore; Onshore
Mangyshlak - Ustyurt	347.4882663	0.20%	No	No	Yes	Azerbaijan; Kazakhstan; Russian Federation; Turkmenistan; Uzbekistan	Offshore; Onshore

A Comparison of Methane Satellites

<p>Global mapping</p> <p>*7,000m x 5,500m pixels across 2,600km swath</p>	<p>Area mapping</p> <p>*100m x 400m pixels across 260km swath</p>	<p>Location mapping</p> <p>*50m x 50m pixels across 12km swath</p>
<ul style="list-style-type: none"> ✓ Global and large-scale regions ✓ Large point sources 	<ul style="list-style-type: none"> ✓ Area sources ✓ Point sources ✓ Sector-wide qualification 	<ul style="list-style-type: none"> ✓ Point sources
<p>TROPOMI* SCIAMACHY GOSAT</p>  <ul style="list-style-type: none"> • Moderate precision • Global mapping • Quantify large-scale regions • Quantify very large-point sources • Guidance from other satellites to interpret point-source emissions 	<p>MethaneSAT*</p>  <ul style="list-style-type: none"> • High precision • Detect and quantify area sources • Sector-wide quantification • Detect and quantify high-emitting point sources • Fills observing and data gaps between location and global mapping missions 	<p>GHGSat* Carbon Mapper Satlantis</p>  <ul style="list-style-type: none"> • Low precision • Detect and quantify moderately high-emitting point sources • Guidance from other satellites to inform target acquisition



Different Tools Working Together

Information from different satellites will be available in different ways at different times for different users. Some information will be public, some proprietary.

Stakeholders can use data from different satellites to develop a fuller, more comprehensive understanding of the emissions landscape, or to cross-check their findings.

- They might combine measurements from a point-source instrument like **Carbon Mapper** with the more sensitive data and wider coverage of **MethaneSAT**.
- Daily global coverage offered by **TROPOMI** will be a useful way to spot high emission events, and as a tool to look for possible targets for other satellites.

"A tiered remote sensing approach using satellite, airborne and ground-based sensors can improve local, regional and international understanding of GHG emission sources."

- World Economic Forum