MethaneSAT

Designed to facilitate Climate Action

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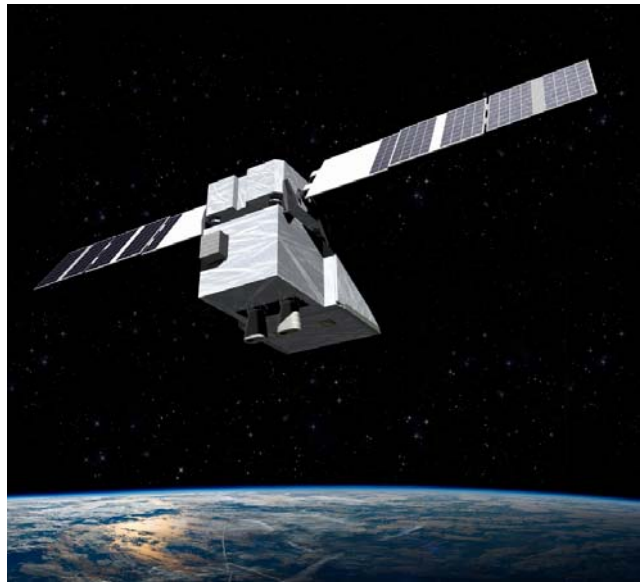


2nd
largest contributor to global warming

> 25%
of current gross warming

1 °C
additional warming in 2100 if no action

Sources: Myhre et al. 2013
Ocko et al. ERL 2021

What is the purpose of MethaneSAT?

- **Motivate countries and** companies to reduce methane pollution
- Make the full extent of the problem (anthropogenic methane emissions) **apparent, unavoidable, and actionable**
- **Launch a new, low-cost, purpose-built satellite** that will map and measure oil and gas methane emissions worldwide
- Potential to **assess emissions** from the full range of man-made sources

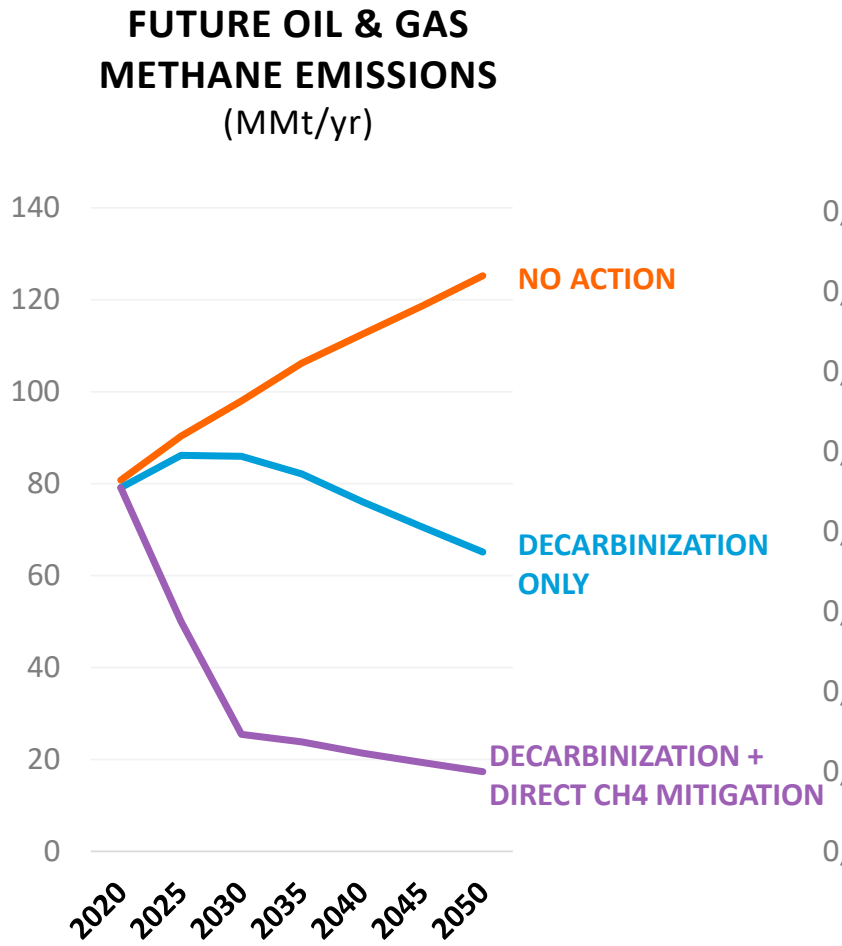
MethaneSAT Mission

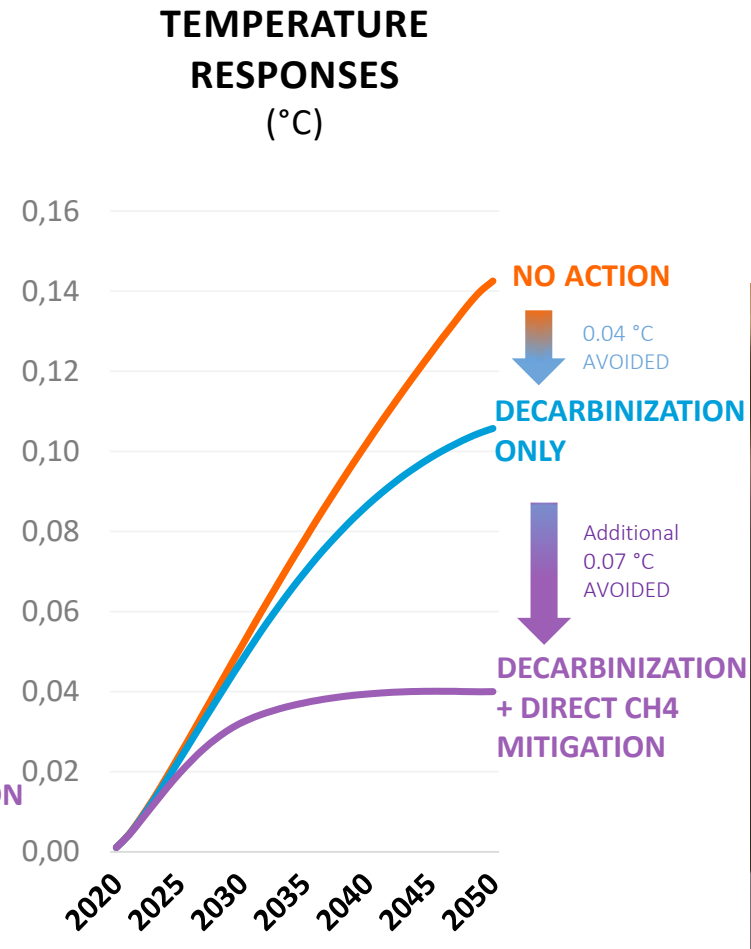
- Primary Mission Objective
  - Provide the data needed to enable a 45% reduction in CH_4 emissions from oil & gas production regions by 2025
- Mission Overview
  - Regular monitoring of regions accounting for > 80% of global oil & gas production
  - Designed to detect, quantify, and track ***area emission*** rates as well as from ***point sources***
  - Targeting satellite in sun-synchronous orbit
  - Passed CDR June 2020; Launch ready by Q4 2022
  - Flux data product publicly available free of charge
  - All Data products freely available to the larger science community
  - Comprehensive advocacy campaign

MethaneSAT℠

EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

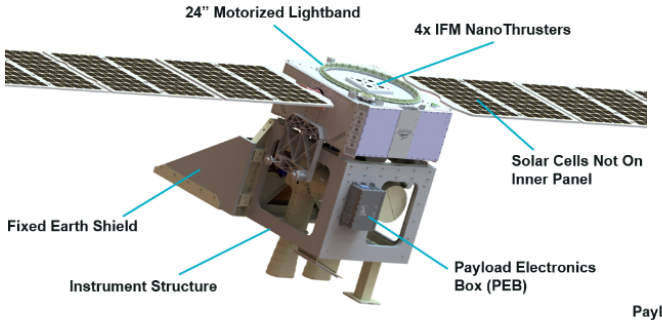
Relying on methane reduced from decarbonization is not enough

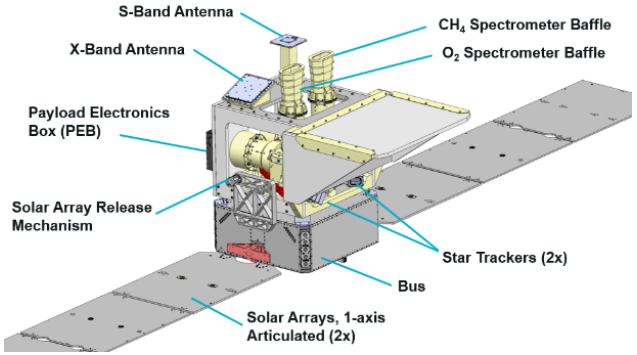




Source: Zavala-Araiza et al. in prep

MethaneSAT Mission





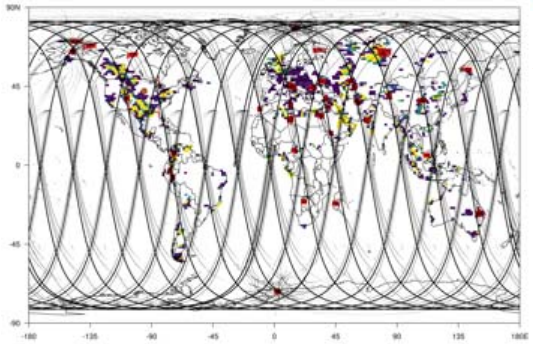
- Two imaging spectrometers by Ball Aerospace
- Saturn-class spacecraft bus by Blue Canyon Technologies
- Primary science teams at Harvard, SAO, EDF

MethaneSAT Specifications	
Orbit altitude (km)	~585
Field of view (deg)	21.0
Swath width @ nadir (km)	~210
Spatial resolution @ nadir (m)	~100 x 400
O_2 passband (nm)	1249-1305
O_2 sampling / resolution (nm)	0.1 / 0.3
CH_4 passpand (nm)	1605-1683
CH_4 sampling / resolution (nm)	0.1 / 0.3
Daily target collects (200km x 200km)	30 - 40

MethaneSAT is designed to fill current critical data and observing gaps with respect to quantification of total methane emissions across geographies, spatial resolution and detection threshold

MethaneSAT℠

New Zealand Team Leads MethaneSAT Mission Operations

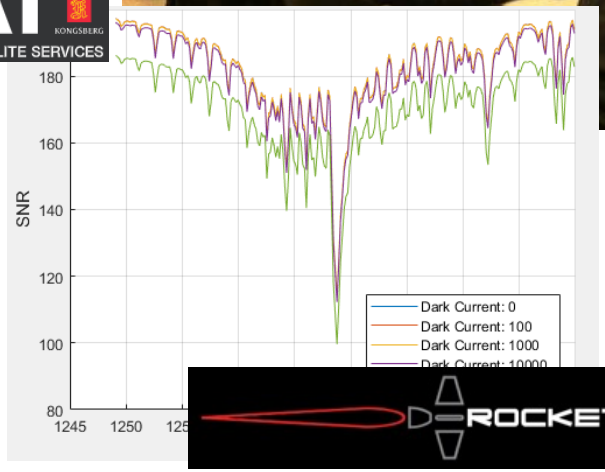


▲ International Ground Station Network

◀ Mission Planning

▶ University Hosted Mission Control

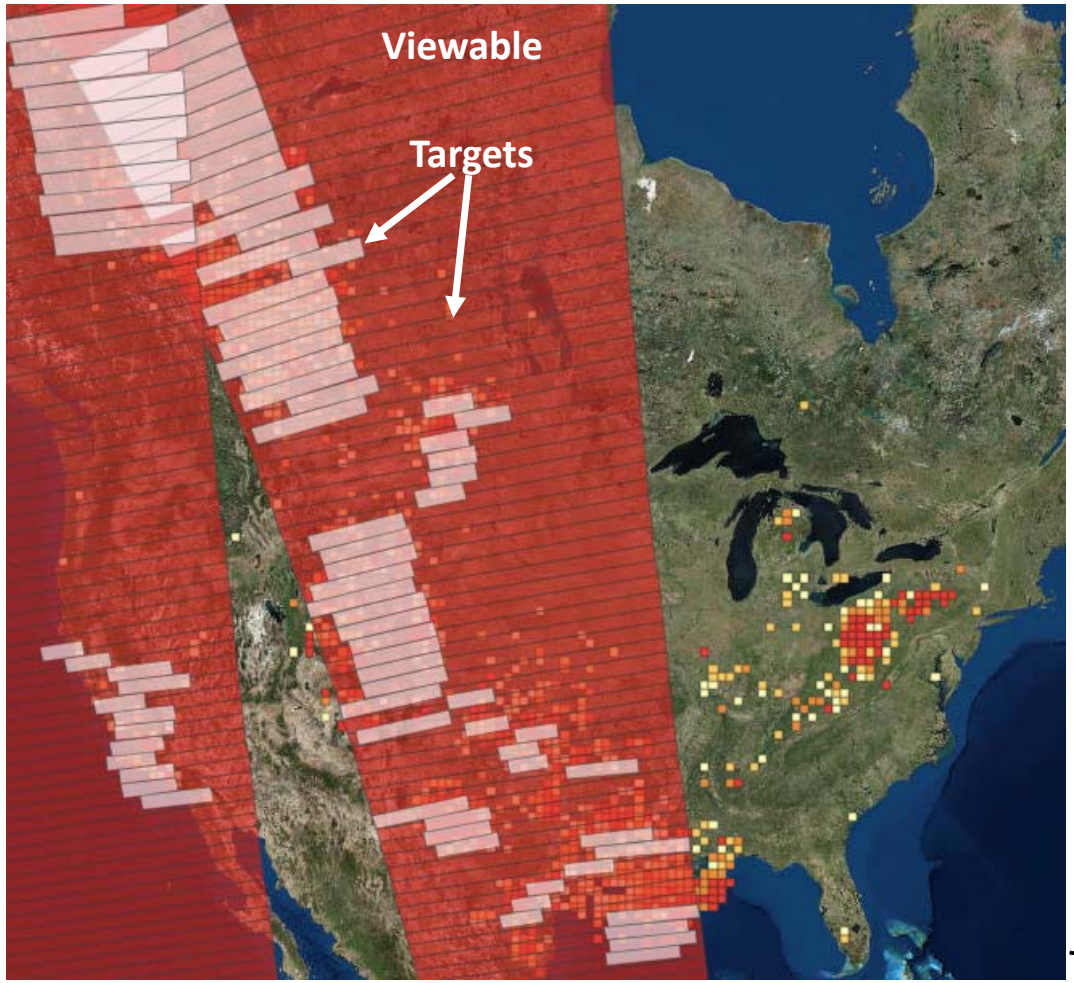
KSAT KONGSBERG SATELLITE SERVICES



◀ Agriculture Science

ROCKET LAB

Defined targets and viewable swath ~200 km from MethaneSAT



Width of CONUS: 4300 km

Viewable Width ca. 1060 km

CONUS Viewable daily: ca. 2000 km

~100 targets/day

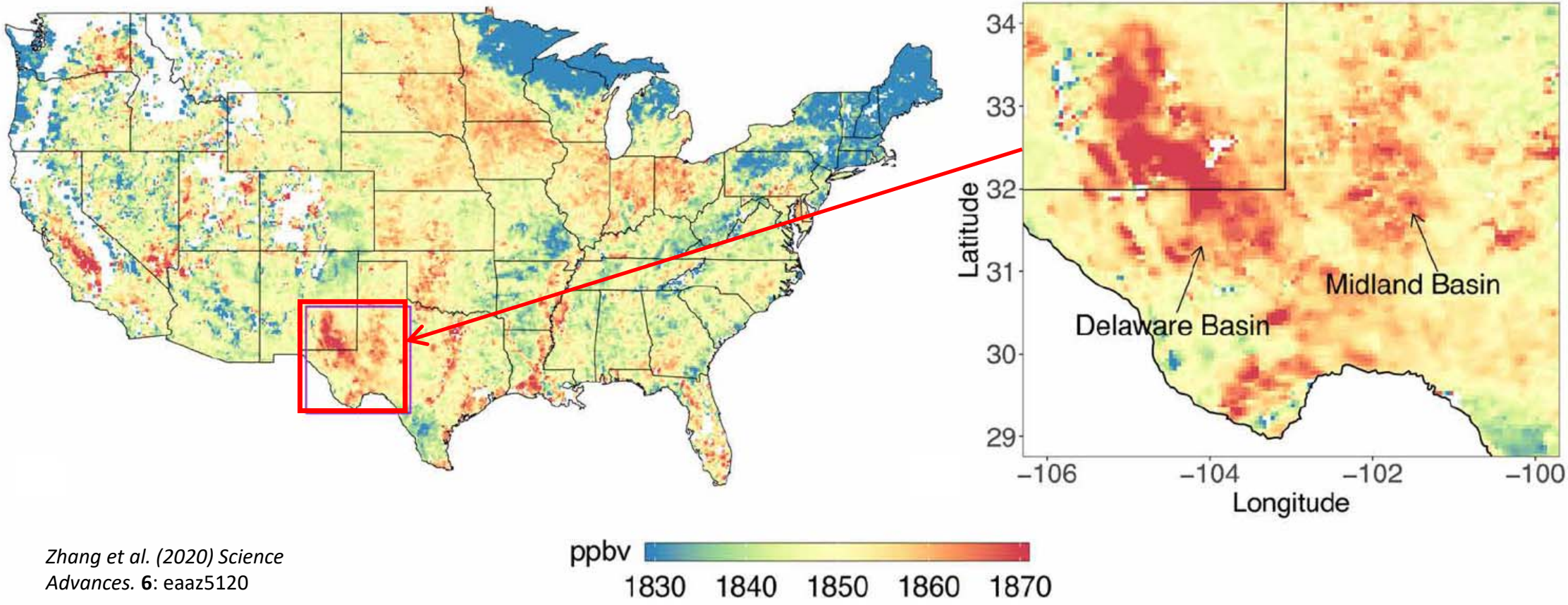
Josh Benmergui/Harvard

MethaneSAT℠

4-Phase Data Processing & Delivery

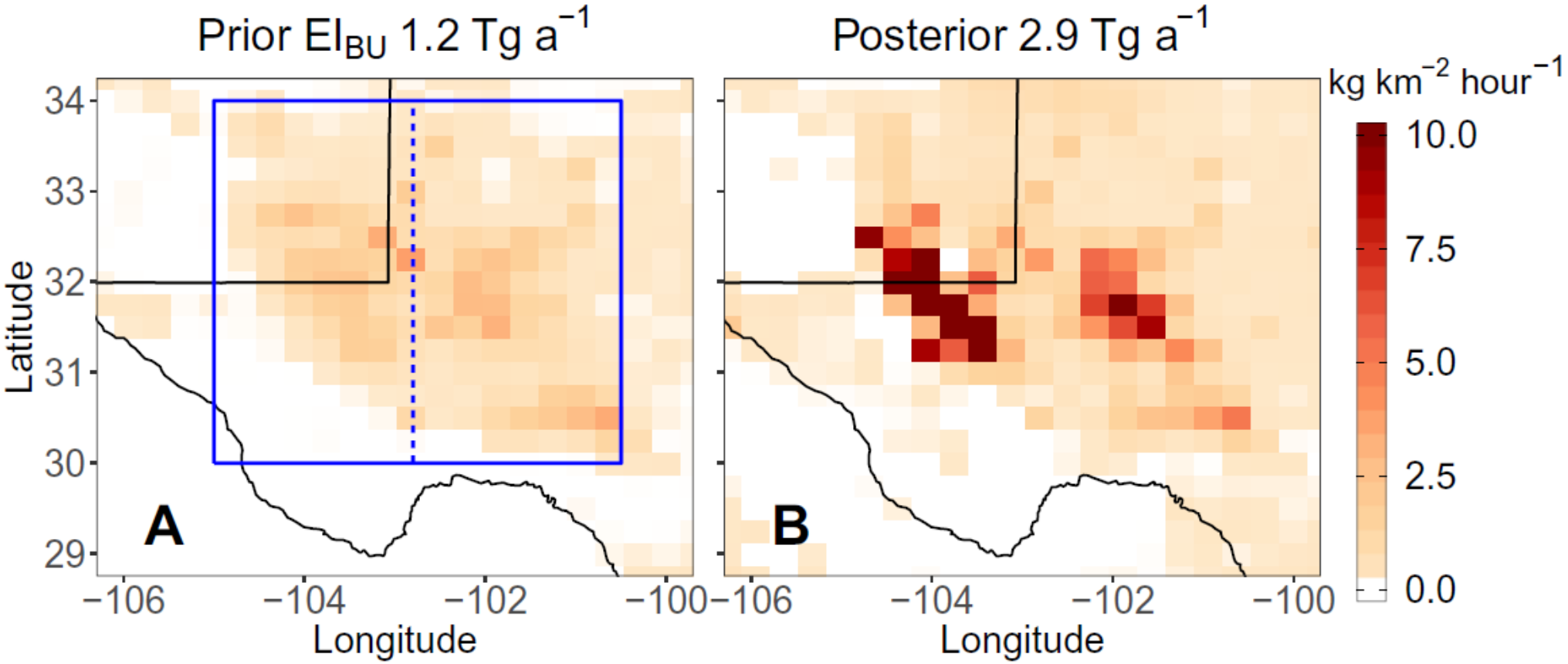
Recent satellite observations reveal the Permian methane hotspot

TROPOMI methane data averaged from May 2018 – March 2019



Zhang et al. (2020) Science Advances. **6**: eaaz5120

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



Measuring Methane emissions from Space

- Types of Instruments
  - Mapper
  - Target
  - Hybrid – Mapper/target
- Types of Data
  - Radiance Spectra
  - Atmospheric column methane concentrations
  - Geographically defined methane flux rates
- Data characteristics
  - Swath width
  - Spatial pixel size
  - **Precision**
  - Pixel size + Precision = **Detection Threshold** (what proportion of emissions can be detected)

Key attributes of an effective ecosystem of satellite remote sensing of methane emissions

- Global coverage
- Rapid repeat measurement
- Detect total emissions
- Identify and quantify point source emissions
- Spatial emission patterns
- Track trends in emissions over time

Key attributes of satellite remote sensing of methane emissions

- Global coverage – Mapper/Target
- Rapid repeat measurement - Mapper/Target
- Detect total emissions - Mapper
- Identify and quantify point source emissions – Target/ Mapper for larger point sources
- Spatial emission patterns - Mapper
- Track trends in emissions over time - Mapper

MethaneSAT Mission Objectives

Quantify total CH_4 emissions (incl. diffuse) for global O & G regions, with quantitative heat maps of emissions

- ***Area diffuse sources*** ***~ 2 - 5 kg/hr/km²***
- **Attribute Emissions to facilities or clusters**
  - ***Point sources*** ***emitting >1000 kg/hr per image. Lower threshold for attribution of selected targets/special viewing geometries;***
  - ***Persistent sources*** ***<< 500 kg/hr with 10-20 images.***
- ***200 priority targets observed 10-20 times/year***
  - **80 – 120 "scenes‡" acquired/day, 1–3 "scenes" = 1 target**
- ***Other types of targets in the overall mission***

‡A "scene" defined as 10s of data (70 km along track).
*Lower thresholds for selected targets in special viewing geometry

Satellites Are *Complementary* For Tackling Global Methane Emissions

Instrument	Dates operational	Grid size (subgrid pixel) (km2)	Swath (km)	Precision (ppbv)
MethaneSAT	**2022**	**1.4 × 1.4 (0.1 x 0.4 raw)**	**200±**	**2-3***
GHGSat	2016 -	0.025 x 0.025	12 x 12	~50
TROPOMI	2017-	7 × 7	2600	~11
GOSAT-2	2018 -	10 km dia., single	Sparse	~8
GeoCARB	2022 -	3 × 6	2800	~18
Carbon Mapper	2023 -	0.03 x 0.03	18	~30

* Gradient measured over 10 – 100 km length scales.