CARBON MAPPER

*Making Emissions Data Actionable and Accessible*

# Global Distributions of Super-Emitting Methane Sources

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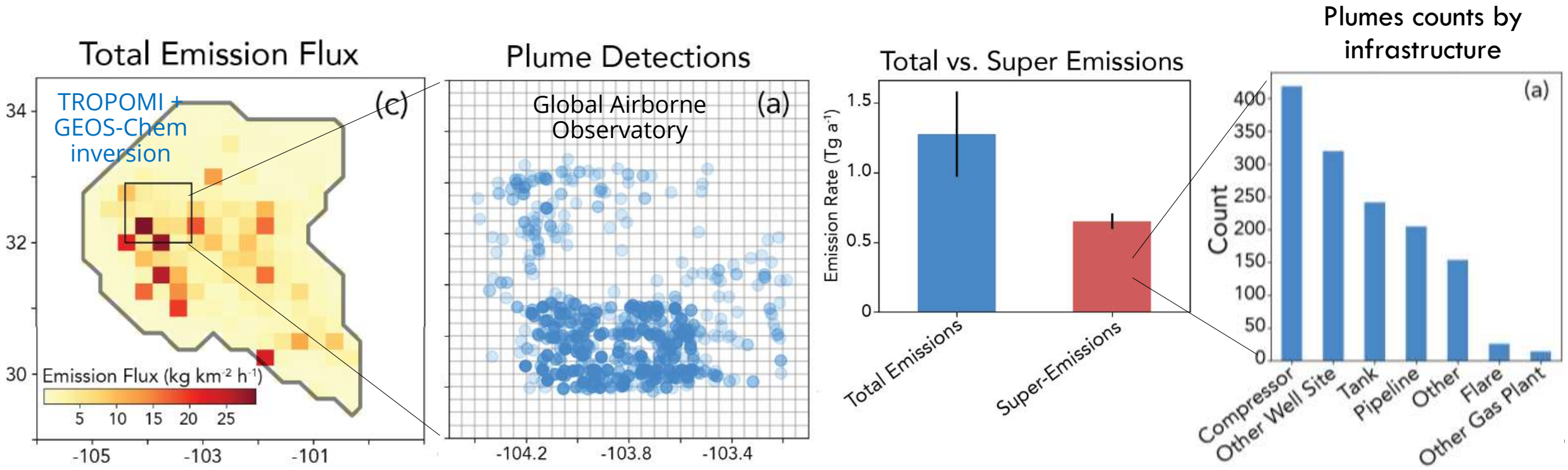
IWGGMS-21
June 10, 2025

# Understanding emissions at basin scales: total flux, super-emitters, attributed datasets

Prototype 2024 airborne + satellite study in Permian Basin, TX




Cusworth et al. (in review)

**Intensity + infrastructure + operator attribution provides a pathway for mitigation**

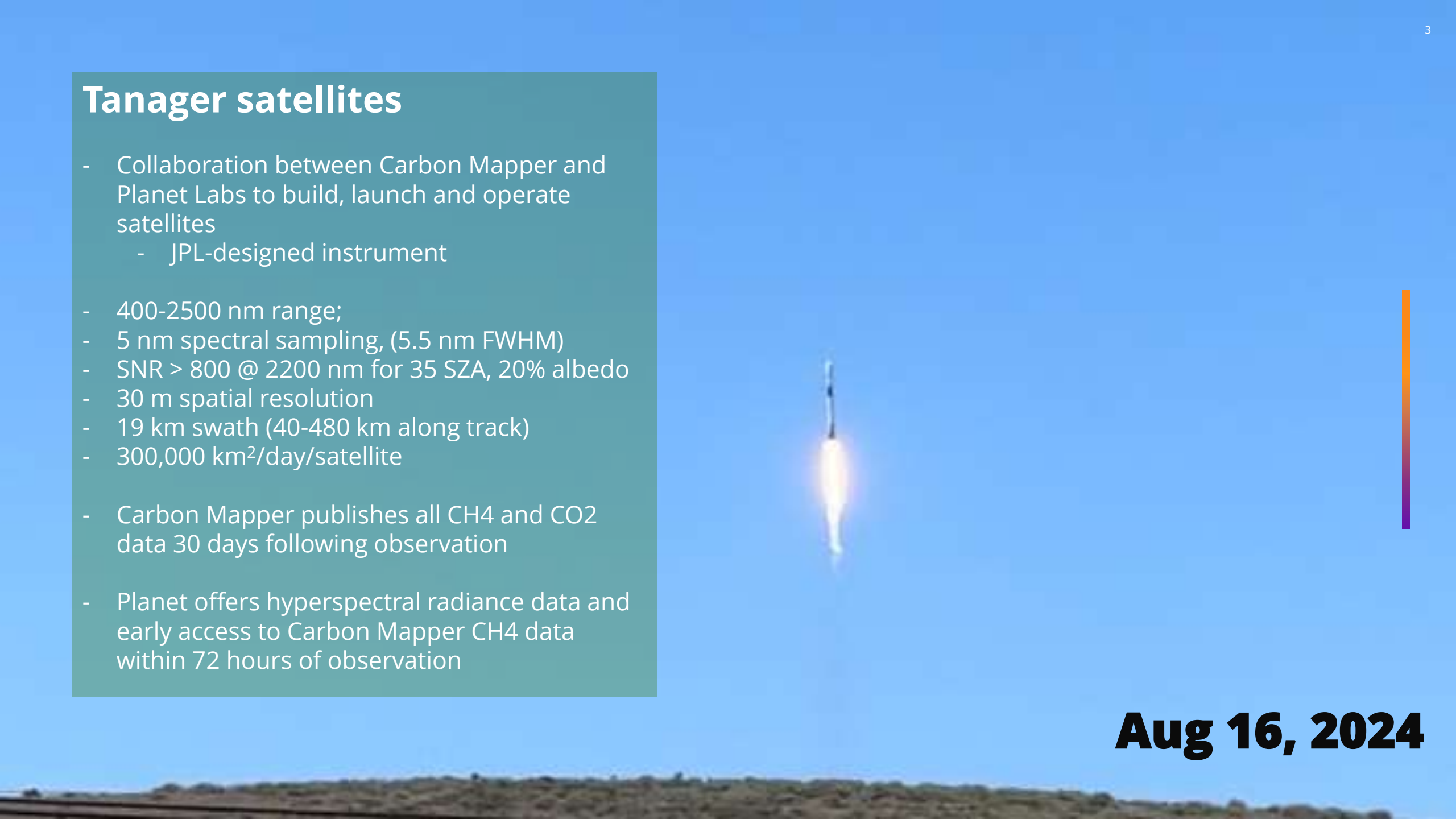
# Tanager satellites

- Collaboration between Carbon Mapper and Planet Labs to build, launch and operate satellites
  - JPL-designed instrument

- 400-2500 nm range;
- 5 nm spectral sampling, (5.5 nm FWHM)
- SNR > 800 @ 2200 nm for 35 SZA, 20% albedo
- 30 m spatial resolution
- 19 km swath (40-480 km along track)
- 300,000 $km^2$/day/satellite

- Carbon Mapper publishes all CH4 and CO2 data 30 days following observation

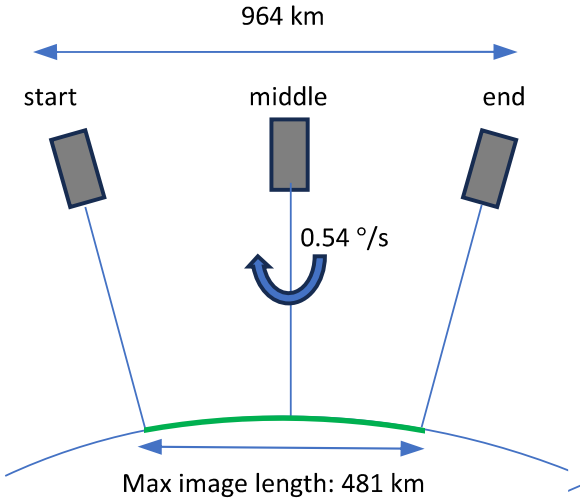
- Planet offers hyperspectral radiance data and early access to Carbon Mapper CH4 data within 72 hours of observation



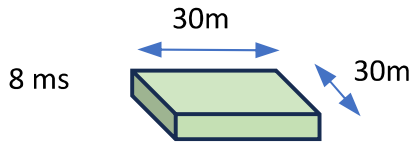
**Aug 16, 2024**

# Tanager-1 employs multiple imaging modes to trade between spatial coverage vs. detection sensitivity

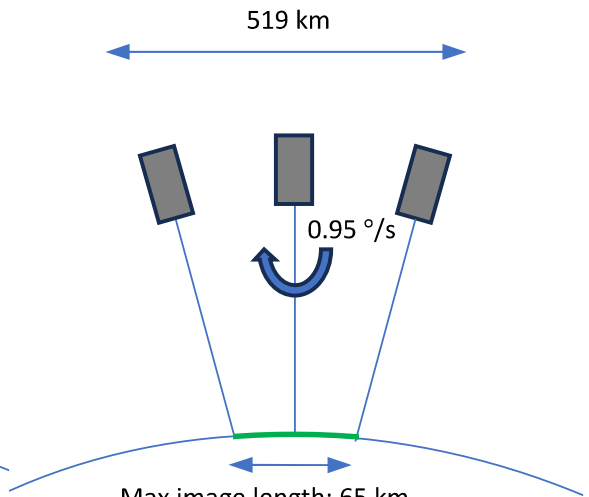
## Standard Sensitivity



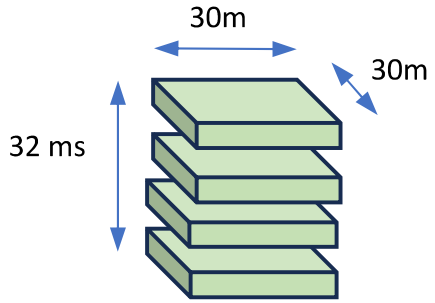

Max image length: 481 km
Max image duration: 126 s
Scan rate: 3.8 km/s



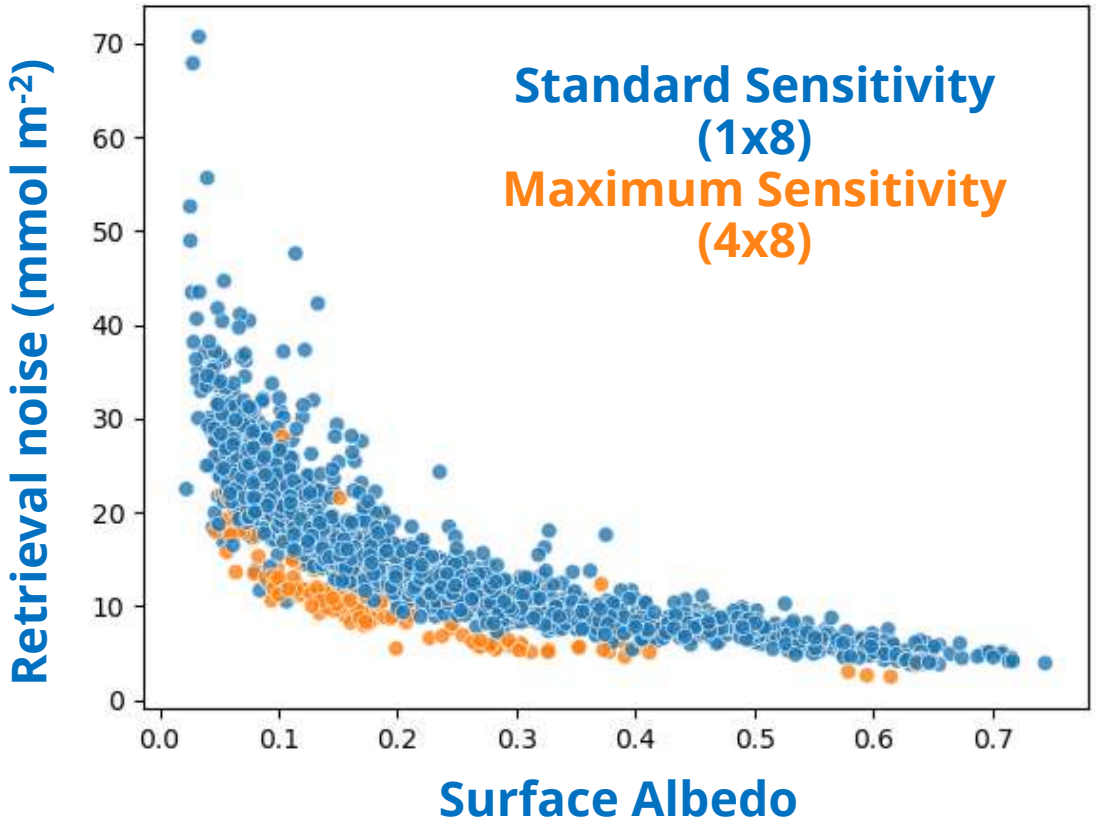

## Maximum Sensitivity




Max image length: 65 km
Max image duration: 68 s
Scan rate: 0.96 km/s




## CH4 retrieval noise by imaging mode & surface albedo



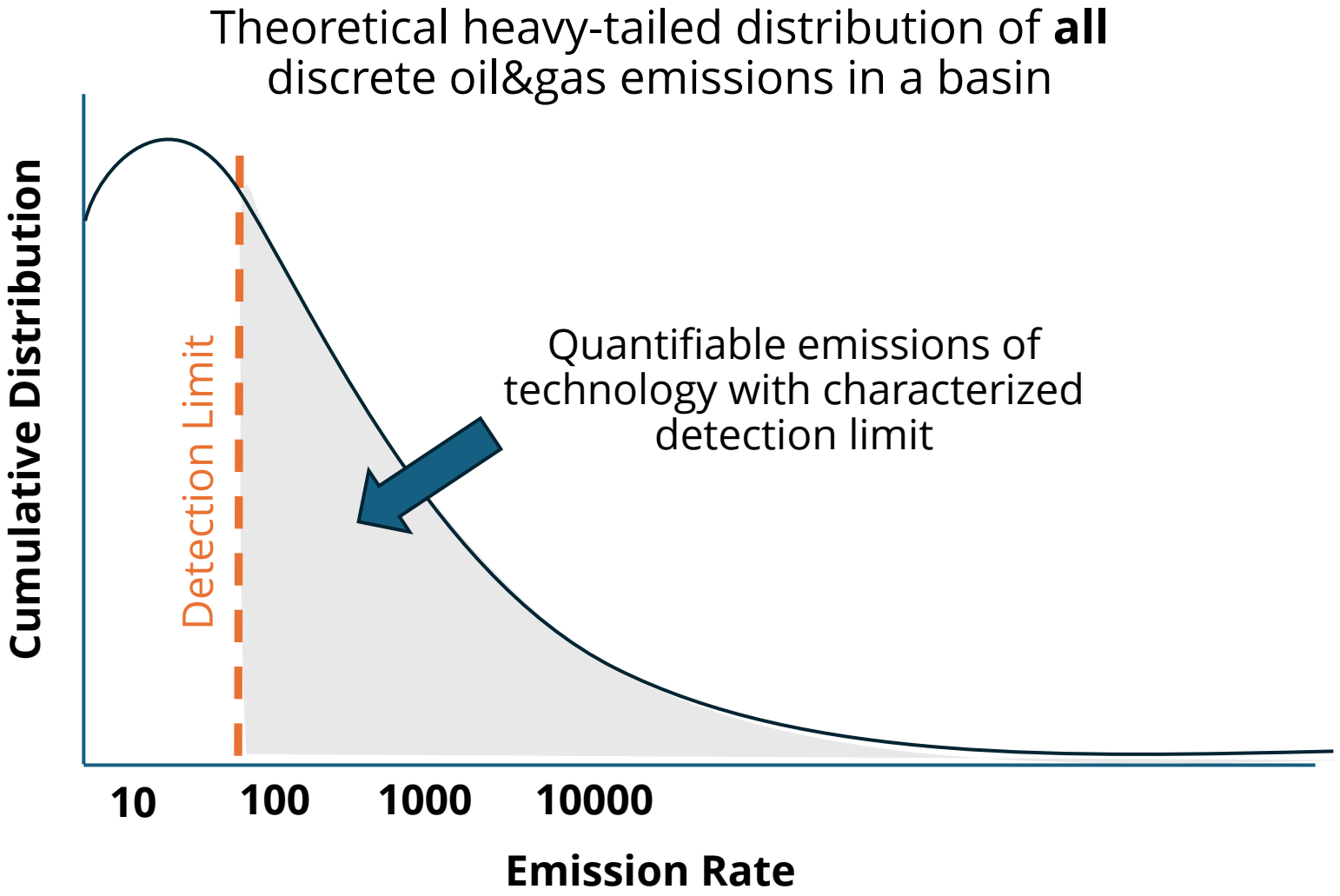
# Towards a Global Baseline of Large Emission Sources.


Aim to observe 50%+ of productions across major oil&gas basins quarterly in 2025-2026

Routine sampling of priority landfills to improve modeling/reporting

Observe all major underground coal ventilation shafts to improve emission factors.

# Quantifying emission "completeness": detection sensitivity + spatiotemporal revisit




Probabilistic detection limits tell you how much of the distribution of emission distribution you could see given sufficient spatiotemporal sampling

**Retrieval precision ≠ probabilistic detection limit**

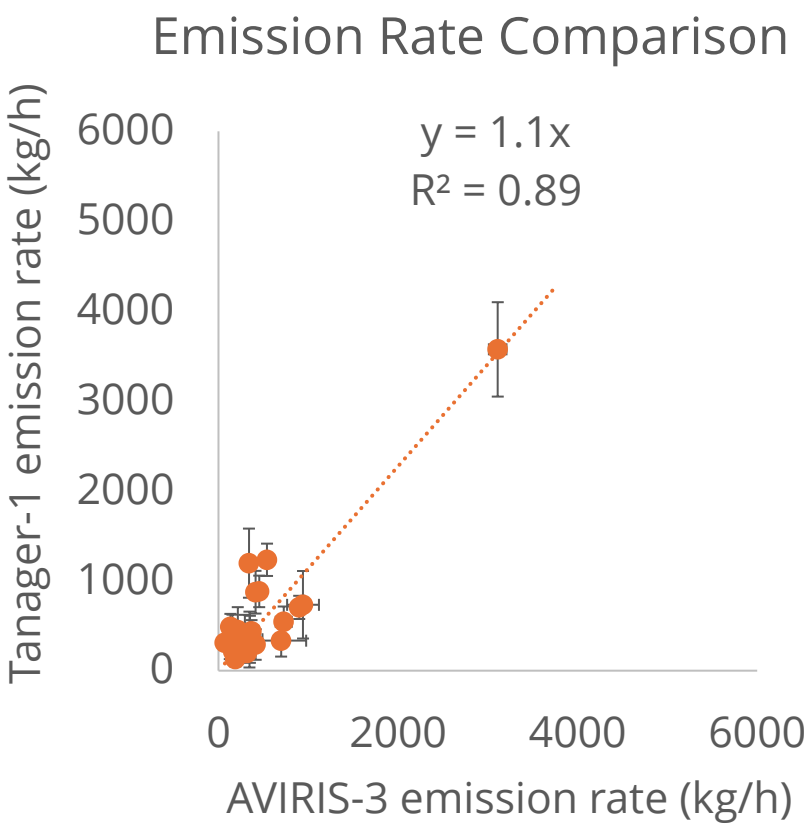
# Characterizing 1x8 detection limits through coordinated observations

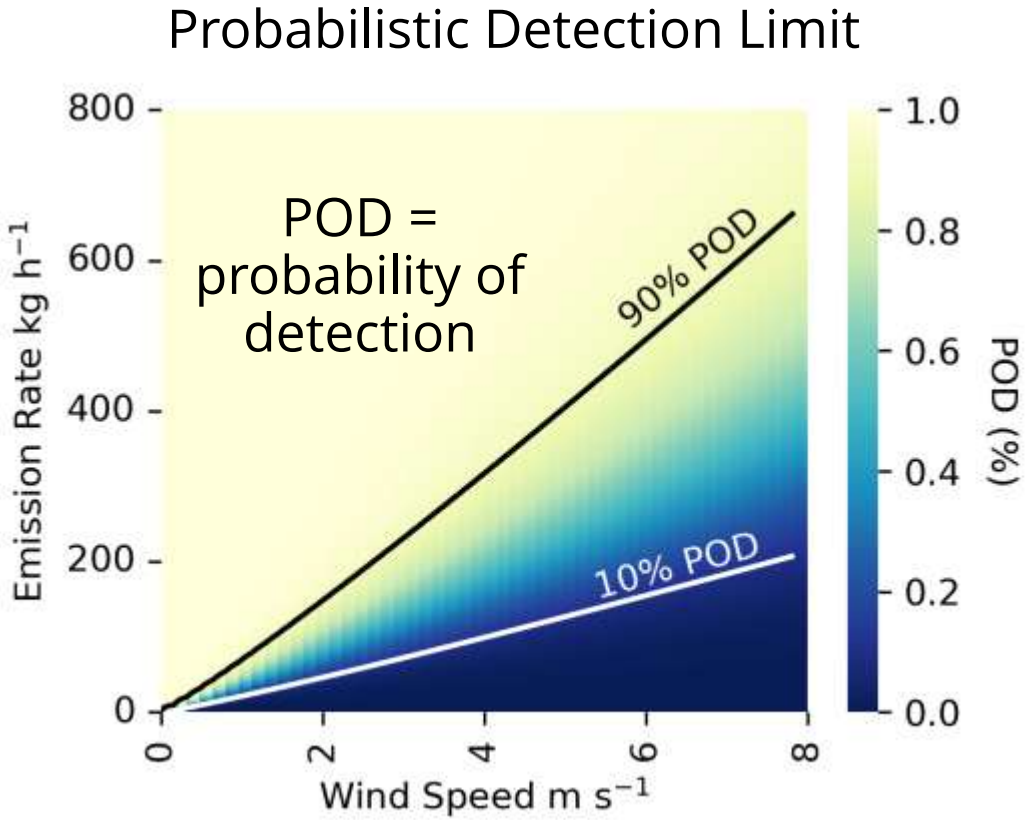
## Fall 2024 field campaign Tanager and AVIRIS-3 (Permian, TX)

86 Plumes detected by AVIRIS within minutes of Tanager overpass

33 Tanager Detections

53 Tanager non-detections

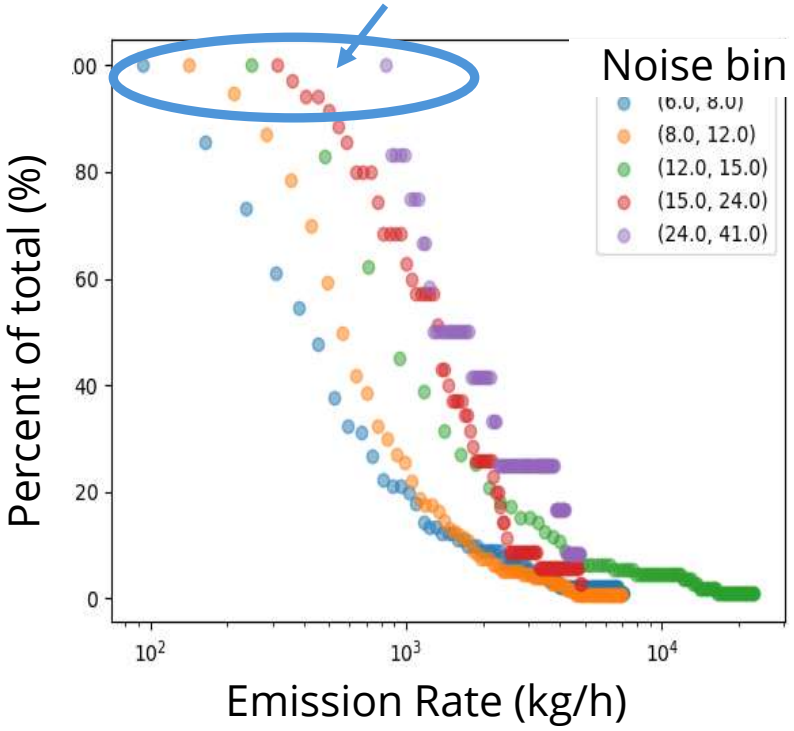


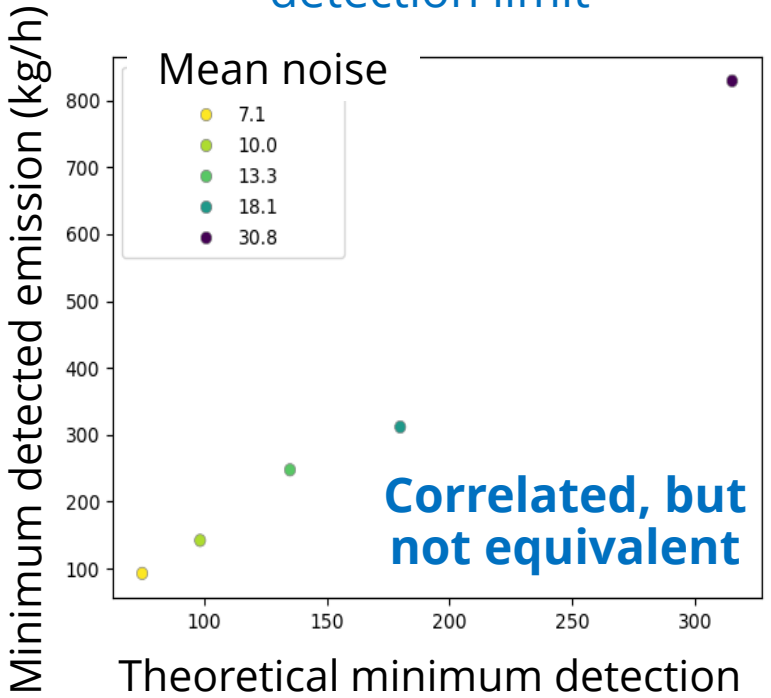

$$P = 1 - (1 + (x^2))^{-1.5}$$ where $$x = \Phi_7 * \frac{(Q - \Phi_1)^{\Phi_3}}{(h)^{\Phi_5 *}(U - \Phi_2)^{\Phi_6}}$$

# Estimation of detection limit in other regions

**Step 1**: quantify minimum "detected" emission across several noise bins

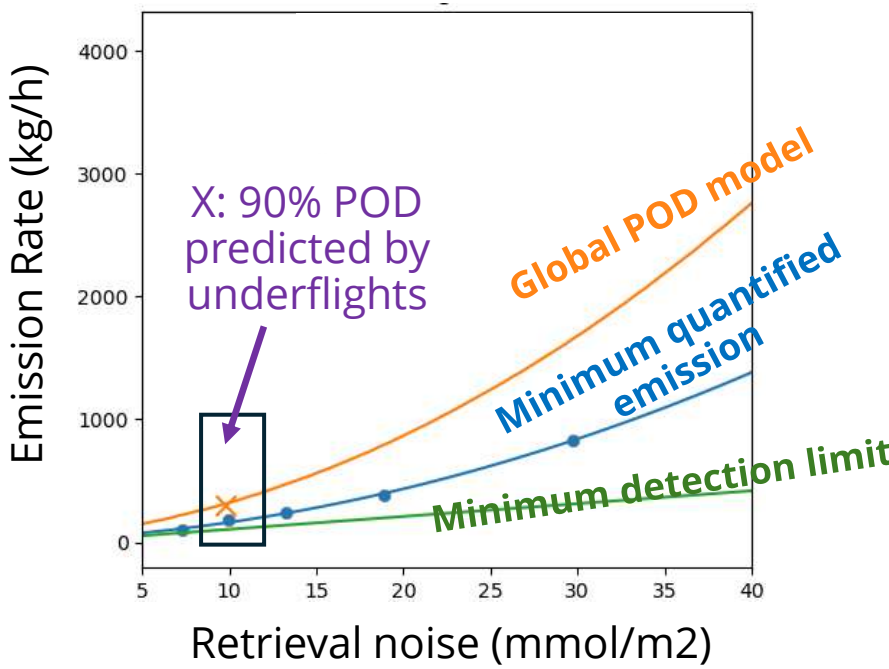



**Step 2**: Evaluate relationship between minimum detection and theoretical minimum detection limit



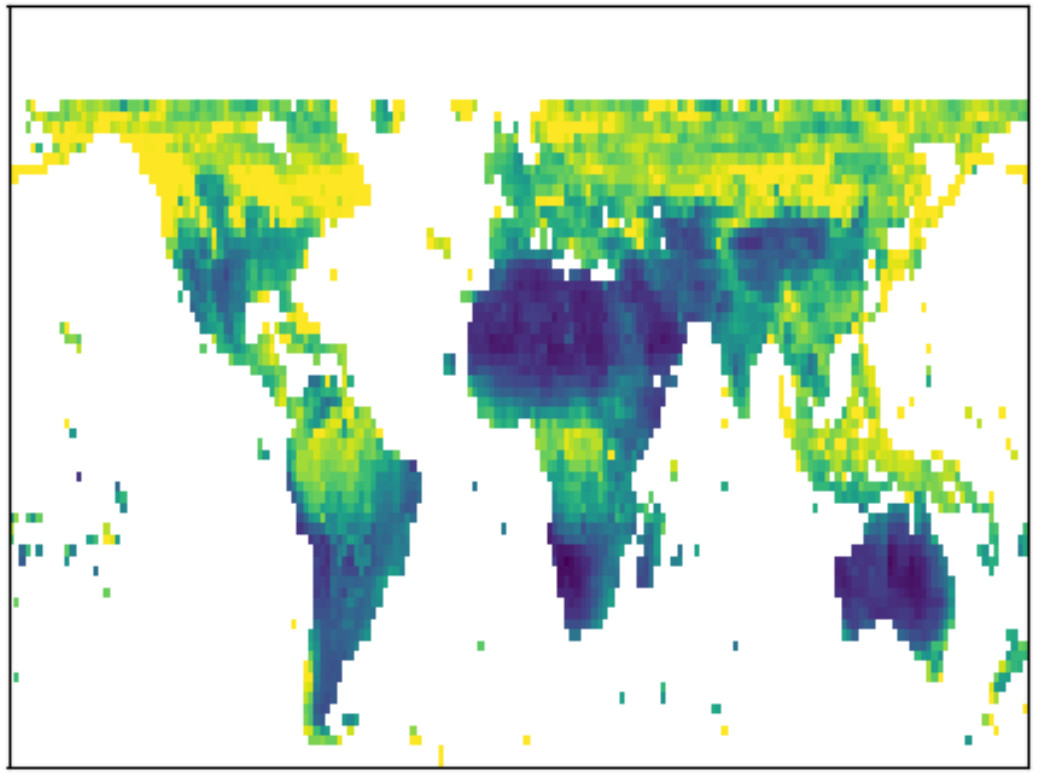

Theoretical minimum detection limit (kg/h) derived using retrieval precision + mass balance

**Step 3**: Derive global POD model by scaling against field-derived POD model

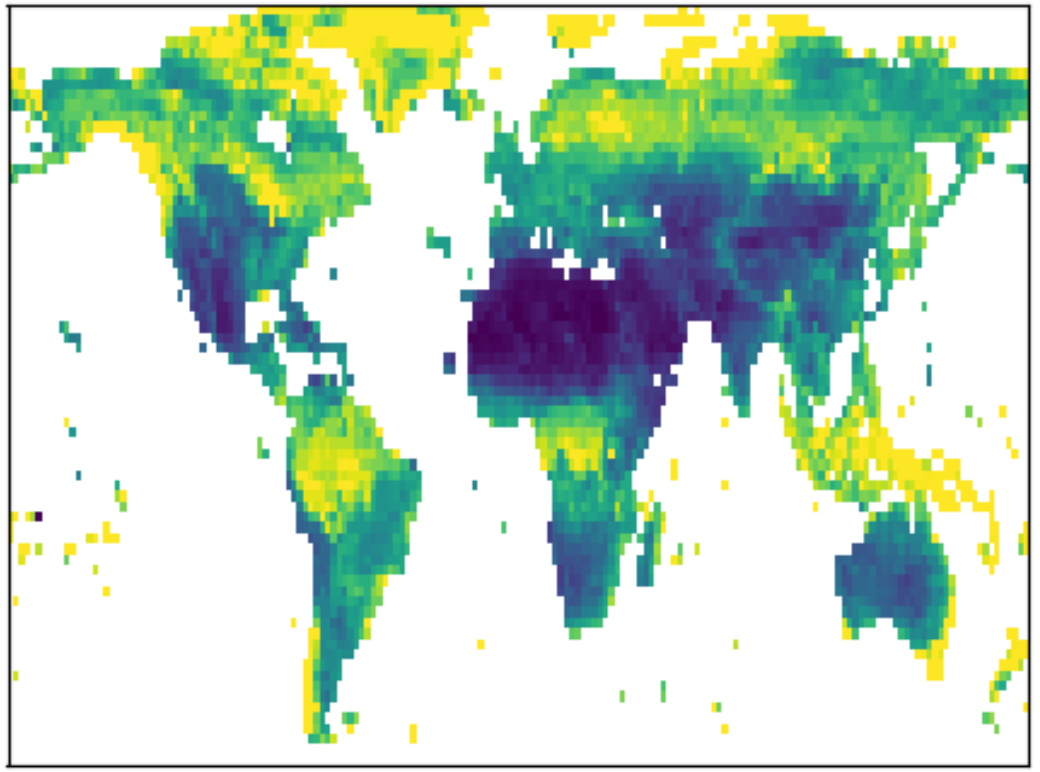


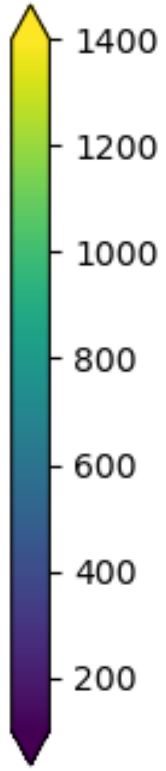
# Estimate of 90% probabilistic detection for Tanager (1x8 mode)

## January 90% POD Prediction



## June 90% POD Prediction

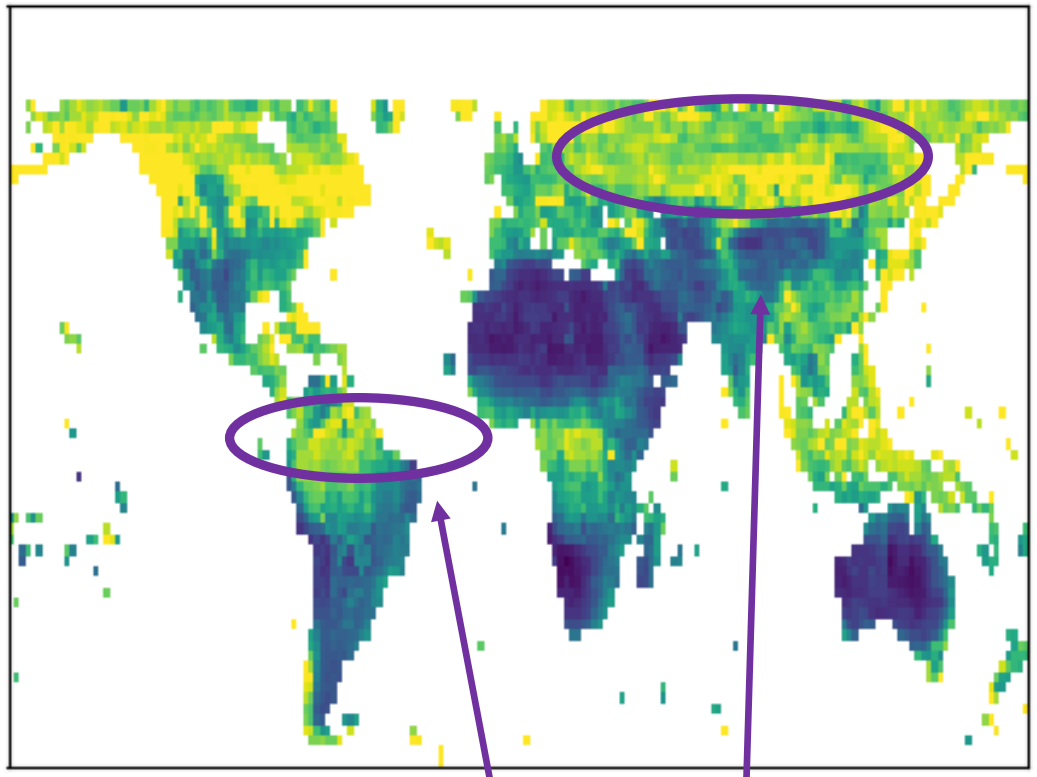





Predicted 90% Detection Limit (kg/h)

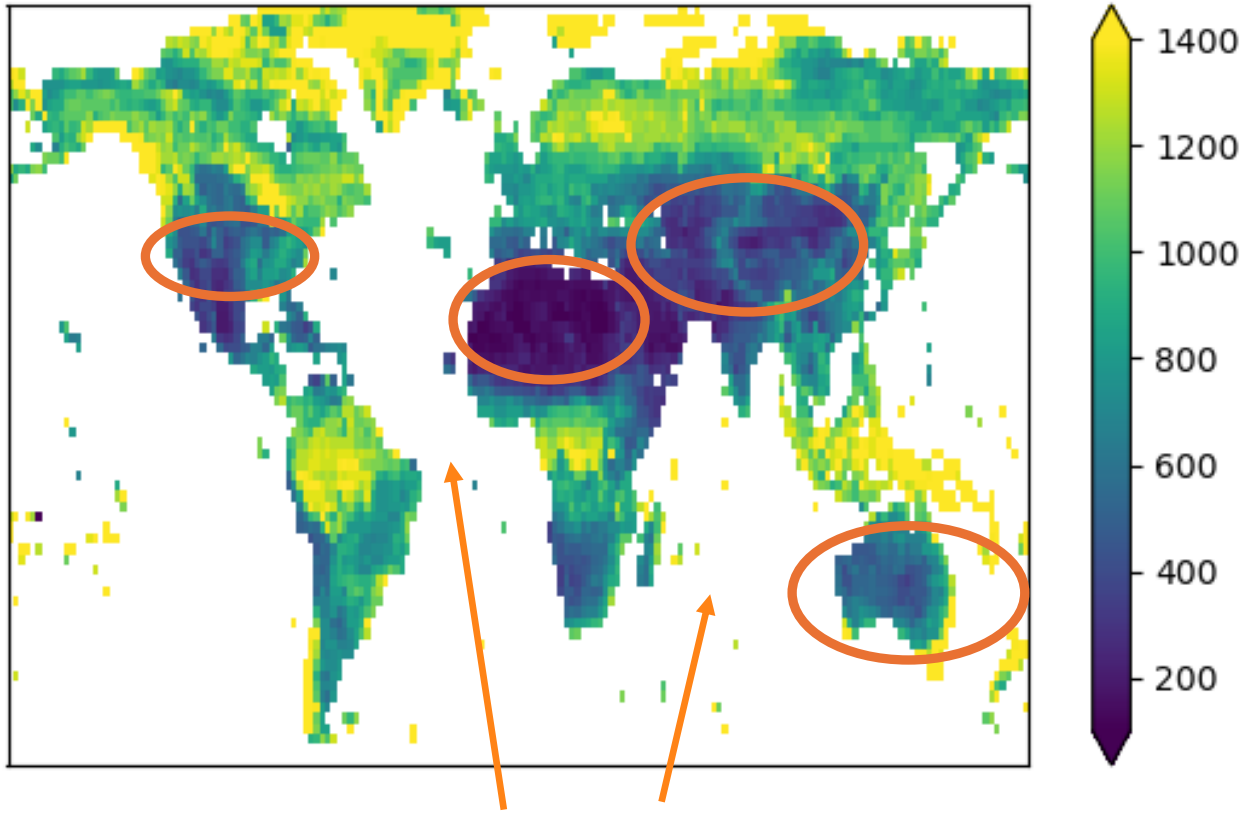
# Estimate of 90% probabilistic detection for Tanager (1x8 mode)

## January 90% POD Prediction



Even in challenging regions (sub-artic, tropic), expect reliable detection to class of super-emitters

## June 90% POD Prediction

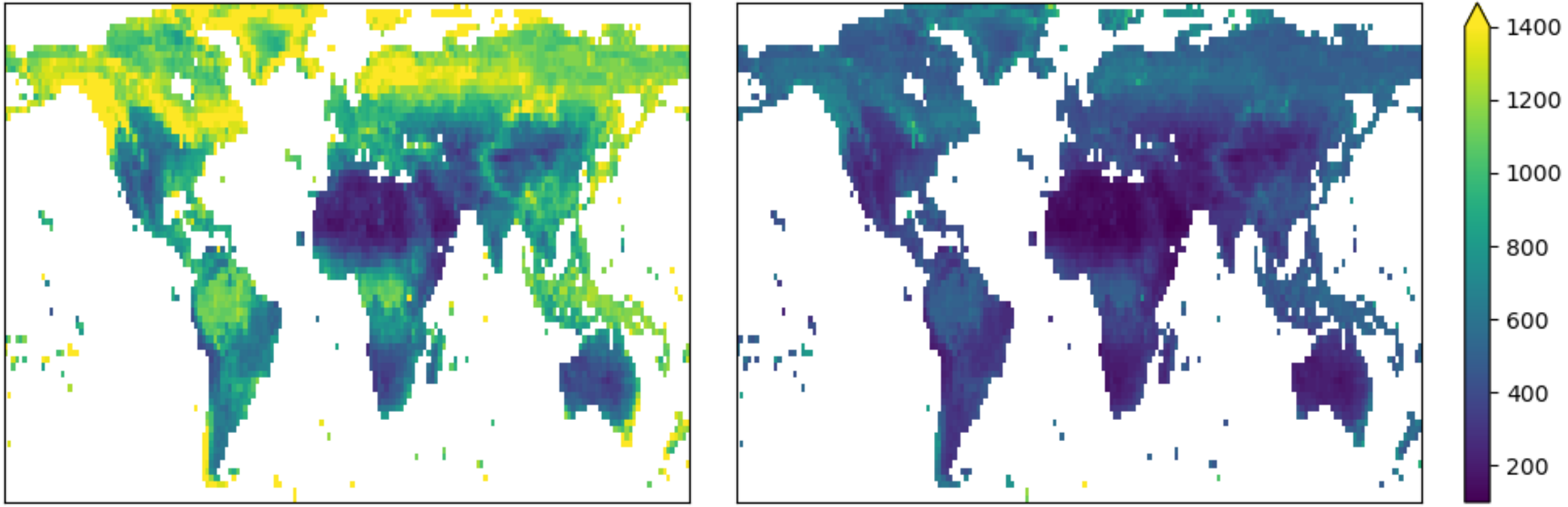



Anticipate reliable detection to most/all super-emitters across multiple oil&gas basins globally throughout year in **lowest sensitivity** mode

# Improvement of detection limit by imaging mode (annual average)

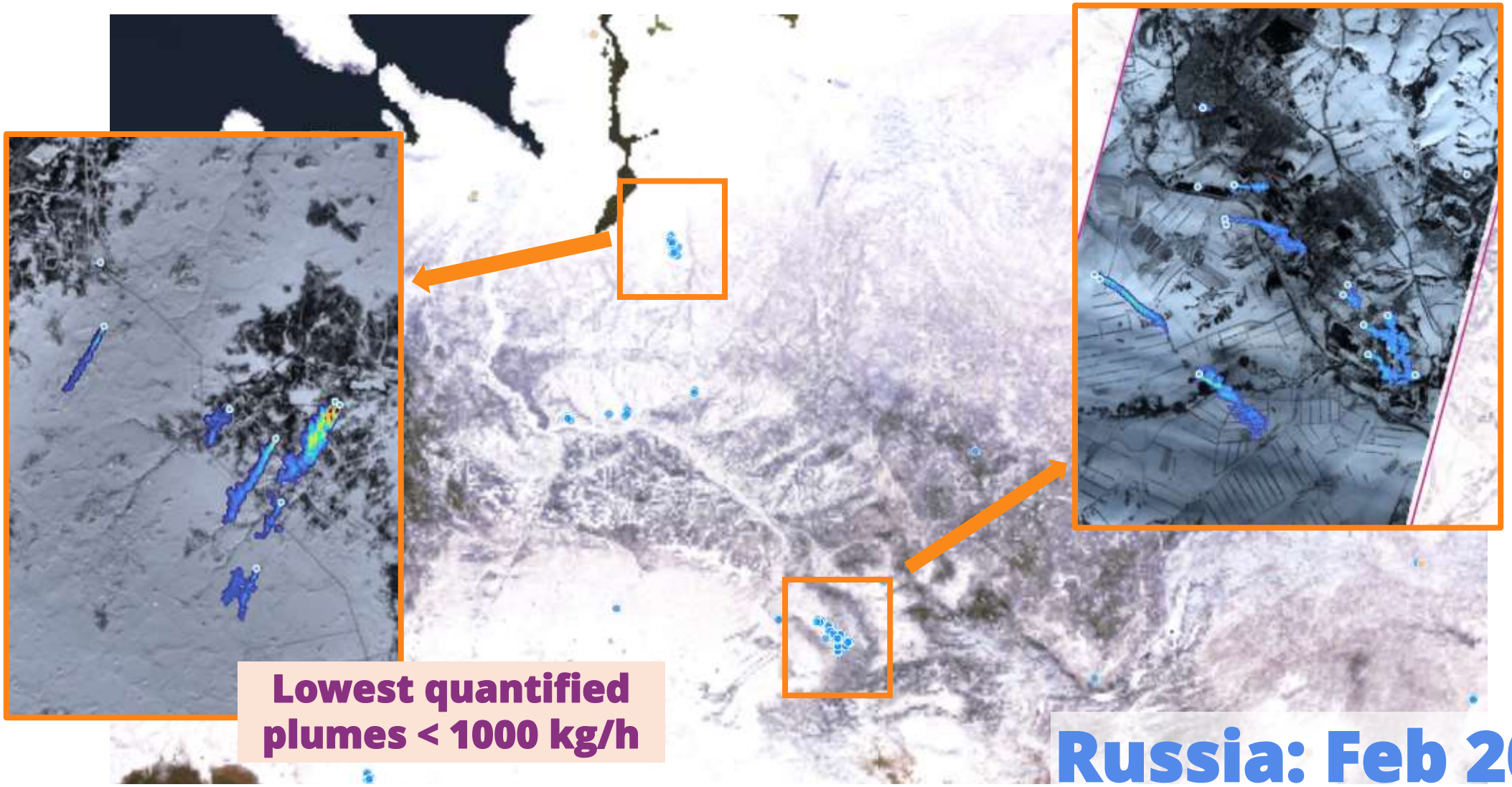
## 1x8 Standard Sensitivity

## 4x8 Maximum Sensitivity




Better than 1000 kg/h nearly everywhere at higher sensitivity mode

# Plumes detected north of 60 degrees consistent with detection limit estimates

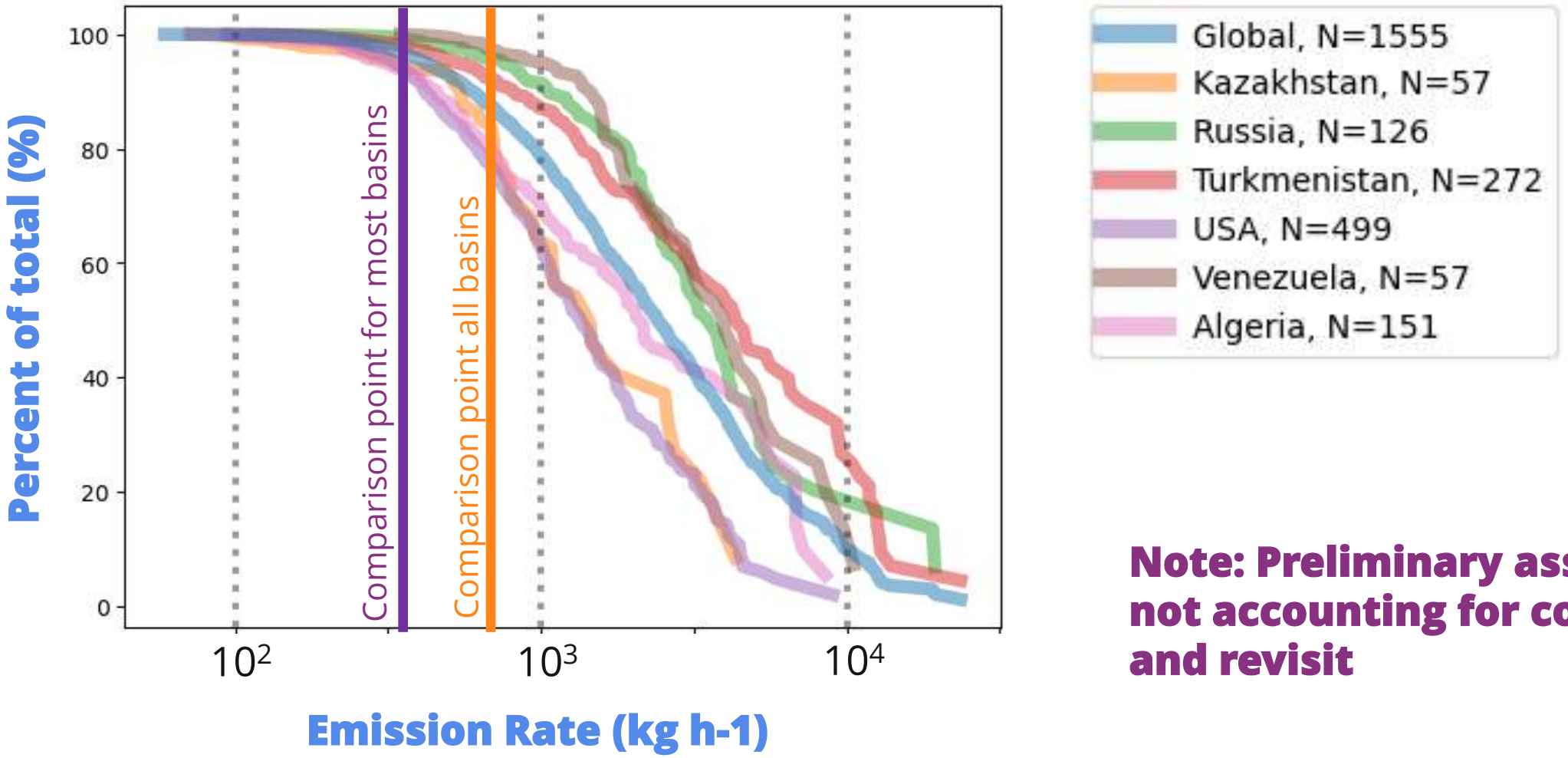


Lowest quantified plumes < 1000 kg/h

Russia: Feb 2025

# Starting to piece together onshore distributions of emissions by country/basin

## Preliminary Oil & Gas emission distributions




**Note: Preliminary assessment, not accounting for coverage and revisit**

# CONTACT INFO

**We love hearing from you! If you have questions or comments, please reach out.**

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