

Colorado Ongoing Basins Emissions (COBE): Measurements and Source Attribution

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Background

COBE is a joint project partnering with three aerial instrument vendors (Bridger Photonics, GHGSat, Insight M) to measure statewide methane emissions from upstream oil & gas facilities. The project will inform the 2026 Colorado Greenhouse Gas (GHG) Intensity Verification Rule through two independent modeling approaches.

Each vendor conducted three different campaigns (spring, summer and fall) in 2024 over upstream facilities throughout the state, which were grouped by the modeling team into 3 basin groups and 4 Prototypical Site (PS) classes.

Primary Objectives:

- Collect representative methane measurements via aerial campaigns (this poster)
- Develop measurement-informed inventories (MIIs) (Michael Moy, Jenna Brown)
- Compare MIIs to operator-reported emissions to provide ratios (Jenna Brown)

Methodology

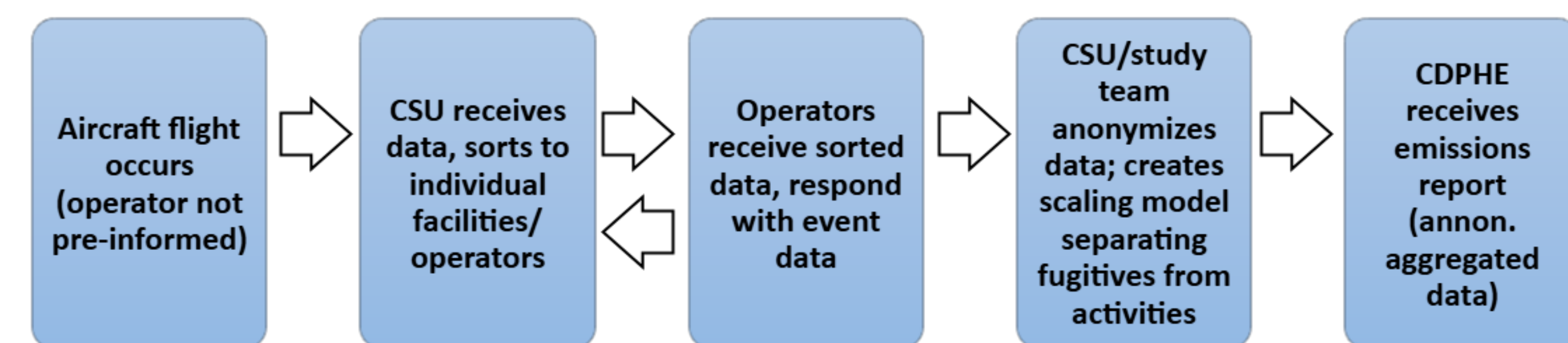
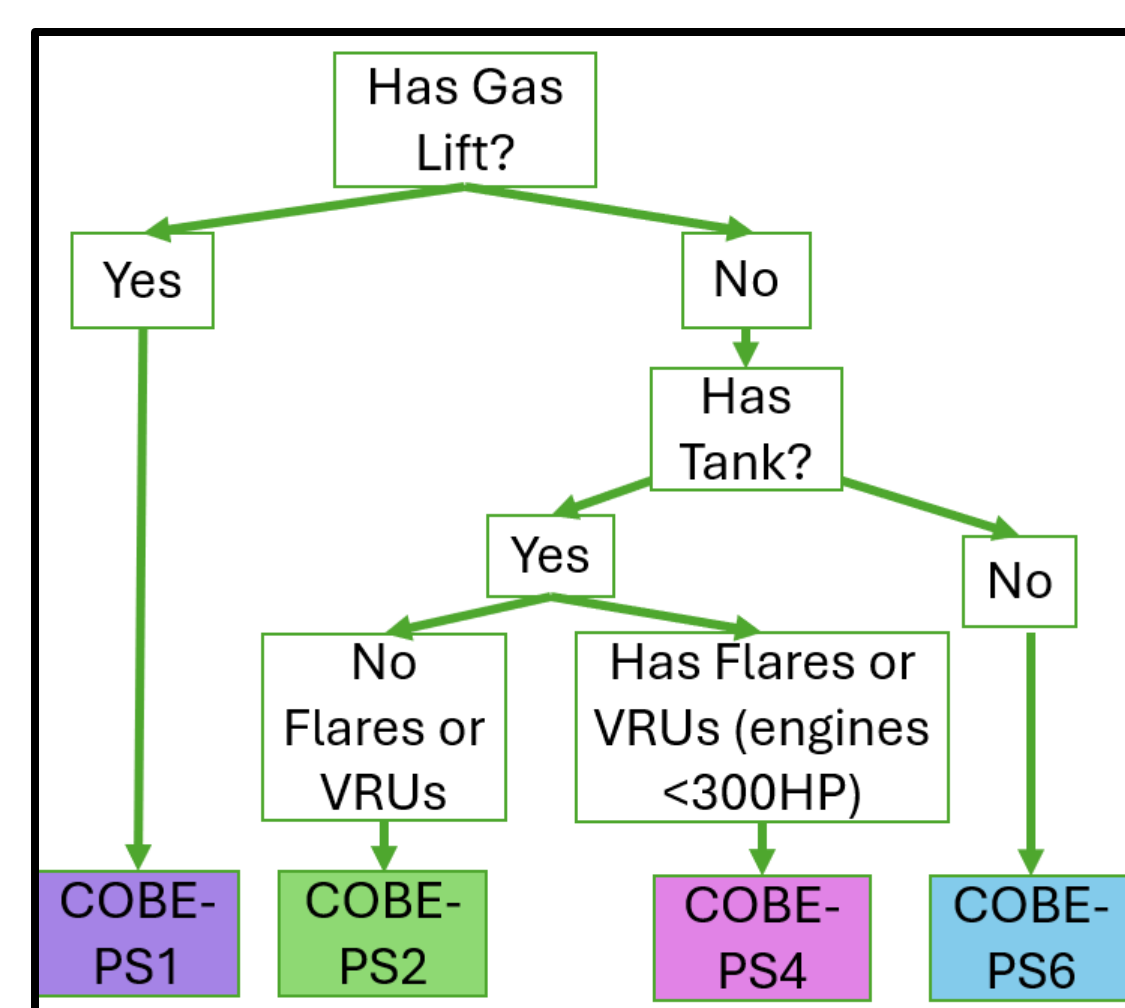


Figure 1: Simplified data pipeline for collecting and implementing measurements into model



➤ Based on publicly available reporting data, facilities of interest are delegated into Prototypical Site (PS) Configurations

Figure 2: Logic tree for classifying sites into Prototypical Sites (PS)

CSU MII Process:

1. Collect representative measurements of CO₂'s upstream O&G facilities
2. Attribute a likely source cause for each significant emission

- This process involves using operator provided cause analysis (when available), along with aerial imagery and metadata
- 12 operators in the state participated, representing approximately 77% of facilities in the state



Figure 3: (Generic) Example of methane plume image captured by aerial instrument

3. Compare emissions to bottom-up inventory (simulated using MAES, Mechanistic Air Emissions Simulator)

Probability distribution developed from inventory (e.g. ONGAIER) (Colorado's reporting database)

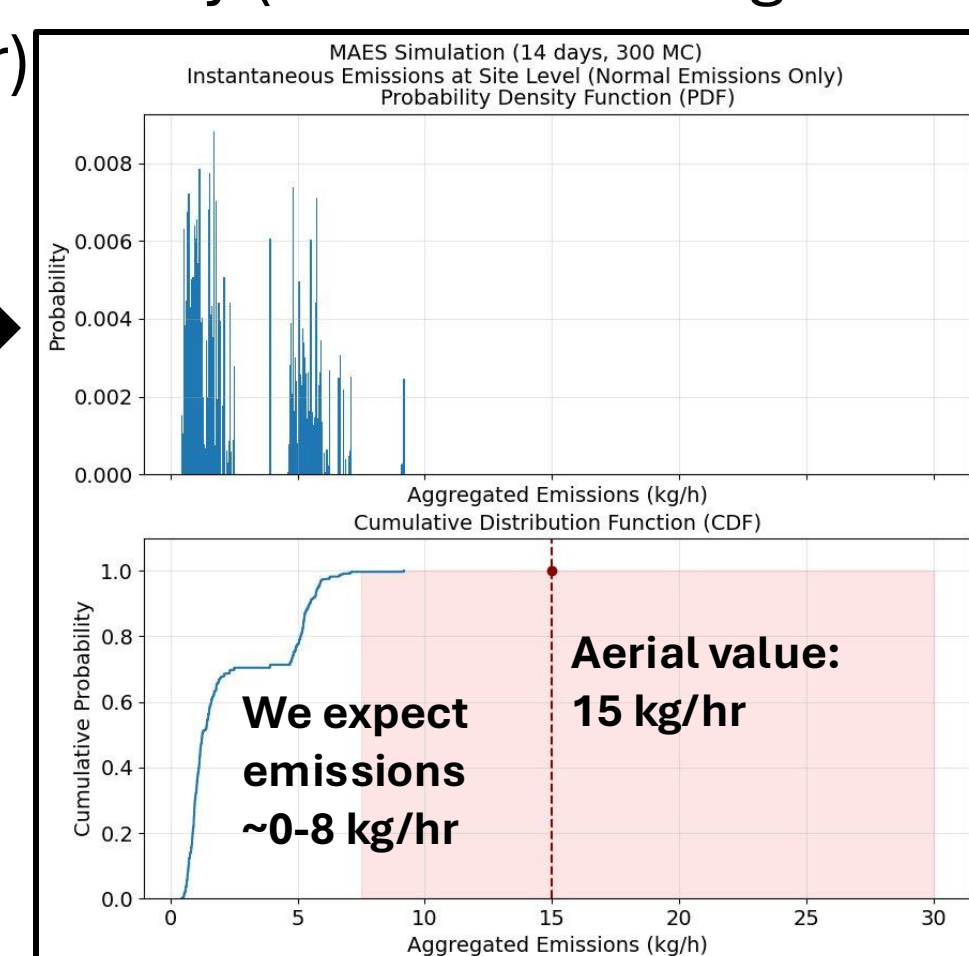


Figure 4: Example of MAES predicted emission profile

Cumulative distribution function (CDF) of inventory

4. Incorporate emissions that are not already captured in inventory -> MII

Results

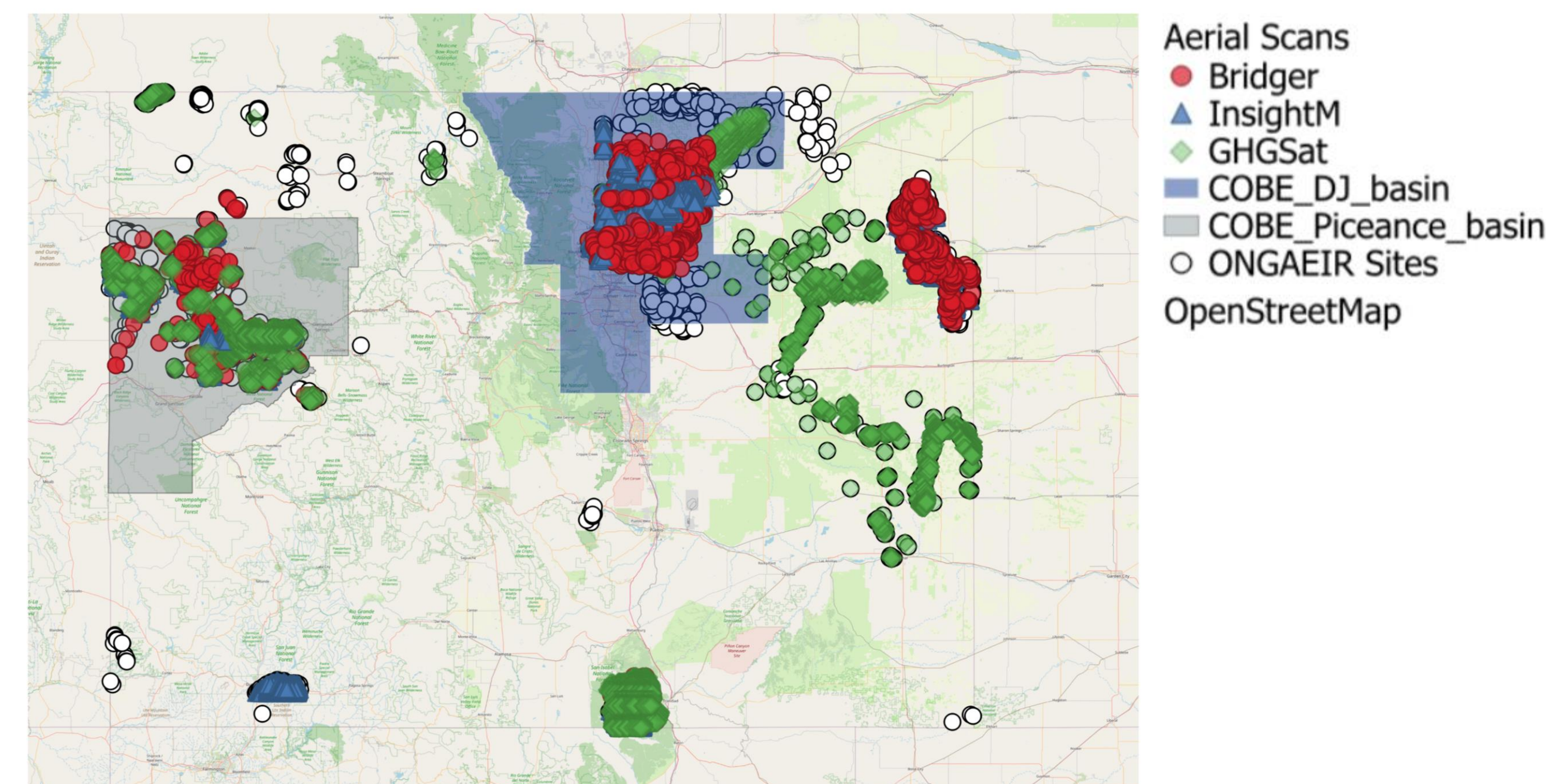


Figure 5: Map of measured facilities across Colorado. The partitioning of each basin (Denver-Julesberg) (DJ) [blue], Piceance [grey], and 'Other' were defined by study partners at CDPHE

Aerial Company	Total Scans	Unique Facilities	Repeat Facilities
Bridger	7,043	3,708	1,836
GHGSat	10,915	7,209	3,057
Insight M	15,127	7,749	4,296
Campaign Total	33,085	10,771	7,732

Table 1: Counts of scanned facilities across all measurement campaigns. 'Repeat Facilities' is applied when a facility is measured more than once in 24 hours.

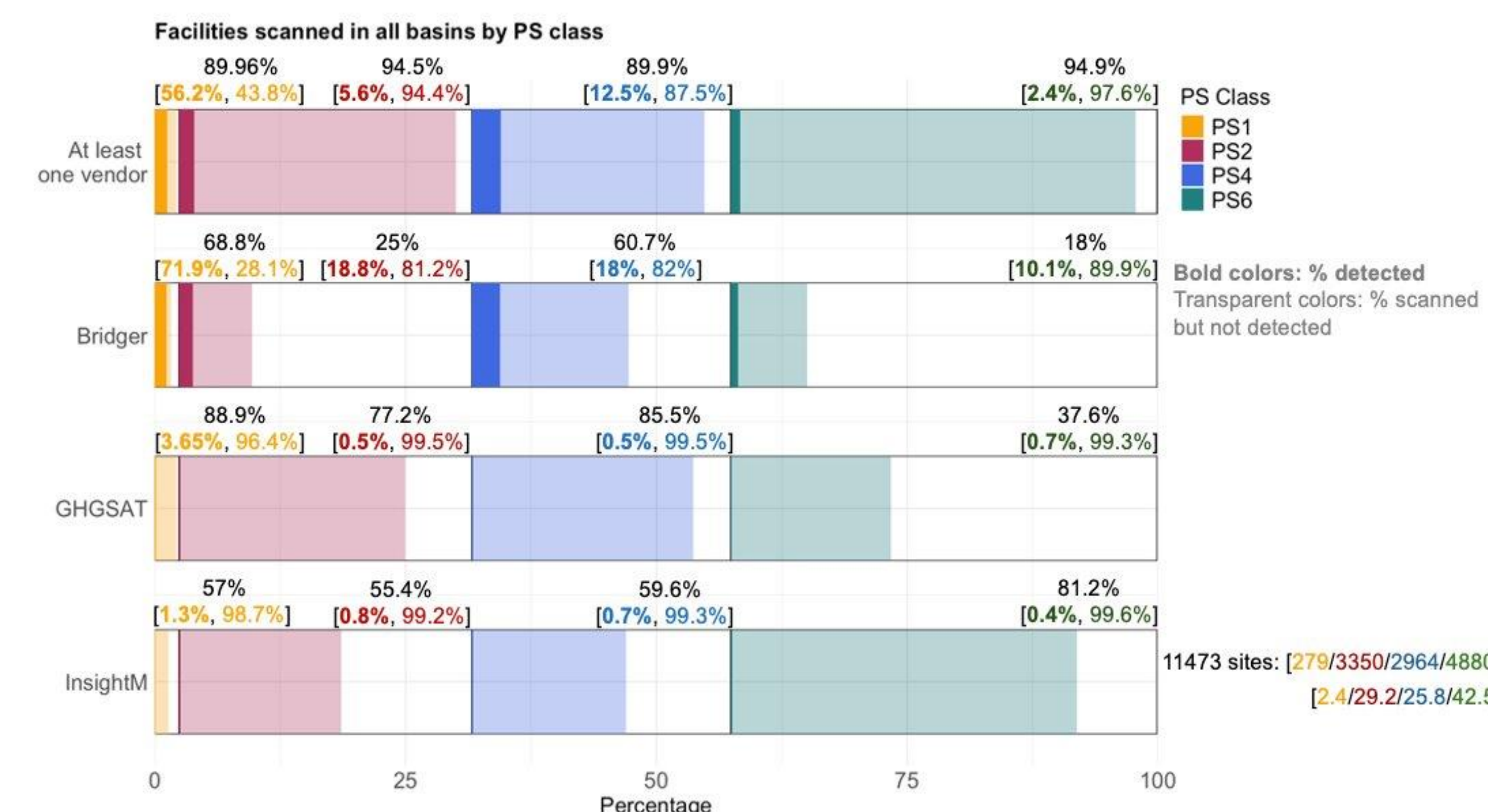


Figure 6: Aerial coverage: 91.4% of facilities in the DJ basin, 96.8% in the Piceance basin, and 92.4% in other basins

Emissions that are determined to be from midstream activities (96), preproduction activities (44), maintenance actions (47), or off of the reported site (40) are excluded from the MII model (but included in the public final dataset).

Company	Basin	Median	Average	Min	Max	Range
Bridger	DJ	2.13	5.33	0.203	189	188
	Piceance	1.53	3.96	0.135	81.9	81.7
	Other	2.09	5.39	0.203	43.7	43.5
GHGSat	DJ	105	118	34	248	214
	Other	29	46.5	8	285	277
Insight M	DJ	36	113	7	353	346
	Other	43	49.4	3	143	140
	Other	17	33	3	114	111

Table 2: Summary of facility-level detected emission rates measured in kg/hr by aerial measurement company and basin.

COBE Measurements Summary and Future Work

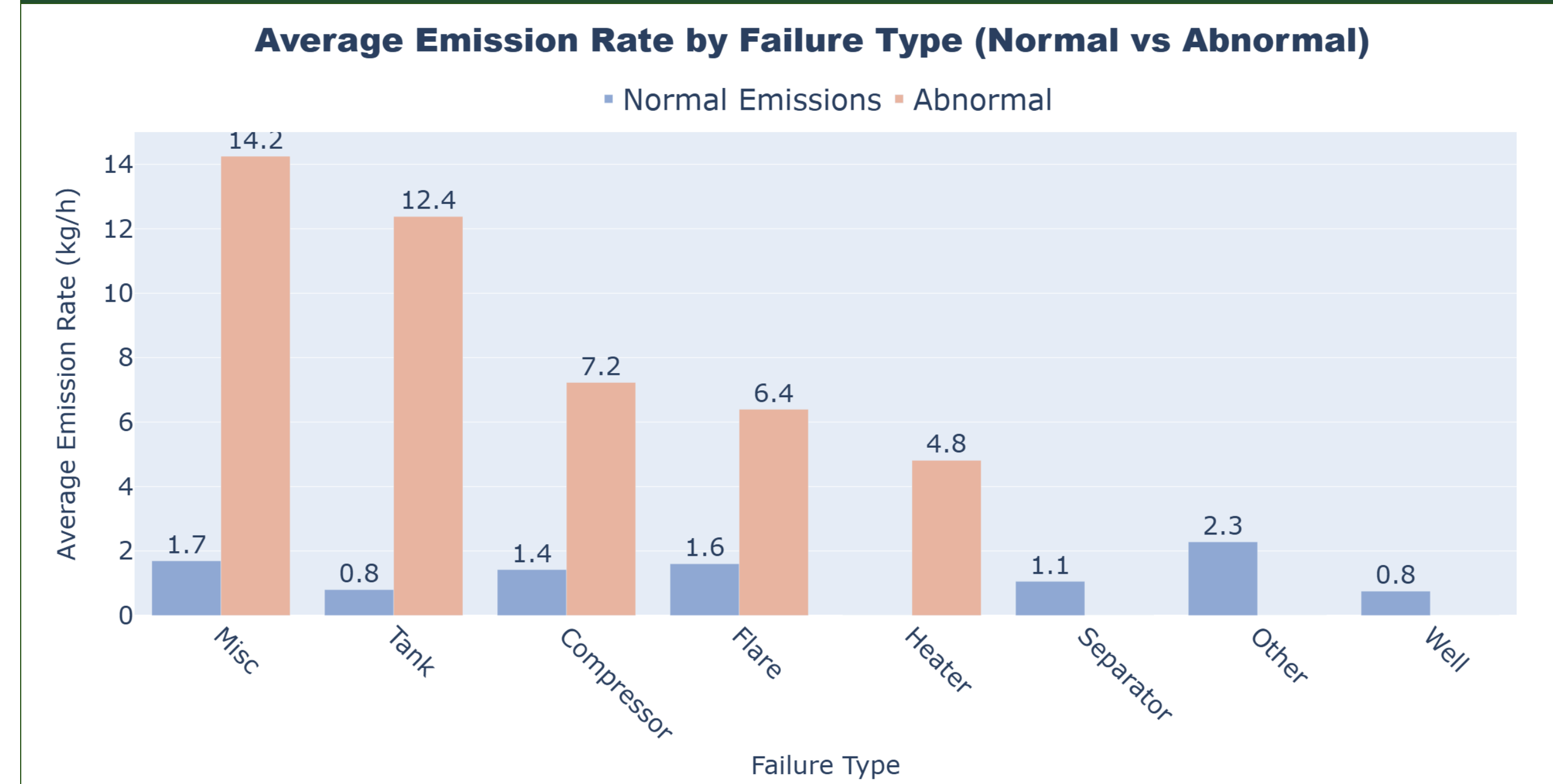


Figure 7: Average emission rate by measured equipment/source, from 999 measurements determined to be abnormal, and 892 normal emissions

After sorting emissions and labeling suspected cause, a combined uncertainty model is applied and measurements are incorporated into an MII (see other COBE posters by Jenna Brown & Michael Moy)

- To incorporate measurements that are determined to be from a failure mode, pLeak (probability of detecting a leak) is used to input frequency into MAES MII

	Sample size	pLeak
Compressors	11,015	0.0160
Miscellaneous emissions	32,865	0.0368
Flares	23,941	0.0038
Heaters	118,799	0.0026
Controlled Tanks	74,051	0.0028
Uncontrolled Tanks	26,854	0.0076

Table 3: Calculated likelihood of leak by associated equipment : pLeak = # failures measured / # units scanned

Future work

- What is the best way to leverage the different vendor's detection capabilities (lower detection limit, number of facilities scanned, equipment identification, etc.)?
- Can other measurement technologies, such as satellite instruments and continuous monitors, further improve this MII?

Acknowledgements and Contact Information

Final dataset is available to the public online, which has 2,102 emissions measured (and anonymized), found @ <https://metec.colostate.edu/colorado-ongoing-basin-emissions-cobe/>
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References

- COBE final report:**
Brown, J. A.; Moy, M.; Santos, A.; Rimelman, E.; Okenberg, C.; Daniels, W. S.; Hammerling, D. M.; Zimmerle, D.; Hodshire, A. L. Colorado Ongoing Basin Emissions (COBE) Final Report.
- COBE anonymized dataset:**
Brown, J. A.; Hodshire, A. Colorado Ongoing Basin Emissions Study (COBE) Anonymized Final Data Set of Emissions Measurements, 2025. <https://doi.org/10.5061/dryad.8kpr4z0p>.

For other COBE-related posters, see:
Jenna Brown– COBE: Measurement Informed Inventory (MII) Results
Michael Moy– COBE: Blending aerial methods