Comparing different sensor types for continuous monitoring of methane emissions at oil and gas sites

Michael Basanese, William Daniels, Dr. Dorit Hammerling

Department of Applied Mathematics and Statistics, Colorado School of Mines

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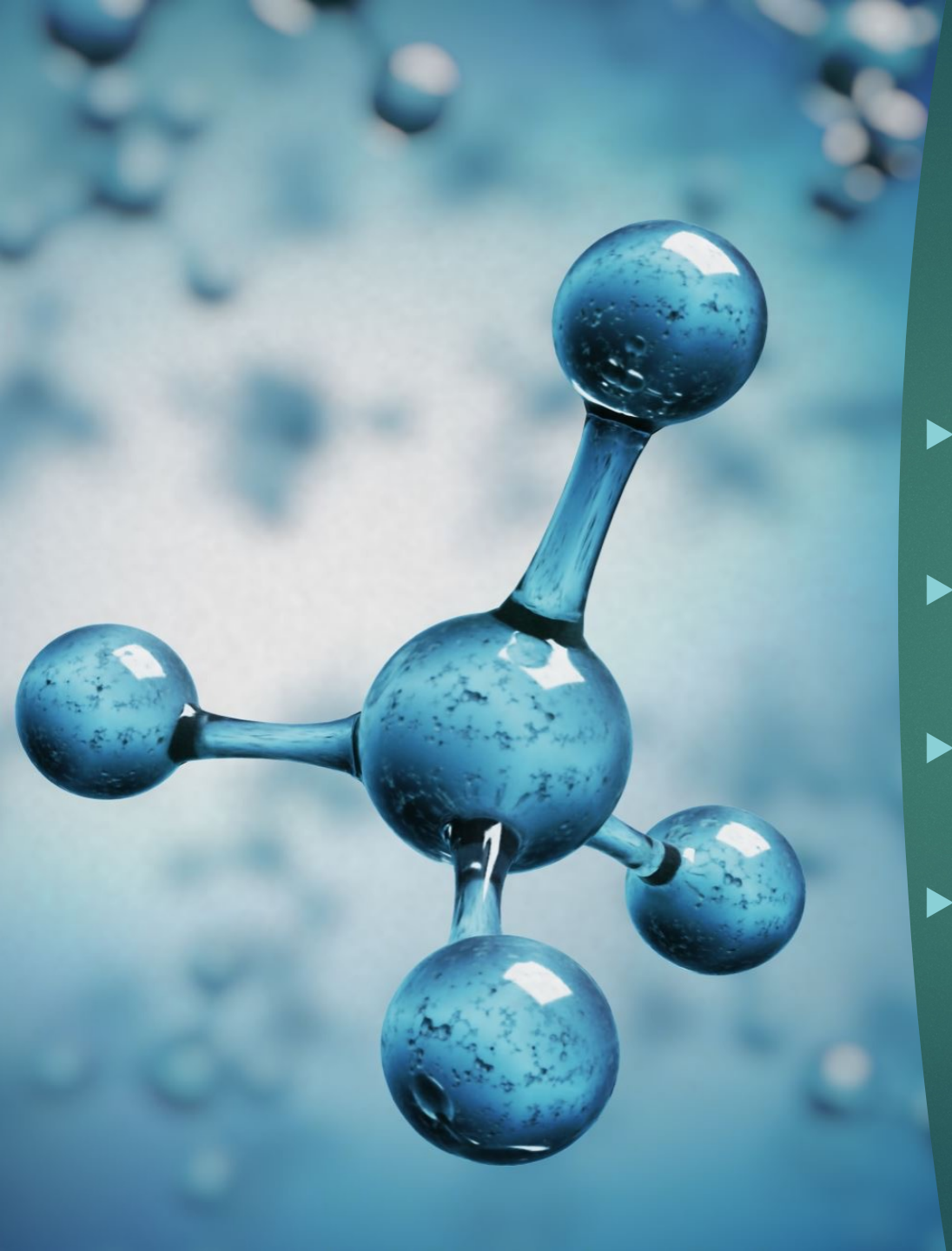

Background

- Methane has a **28x** greater global warming potential than CO2 over a 100-year period
- Methane accounts for **16%** of global greenhouse gas emissions
- Methane has a lifespan of only **7-12 years** in the atmosphere
- Natural gas and petroleum accounts for **29%** of all U.S. methane emissions.

Backgroun

Methane matters, and we can do something about it!

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years in

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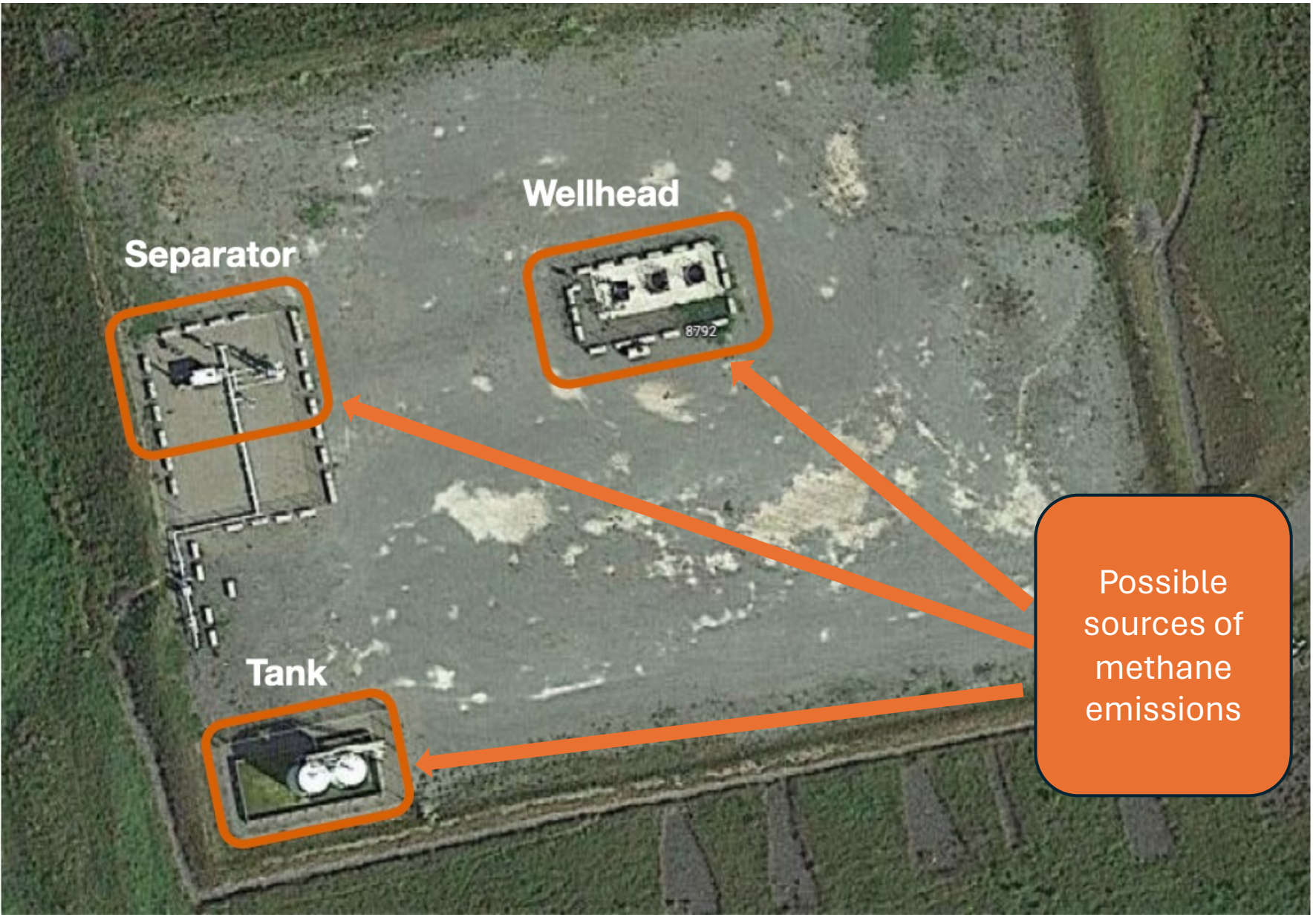
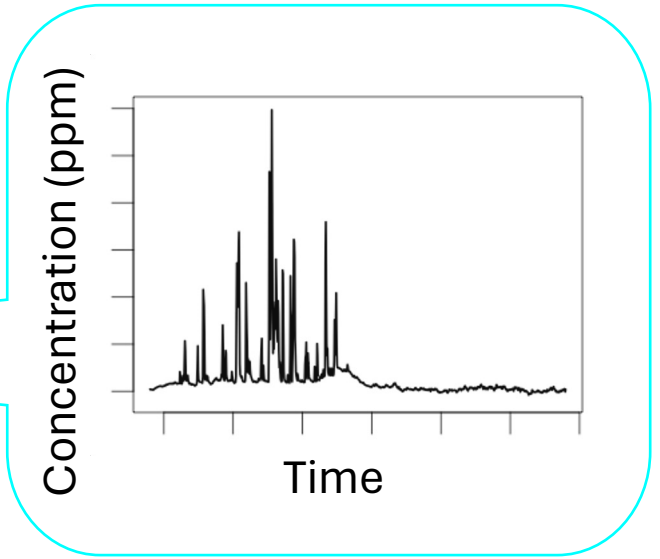
methane emissions.

Example oil and gas site



How do we measure the emissions from these sources?

Continuous monitoring systems (CMS)



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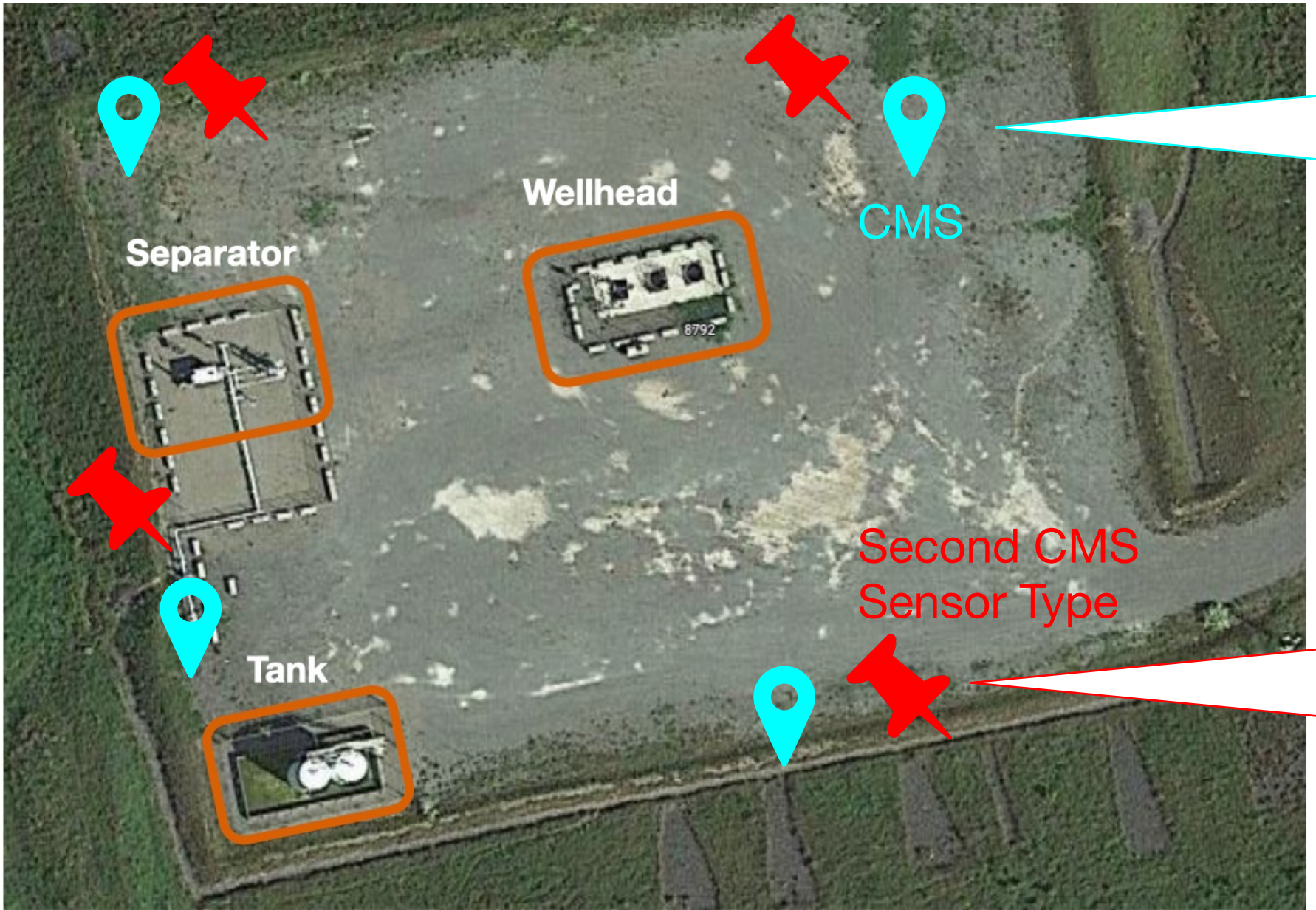

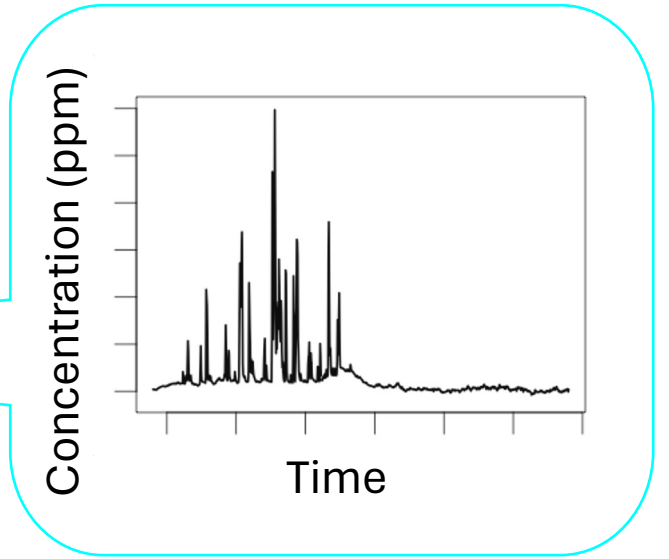

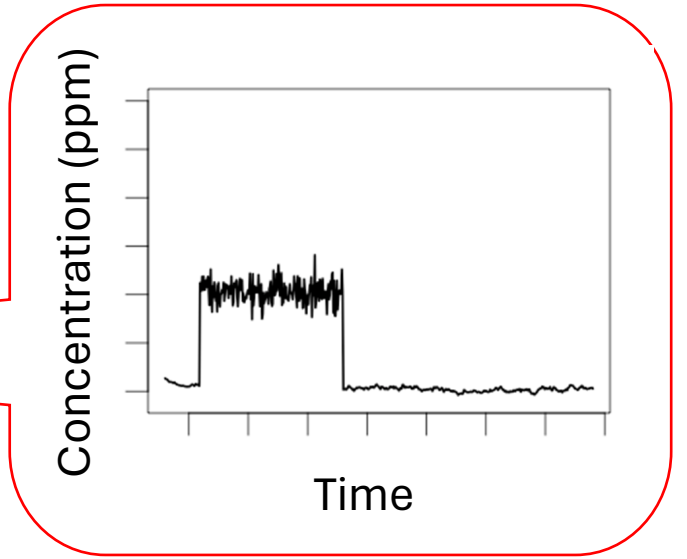

Question: Which type of sensor should operators use?

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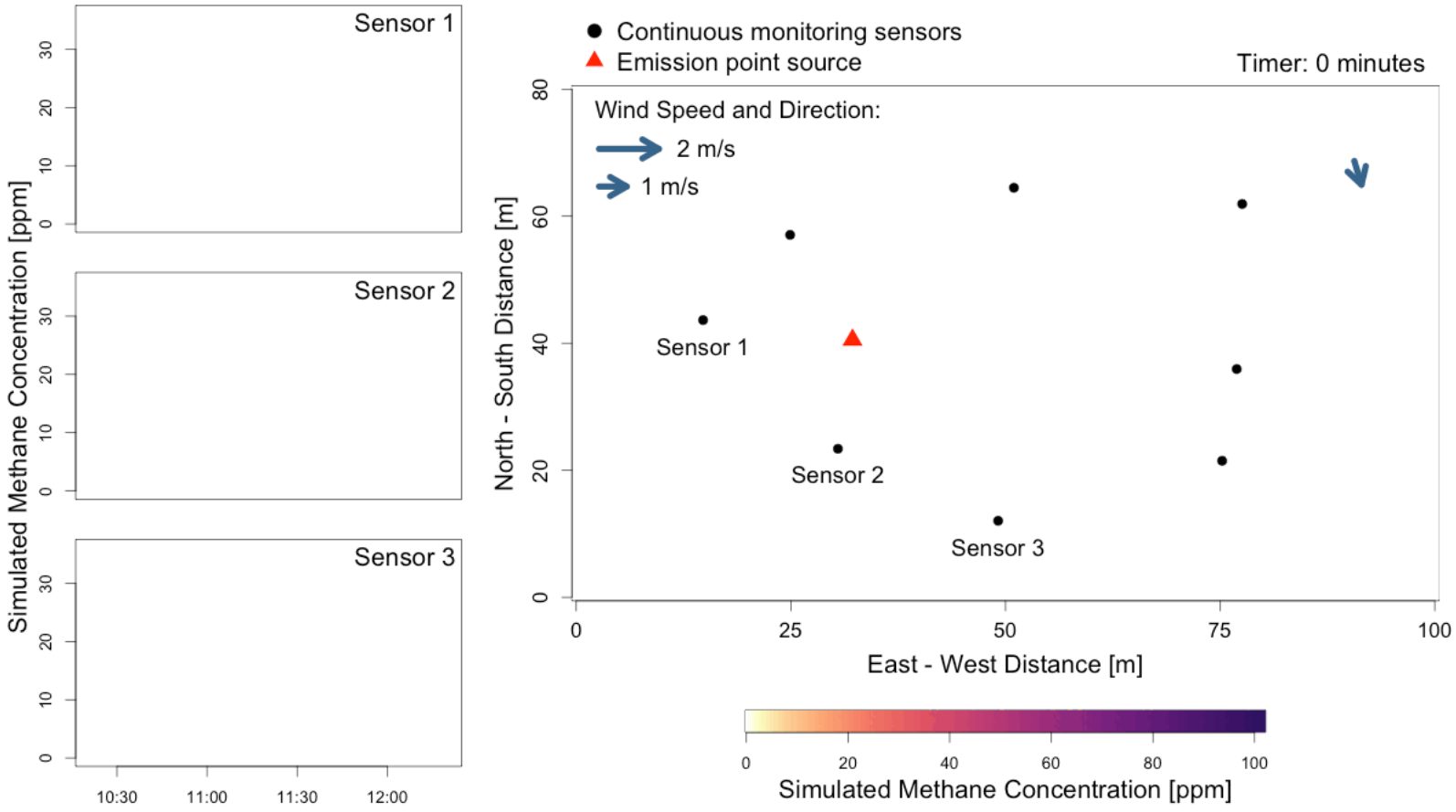
To answer this question, we need to first discuss what CMS are used for.

CMS help us find out:

- When is an emission happening?
- Where is the emission coming from?
- How much is being emitted?

Detection, Localization, and Quantification Algorithm



Step 1 — Background removal, event detection

Step 2 — Simulation

Step 3 — Localization

Step 4 — Quantification

We have data from a real oil and gas site with two types of sensors installed.

Metal Oxide (MOx)	**Laser-Based**
Less expensive	More expensive
Potentially less accurate	Likely more accurate

Goal: Compare these two types of sensors

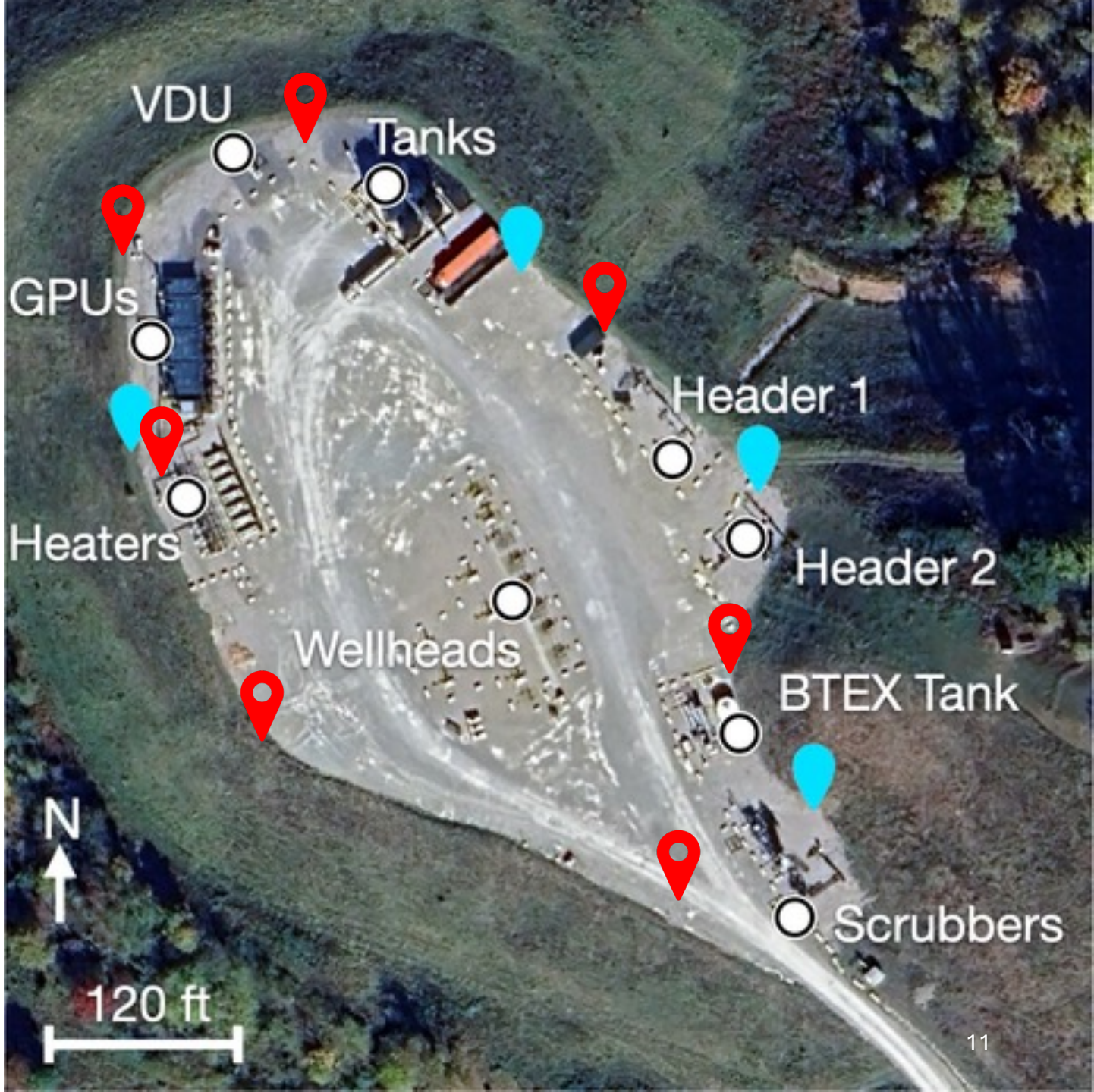
Site chosen for analysis

- 7 laser-based sensors
- 4 MOx sensors
- 9 possible emission sources

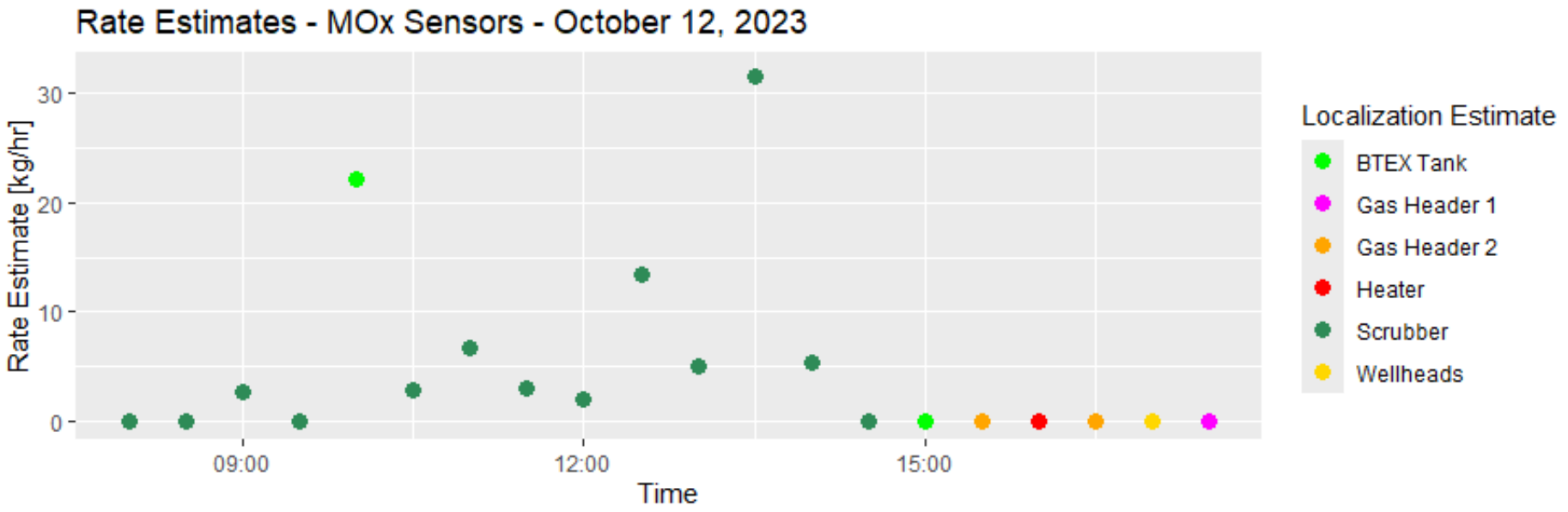
Possible Emission Sources

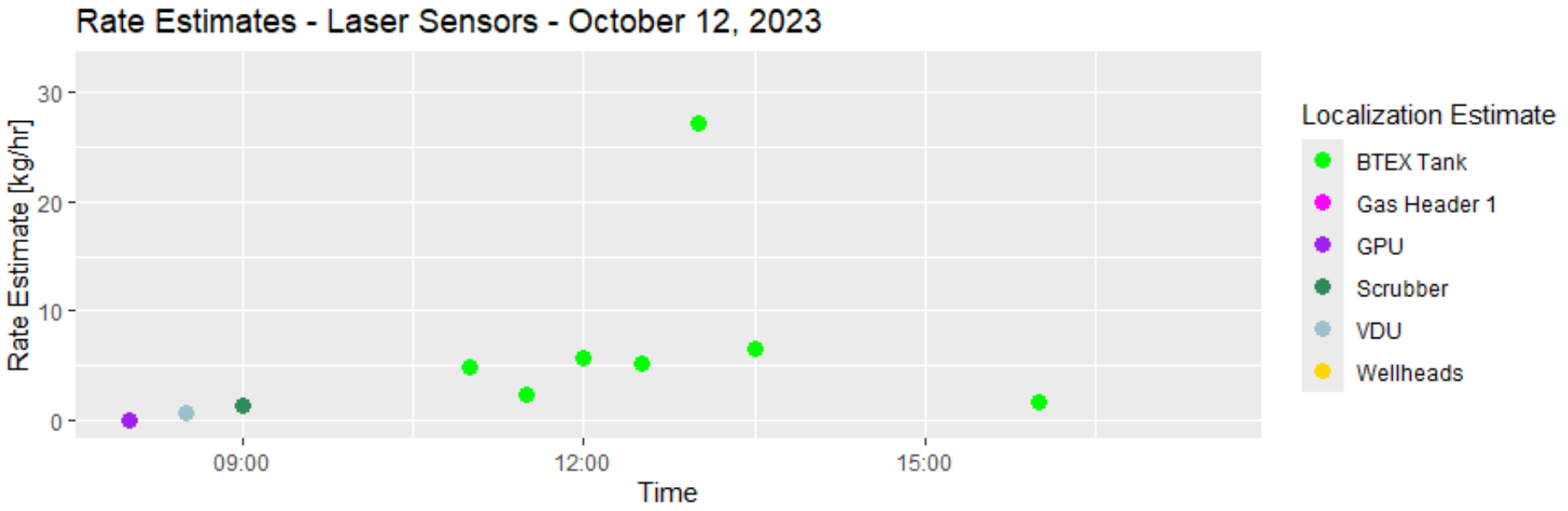
MOx Sensors

Laser-Based Sensors



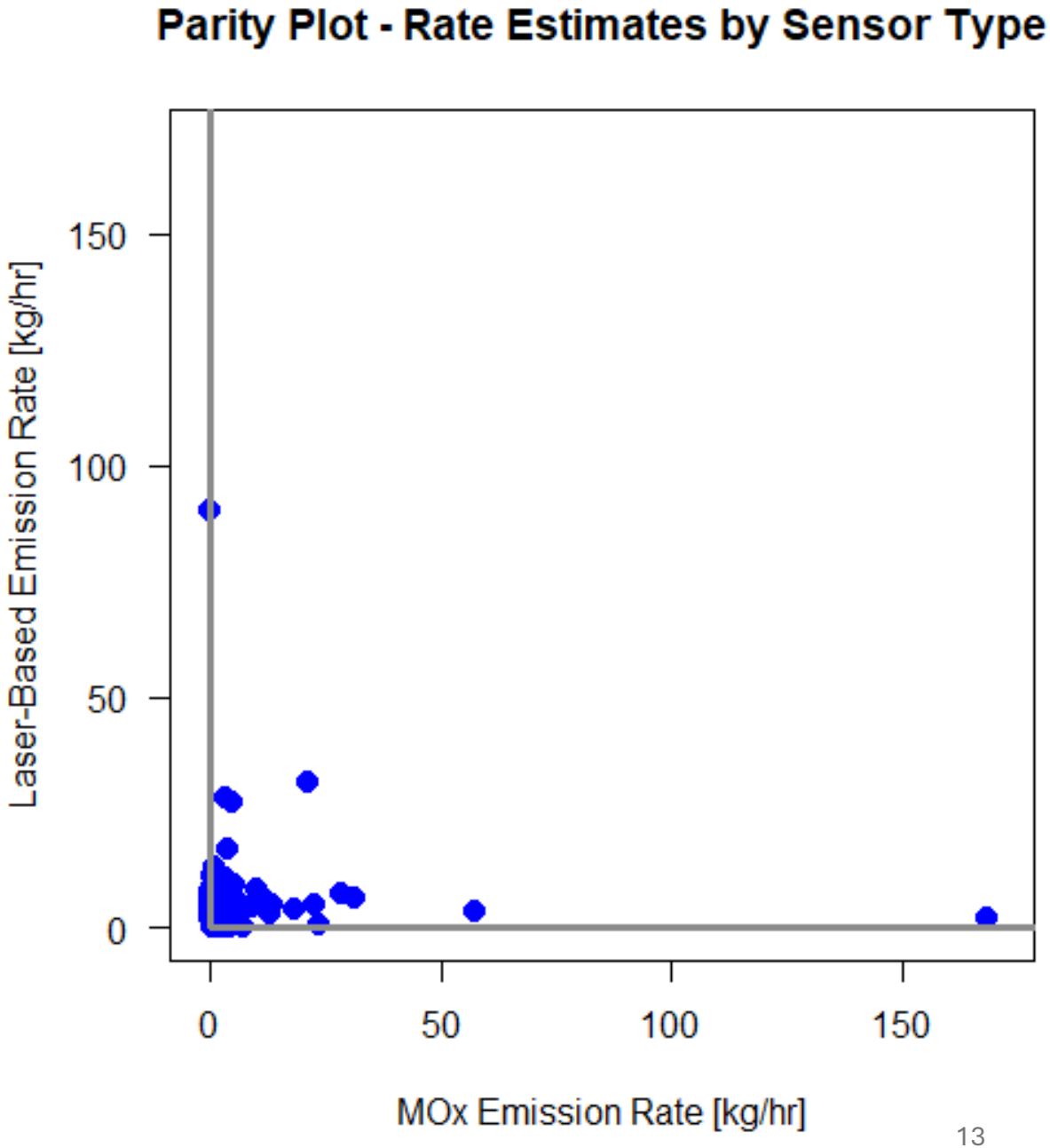
Results – Time Series Plots of Emission Rate Estimates (Single Day)





Results – Parity Plots (All Nonzero Data)

- Blue dots represent points in time with a MOx emission rate estimate and a laser rate estimate



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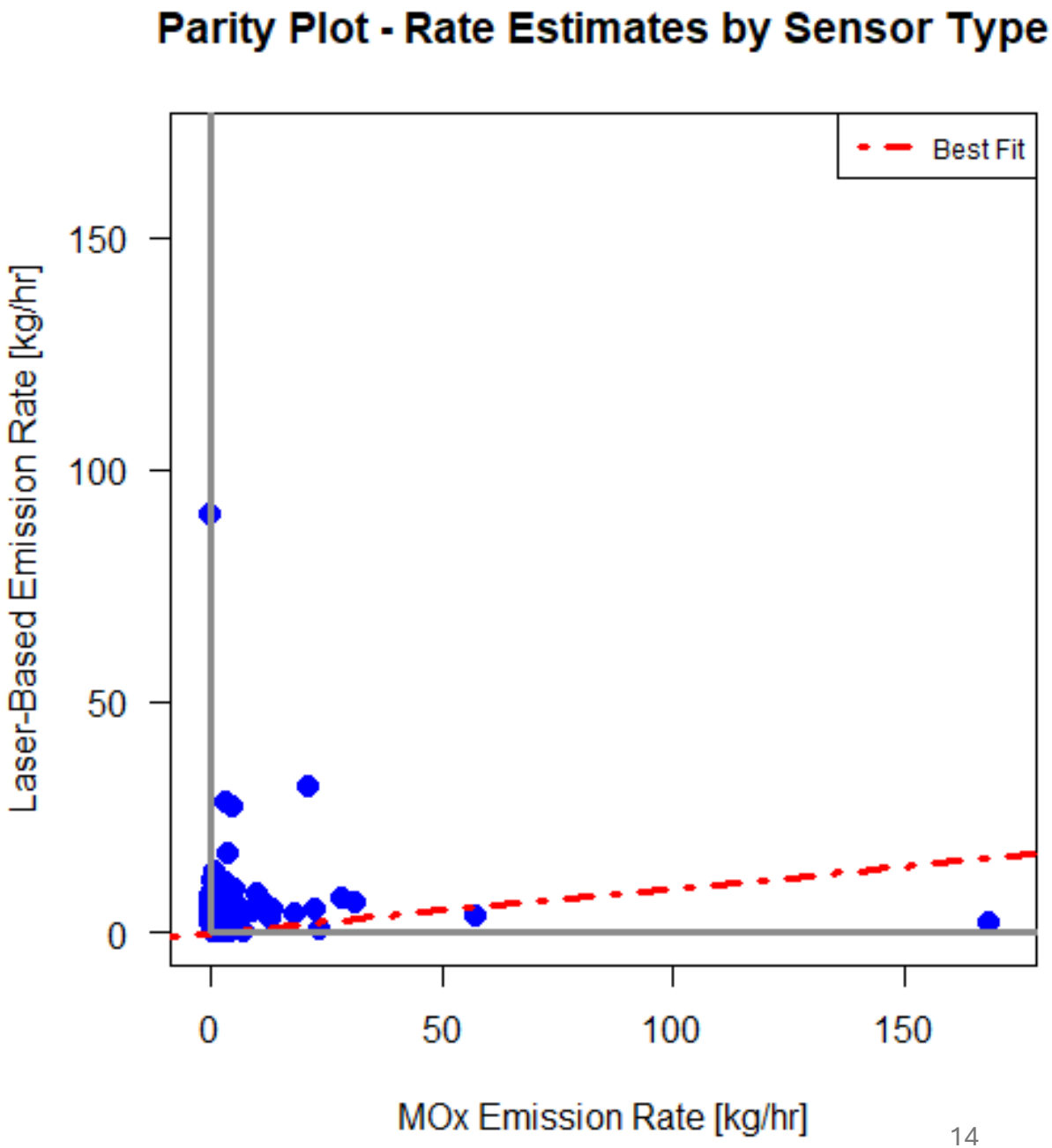
- Red line shows the best fit for **all times** with MOx and laser rate estimates above 0.

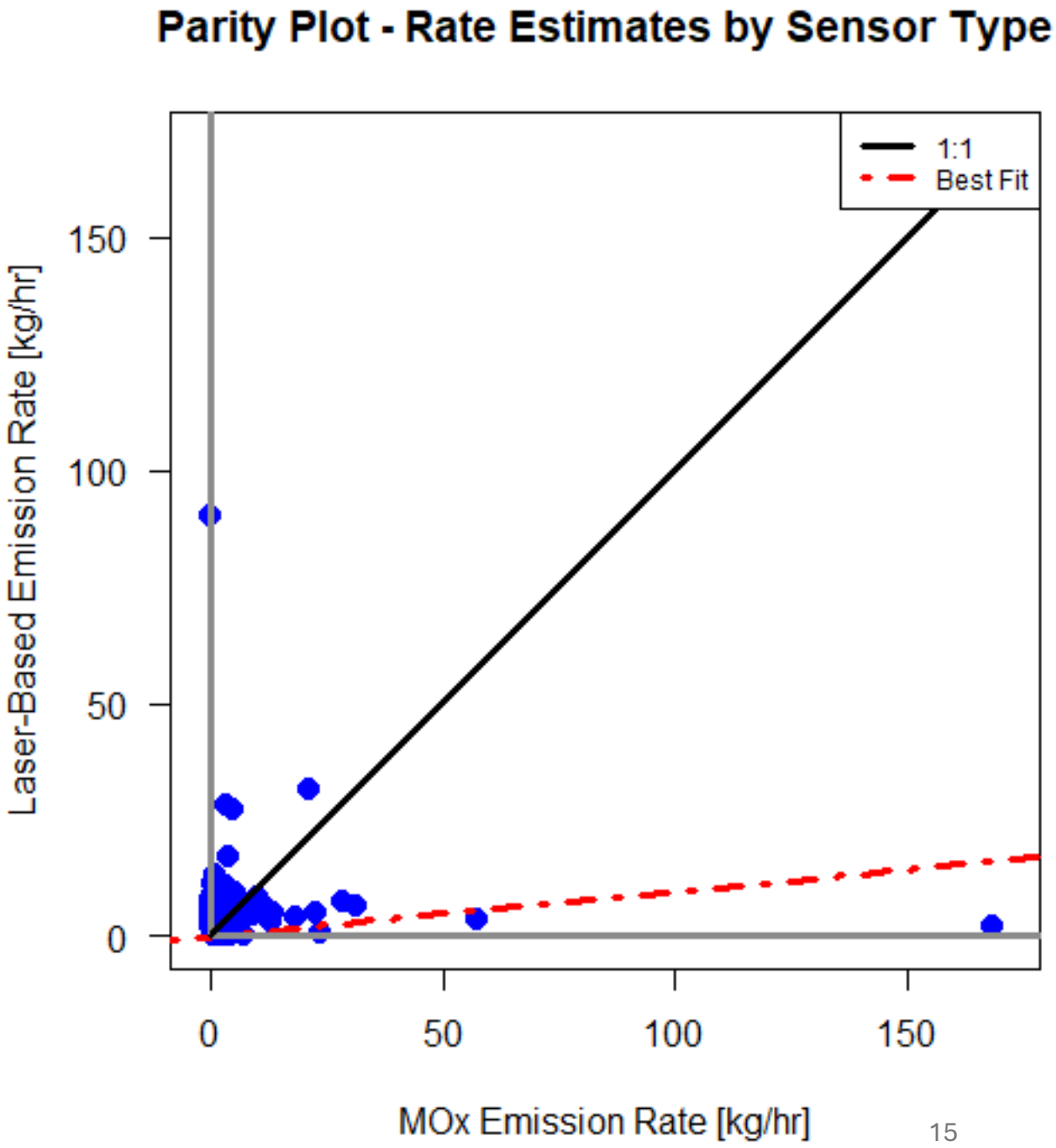


Results – Parity Plots (All Nonzero Data)

- The emission rates generated from the two sensor types are **clearly different.**

- When both sensor types capture an emission, the **MOx sensors** tend to generate **higher** rate estimates than the laser-based sensors.

- Red line shows the best fit for **all times** with MOx and laser rate estimates above 0.



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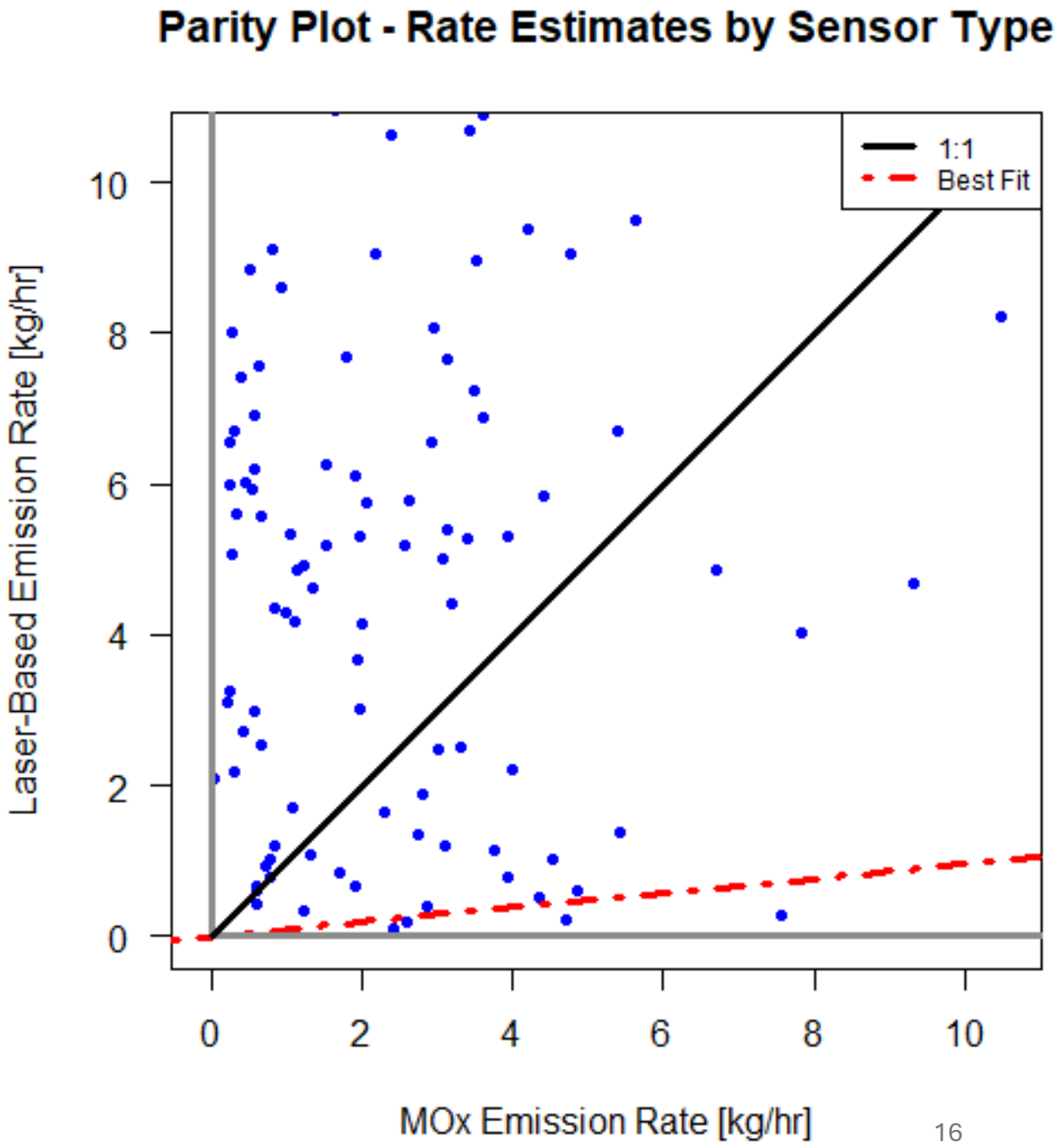
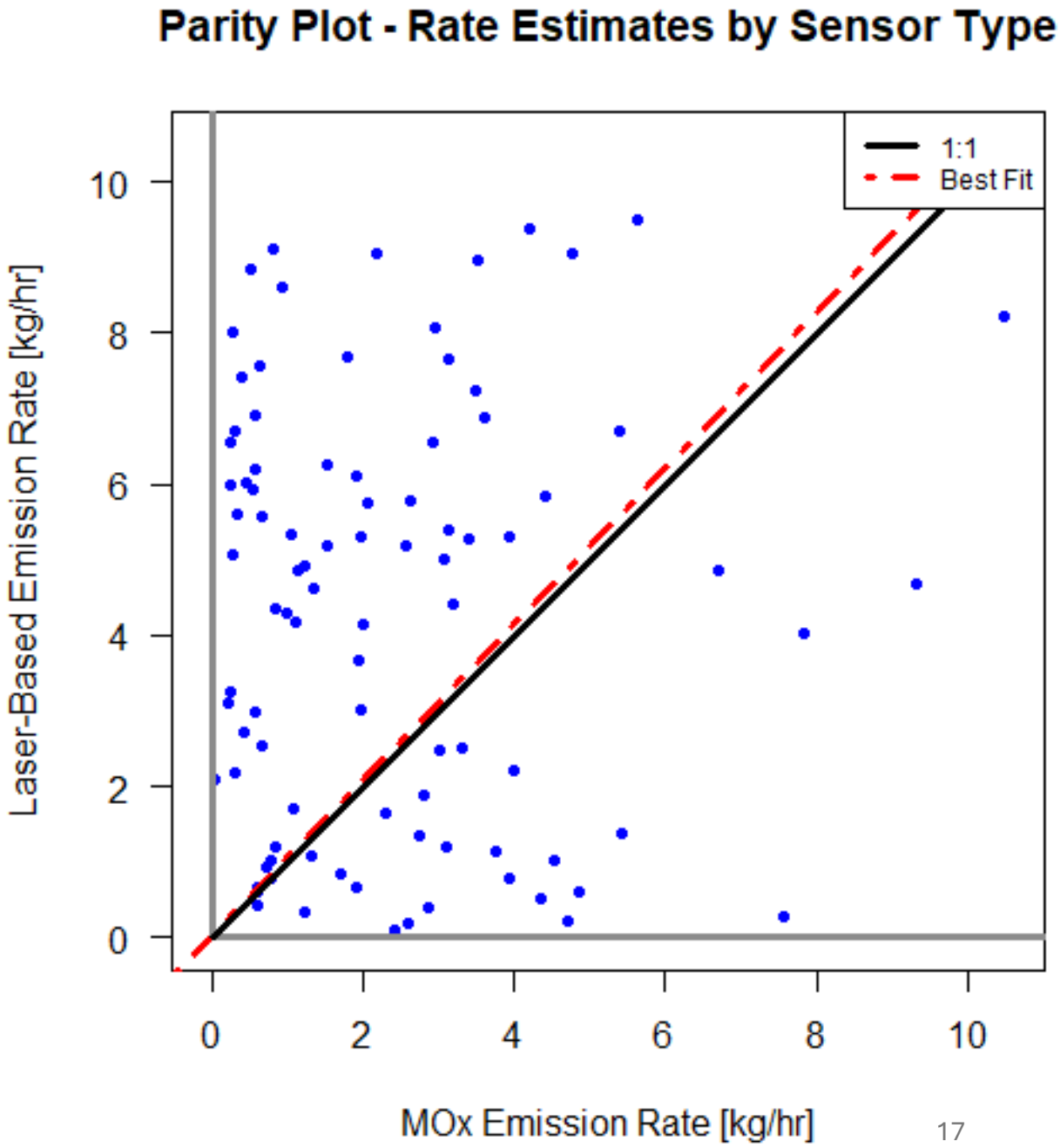


Results – Parity Plots (All Nonzero Data)

- Here we remove all rate estimates **greater than 10.5 kg/hr.**

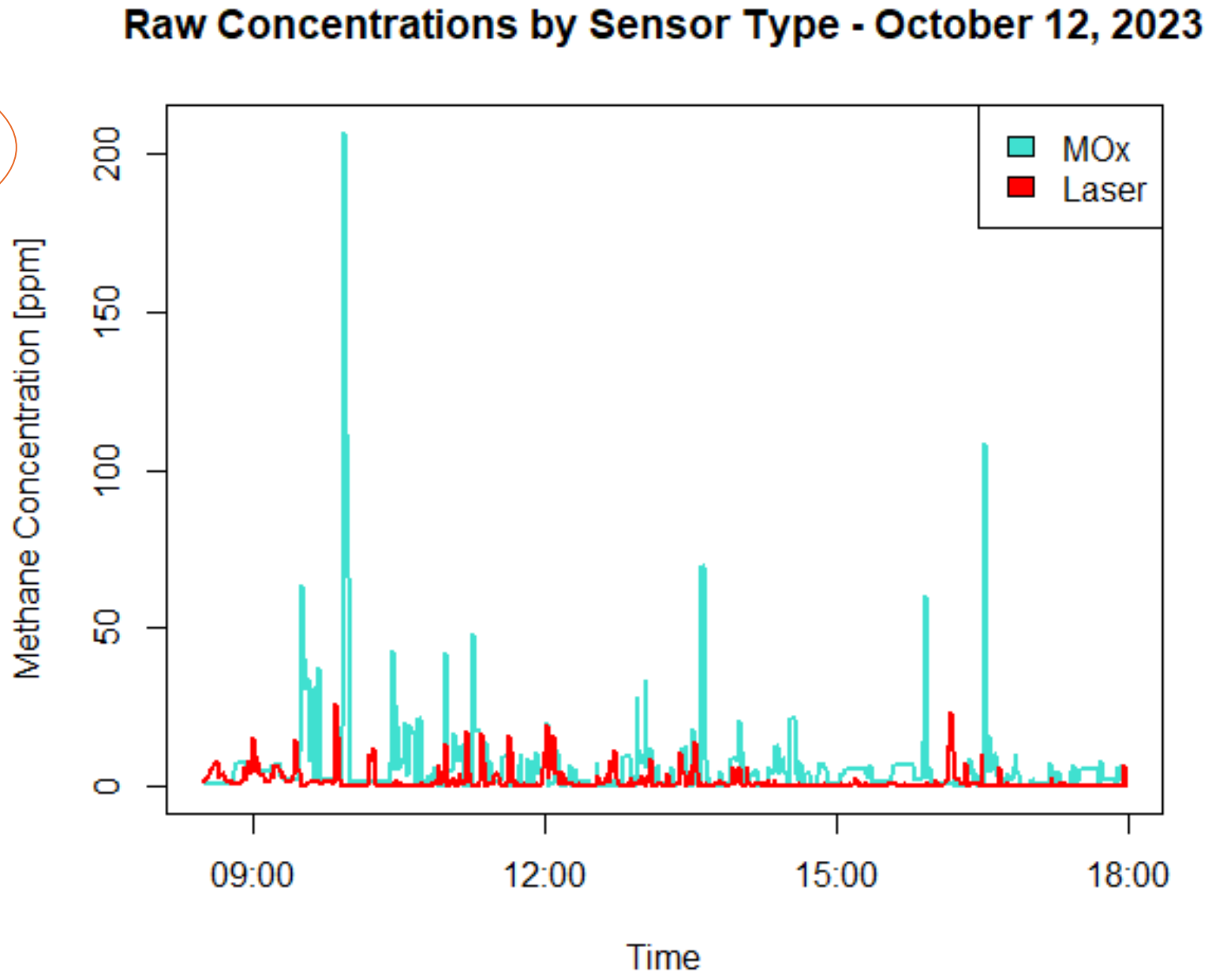
- When **outliers are removed**, the emission rates of each sensor type are, on average, **about the same.**



Why are rate estimates different between different sensor types?

- Raw data from the MOx sensors tends to **overestimate** the raw data from the laser sensors.

- This explains why there are some large rate estimates in the MOx detection, localization, and quantification results.

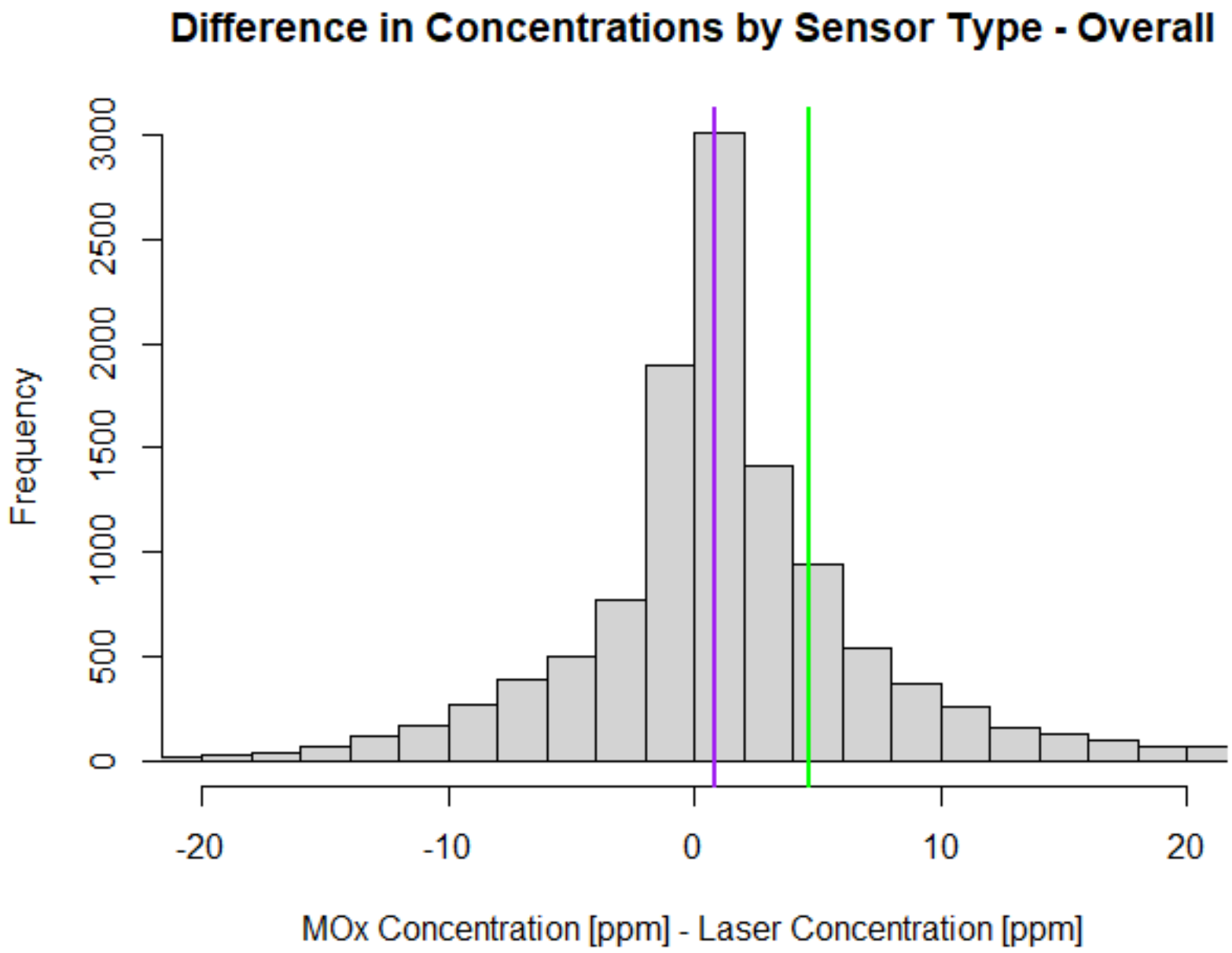


Histogram (All Nonzero Data)

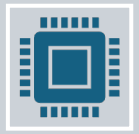
Distribution of differences appears to have a very slight **rightward skew.**

Mean Difference = **4.70**

Median Difference = **0.84**



Conclusions



There are **noticeable differences** between MOx and laser sensor rate estimates. MOx sensors tend to generate **higher** emission rate estimates than the laser sensors.

Differences can potentially be explained by the **quality of the underlying concentration data.**

Dorit Hammerling

Spencer Kidd

Olga Khaliukova

Meng Jia

Ryker Fish

Cal Richards-Dinger

Troy Sorensen

Kellis Ward

William Daniels

Dishita Sharma

Thanks for listening!

Questions?