Using continuous monitoring systems for data-driven methane emissions inventories for oil and gas facilities

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Motivation

- Creating accurate methane emissions tallies ("inventories") for the oil and gas sector is a critical aspect of recent environmental regulation (e.g., the Inflation Reduction Act).

- Conventional inventories are based on out-of-date emissions factors rather than actual data (i.e., measurements). Much research has gone into updating these inventories, often using snapshot methane measurements from a plane or drone.

- However, it is hard to reconcile conventional inventories, which represent year-long averages, with these snapshot measurements, as methane emissions have a high degree of temporal variability.

- **In this work, we demonstrate how continuous monitoring systems (CMS), a relatively new measurement technique, can be used to reconcile conventional inventories and snapshot measurements for more accurate, data-driven emissions inventories.**

Continuous monitoring systems (CMS)

- CMS measure ambient methane concentrations at their location, usually once per minute, not emission rates directly.
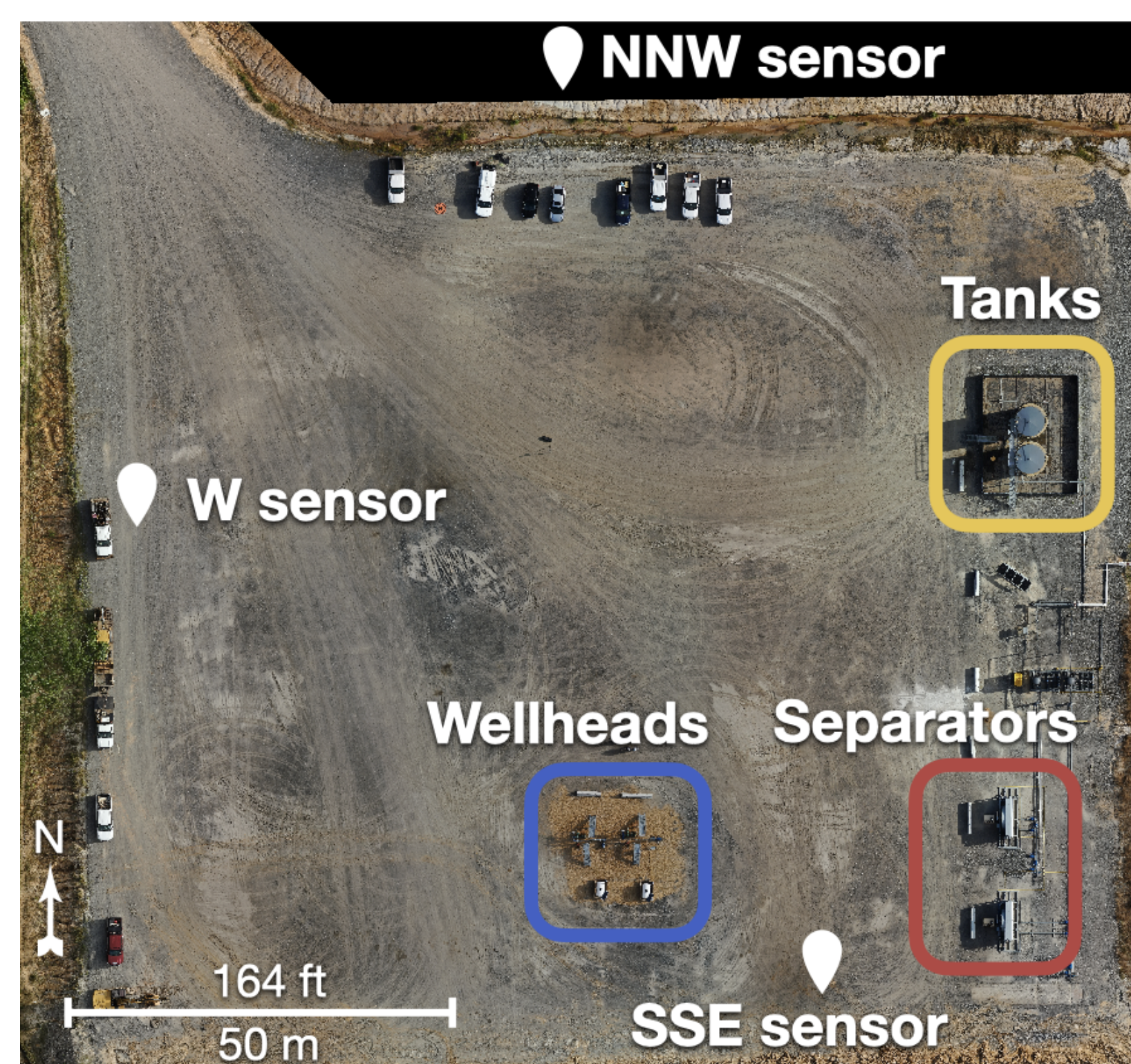

Figure 1: Example oil and gas facility with three CMS sensors installed.

- Our research group has developed a framework for creating source location and emission rate estimates by pattern matching simulated concentrations to actual concentration observations. **See Meng's poster for details!**

Use CMS to verify snapshot measurements

- A very large snapshot measurement was followed by a zero measurement three minutes later. Is the zero measurement valid?
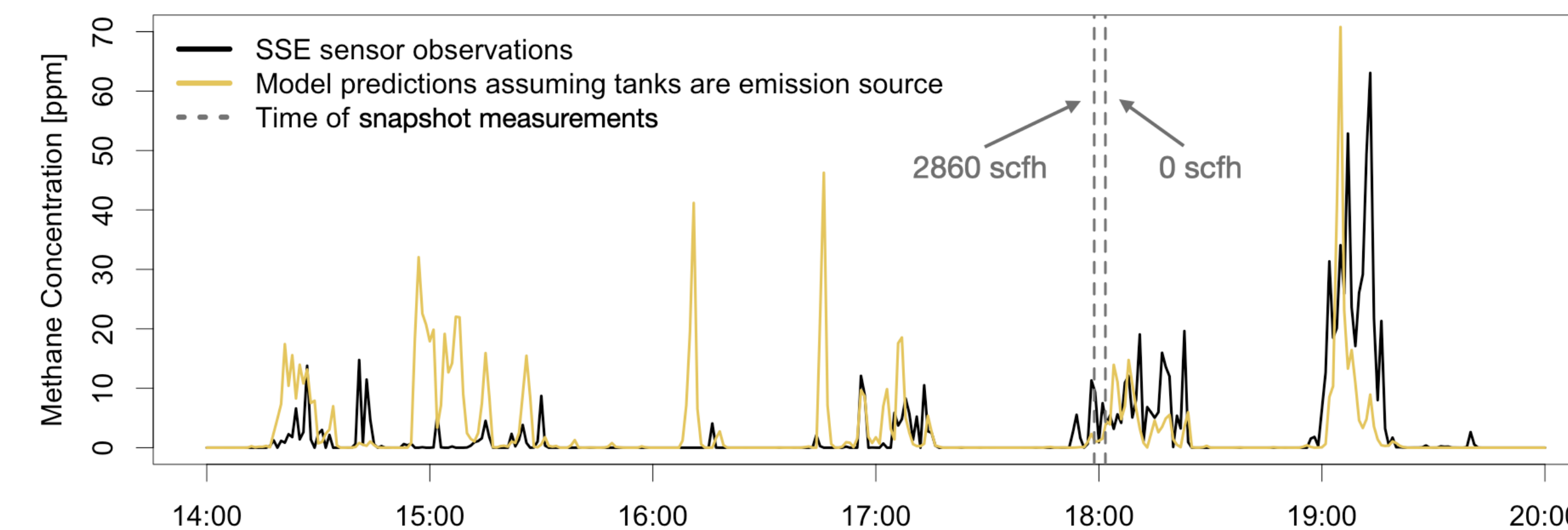

Figure 2: CMS observations and simulated concentrations on site shown in Figure 1.

- Simulate what a constant tank emission at 2860 scfh would look like at SSE sensor.

- **Conclusion: second snapshot measurement likely a false negative, as simulation closely aligns with observed concentrations.**

Use CMS to place snapshot measurements in context

- The 2860 scfh measurement drove up the average snapshot measurement. Are emissions this large typical on this site?
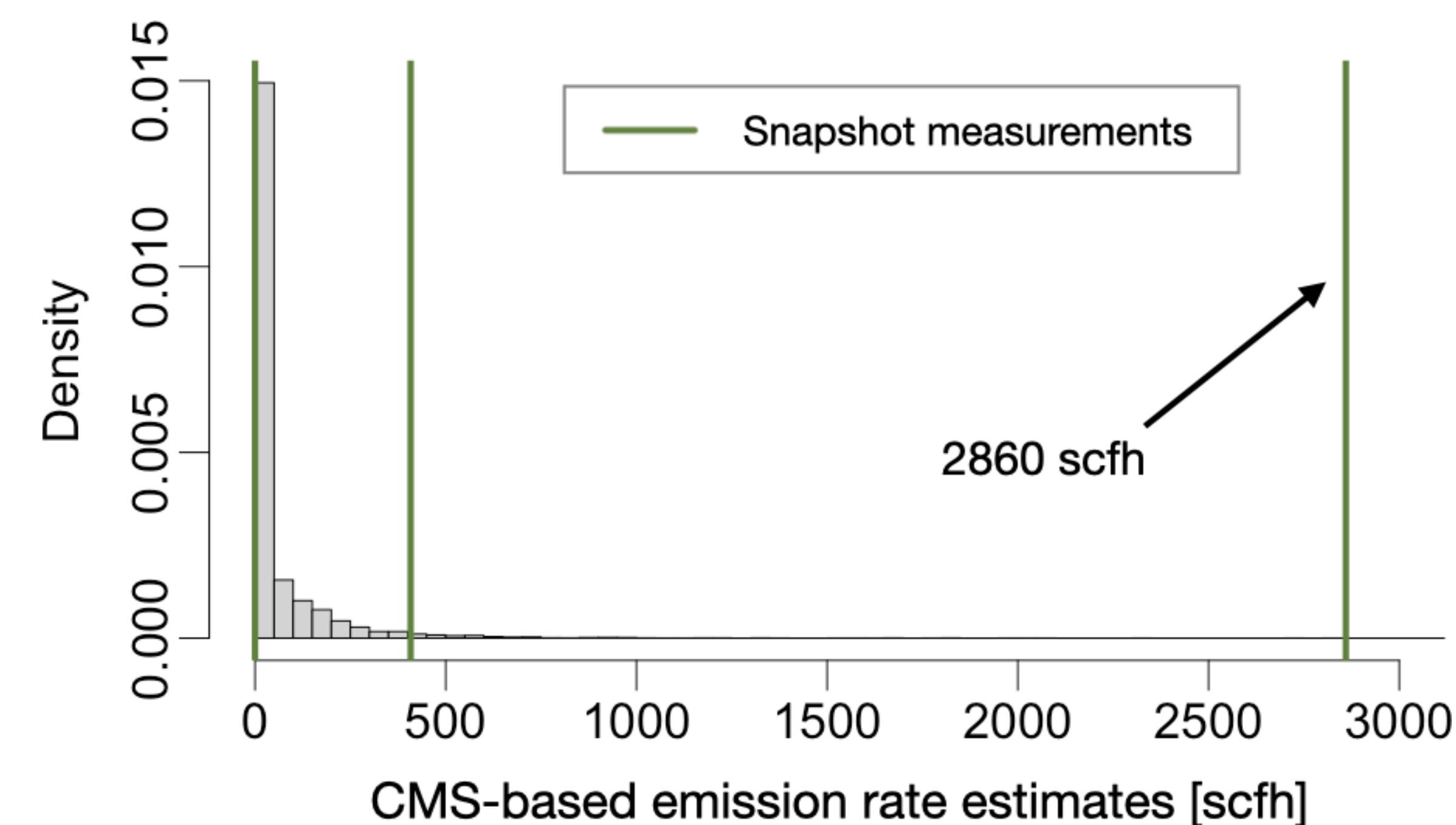

Figure 3: CMS-based rate estimates and snapshot measurements on site in Figure 1.

- Use the CMS data collected on this site to estimate emission rates over a long (6-month) time period.

- **Conclusion: 2860 scfh snapshot measurement was an unusually large emission for the site, as it is in the 99th percentile of CMS-based emission rate estimates.**

Use CMS to create measurement-informed inventory

- There was a large gap between the conventional inventory and snapshot measurements taken in April, 2022. Is the gap due to temporal variability or an underestimated inventory?
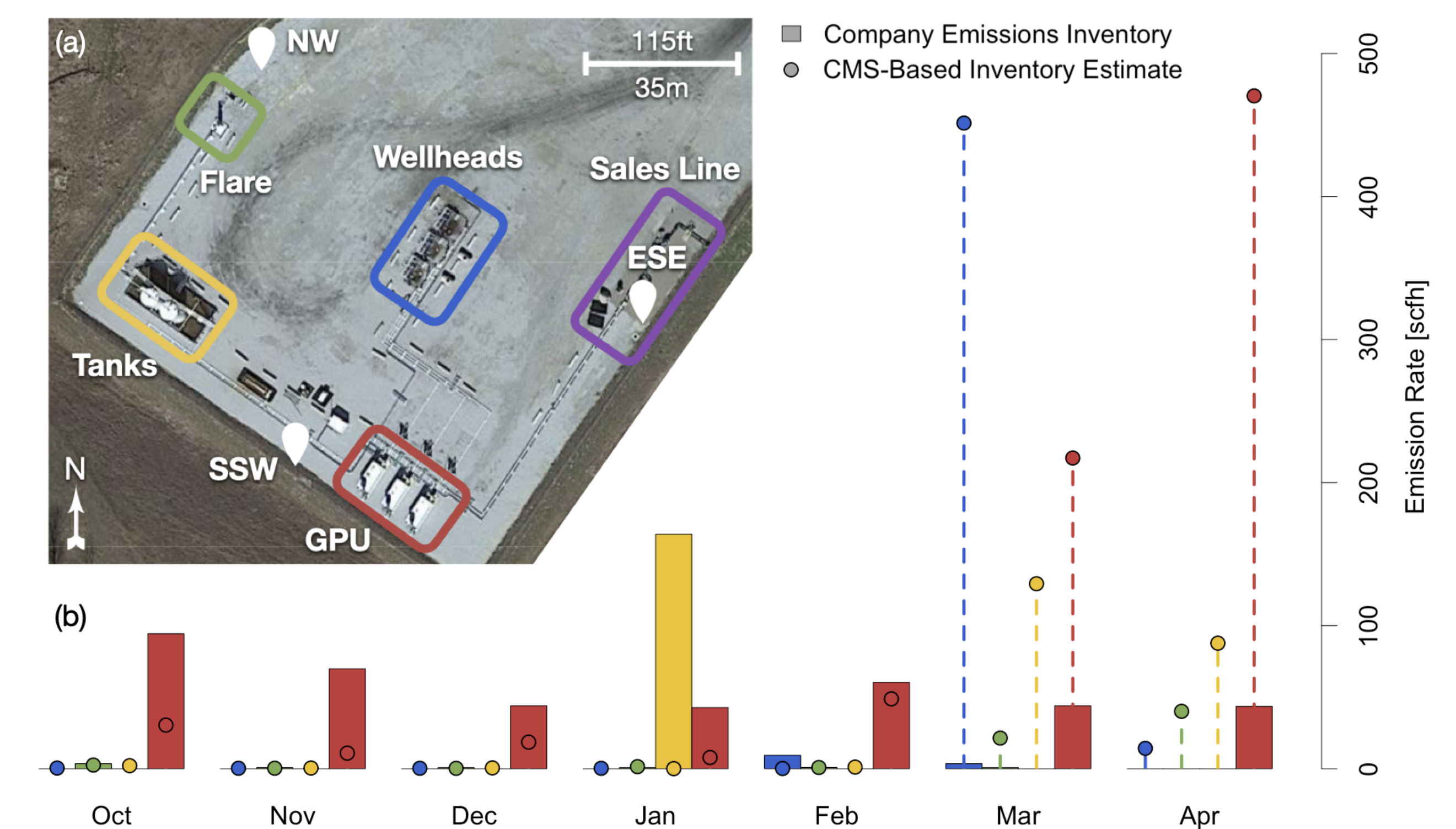

Figure 4: Conventional methane emissions inventory and CMS-based, measurement-informed inventory for the same time period. Note that the Sales Line is not owned by the operator and hence is excluded from both inventories.

- Create a measurement-informed inventory by taking monthly averages of the CMS rate estimates separated by emission source.

- **Conclusion: data-driven inventory reveals that conventional inventory did not adjust to GPU swap on February 23, 2022.**

Conclusions

1. CMS can be used to verify snapshot measurements.

2. CMS can be used to place snapshot measurements within the temporal emissions profile for a given site.

3. CMS can be used to create measurement-informed methane emissions inventories.

For more details, see Daniels et al. preprint!

References

[1] W. S. Daniels et al. "Towards multi-scale measurement-informed methane inventories: reconciling bottom-up inventories with top-down measurements using continuous monitoring systems". In: *ChemRxiv* (2023). DOI: 10.26434/chemrxiv-2023-jp5nt.