Project Canary

The case for continuous monitoring

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President & Co-founder

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Who We Are

- A Public Benefit Corporation, accountable to double bottom line of profit and social good.
- Certified B-corporation

Certified B Corporation

Selected Partners

NSF

Stanford | Natural Gas Initiative
School of Earth, Energy & Environmental Sciences and Precourt Institute for Energy

Energy Impact Partners

Colorado School of Mines

Alabama Power

techstars_

Quantum Energy Partners

Caltech

What We Do

Trusted, independent data.

TrustWell™ Certification

Verification of responsibility in natural gas production with respect to air, water, land and community

+

Continuous Monitoring

Independent, certified, and quantifiable data on methane emissions

Our sensor network

- Over 30 operators under contract
- Primarily, but not only, upstream production facilities
- Network of >200 sensors located across DJ basin, Marcellus, Green River, Permian, SE US
- Sensors each send data every minute

Selected Customers

NEXTDECADE
JONAH ENERGY LLC
BAYSWATER
CHESAPEAKE ENERGY
EQT
KINDER MORGAN
SWN Southwestern Energy®
Colorado Springs Utilities®
It's how we're all connected
New Jersey Natural Gas

Our Canary sensor

Field deployment

Human for scale

Anemometer

Ultra-sonic

Chemical sensor

TLDAS for methane,

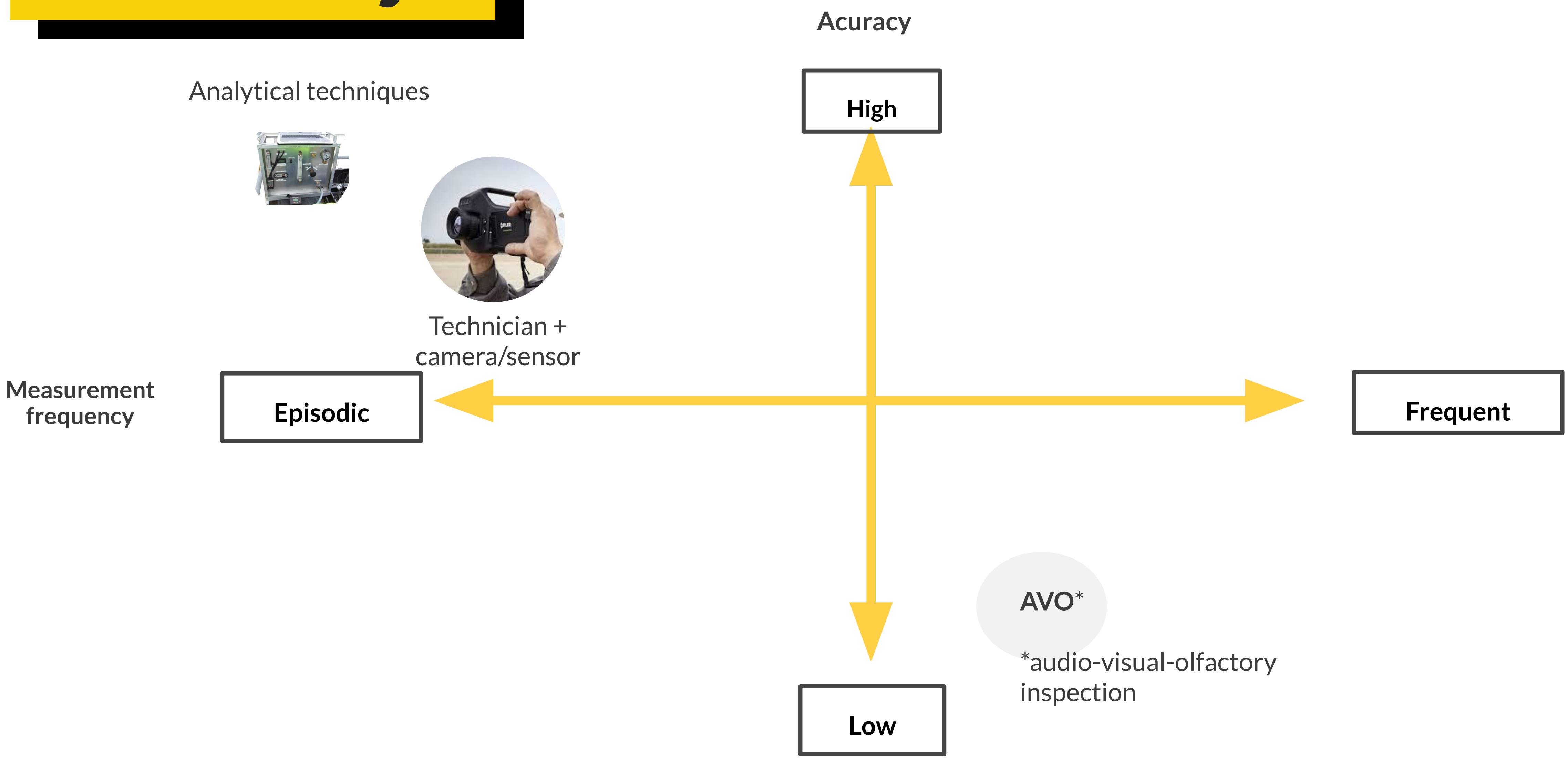
PID for tVOC

Solar panel

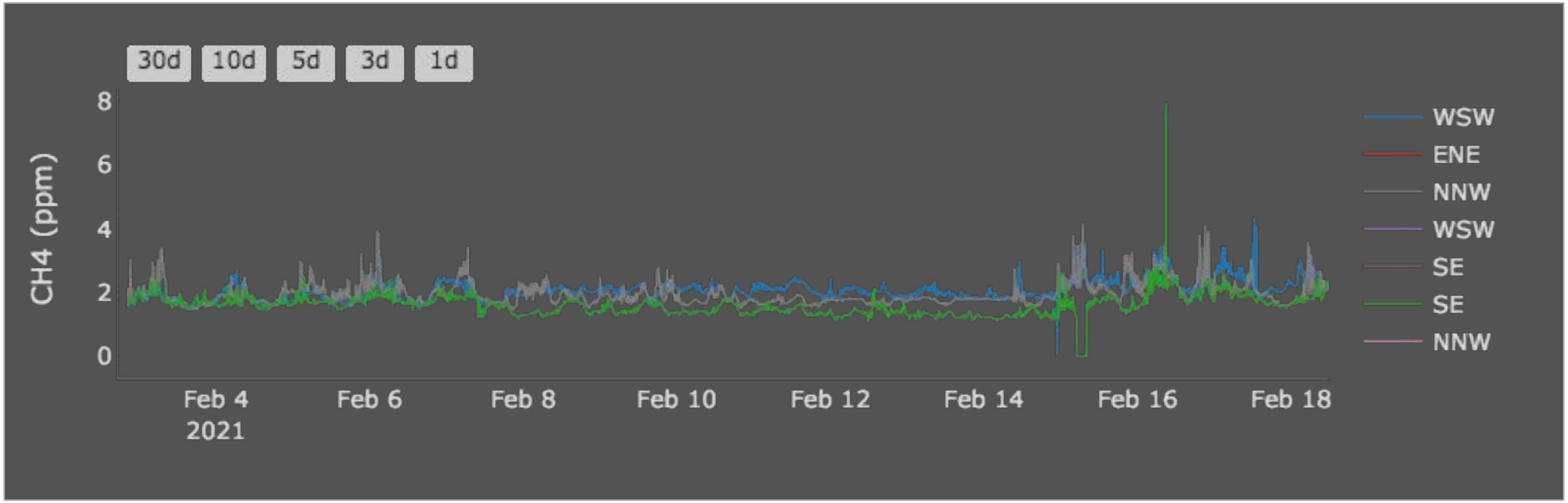
(Self-explanatory)

So why continuous monitoring?

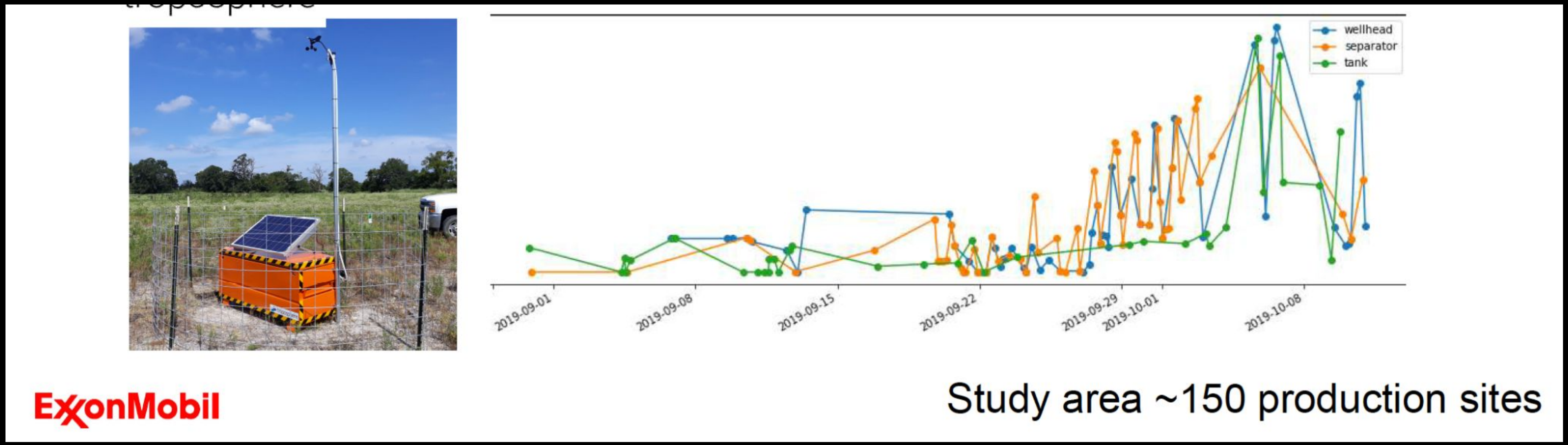
Traditionally...



Most emissions are intermittent.

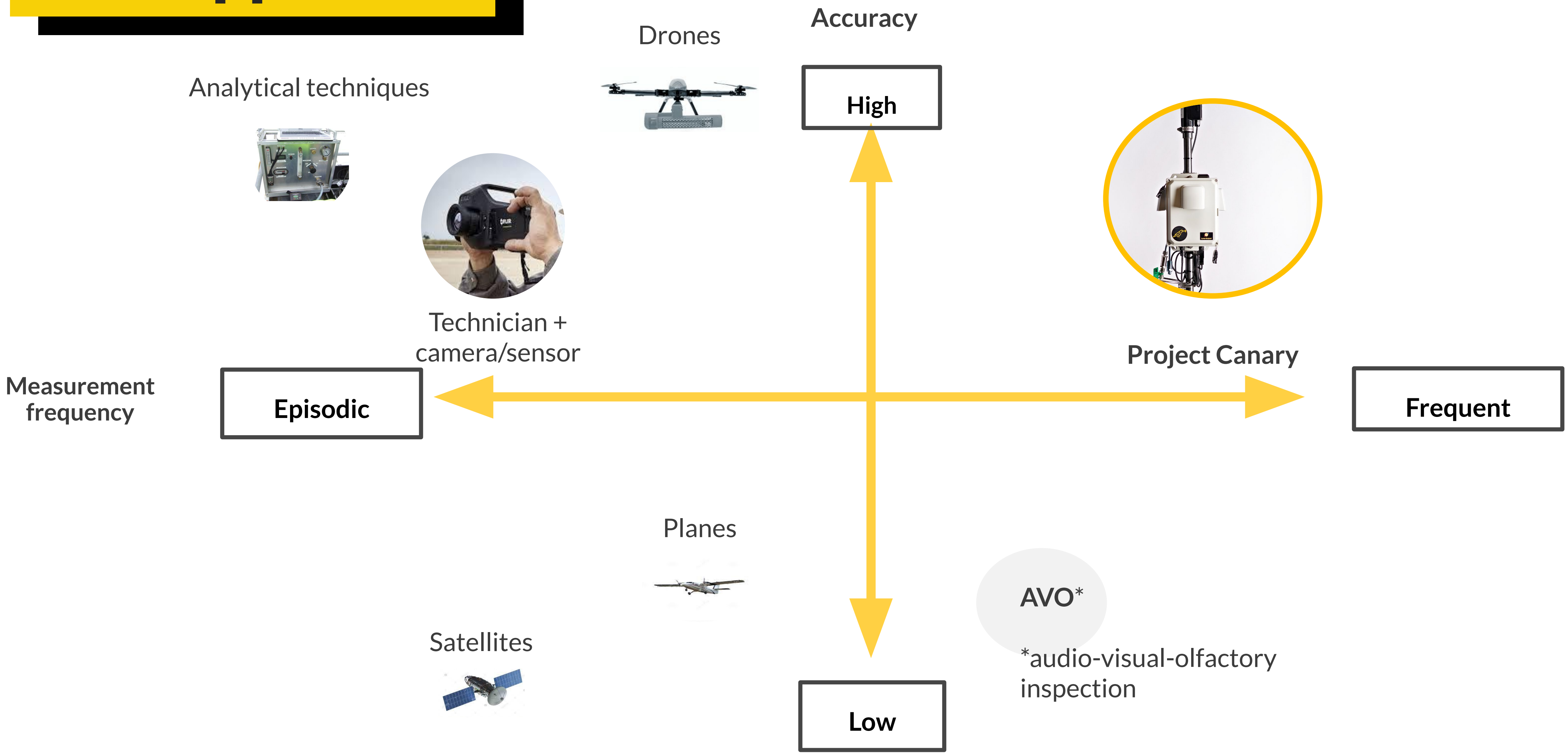


Also: small leaks grow.



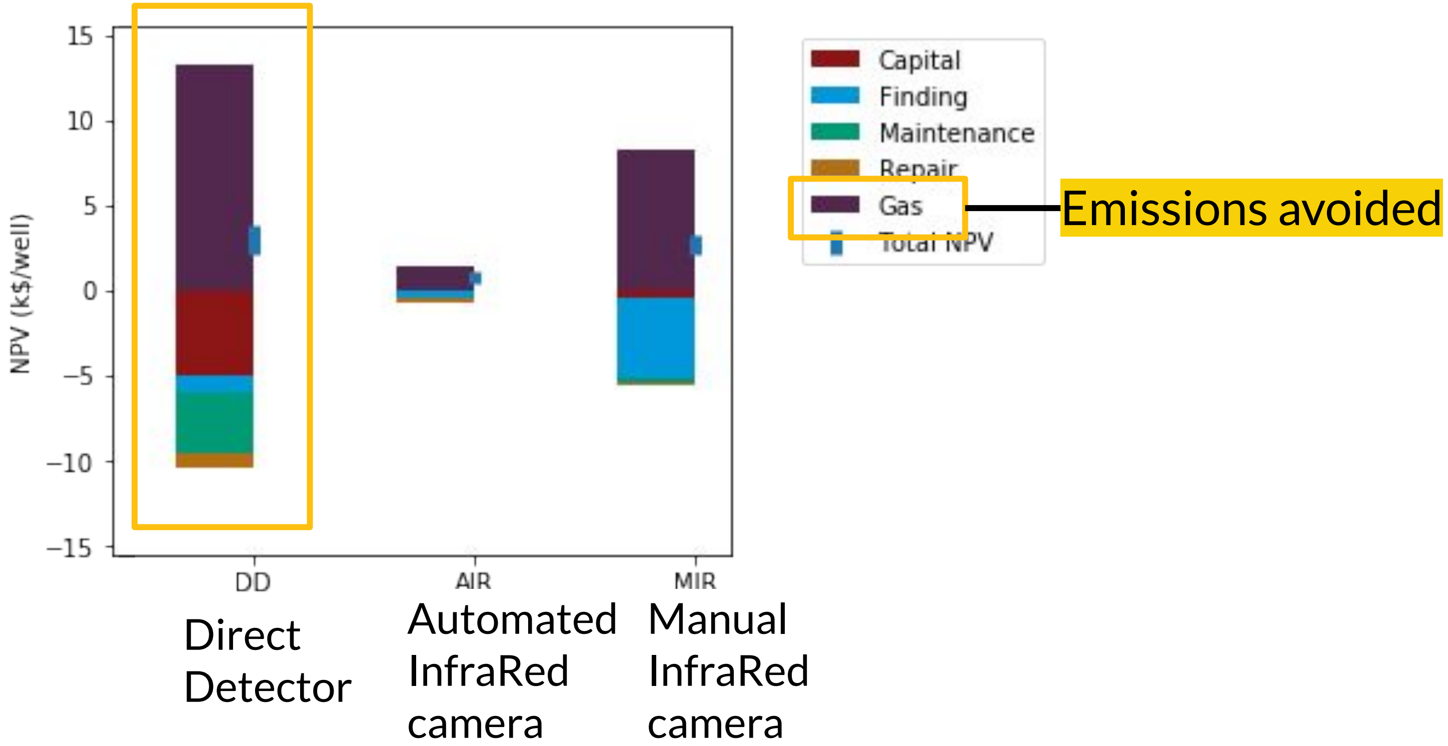
“High frequency monitoring… may offer faster emissions mitigation and insights into temporal patterns.” - from Tullos, Erin E., Sam Aminfard, Felipe J. Cardoso-Saldaña, David Allen, Isabel Mogstad, Langley DeWitt, Bradley Flowers et al. "*Insights from a Field Trial of Methane Detection Technologies*." AGU Fall Meeting 2019. AGU, 2019.

Our approach



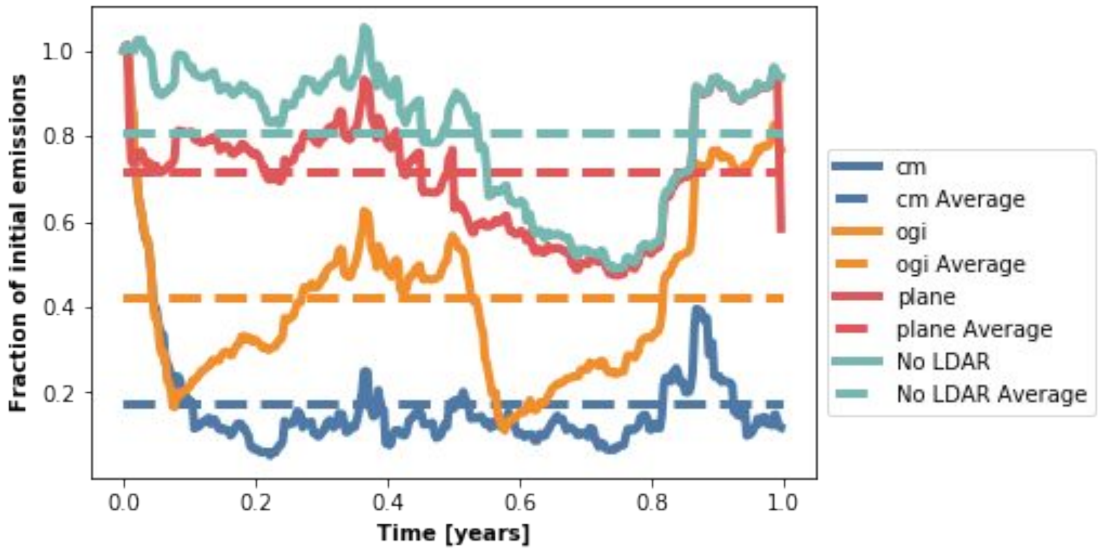
FEAST modeling v.1

FEAST model v2.0 results simulating a stationary sensor with 1ppm precision (current CanaryX is 4x more precise) showed gas savings exceeded those of manual infrared camera.



Source: FEAST: Fugitive Emissions Abatement Simulation Toolkit. Copyright (2016), Chandler E. Kemp; Arvind P. Ravikumar; Adam R. Brandt.

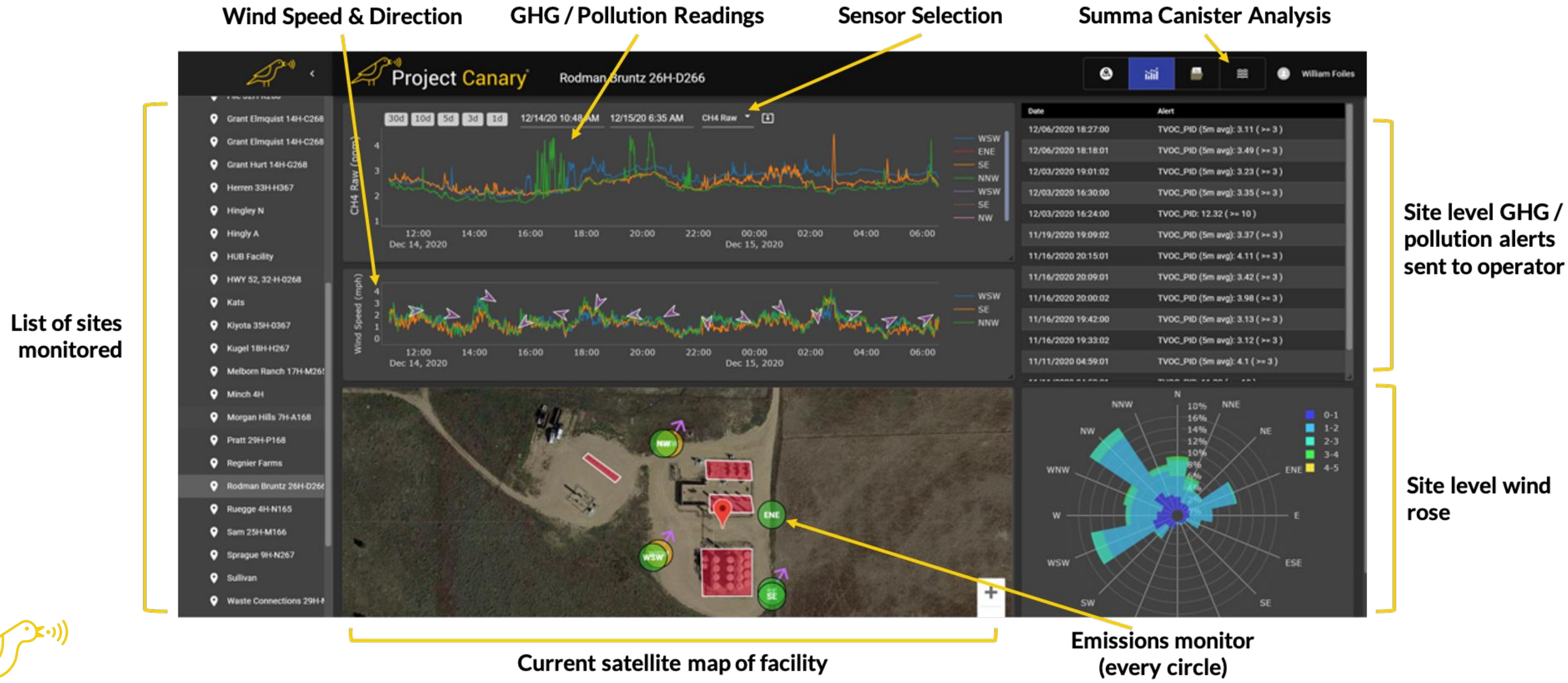
FEAST v3.1 modeling



Using continuous monitoring program (cm) for LDAR with the use of a follow-up OGI camera

- **avoids > 80% of emissions**
- reduces emissions by >2x compared with OGI camera only

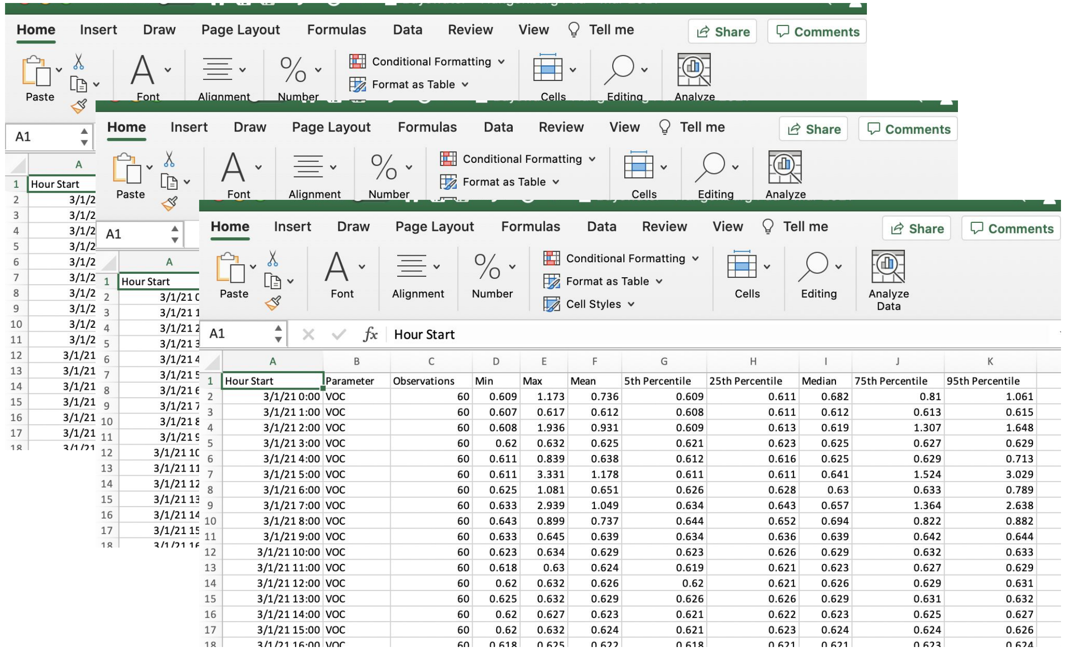
Implementation



Catching Issues Fast

Problem	Event Type	Time from Alert to Source Attribution/remediation	Solution
Liquid Knock Out Tank Frozen	Normal Operation	73 hours	Frozen tanks had to have their vapor lines disconnected, leading to emissions.
Inefficient Flaring	Hardware Inefficiency	42 hours	SCADA data confirmed that a combustor didn't light, flow pressure issues fixed - improving combustion.
Vapor Recovery Unit Pressure Issues	Hardware Inefficiency	7 hours	Vapor Recovery Unit pressure levels accounted for, preventing continued emissions.
Thief Hatch Left Open	Leak	4 hours	Operations team made aware of event; hatch closed and leak remediated.
Unplanned Storage Tank Venting	Hardware Inefficiency	40 minutes	A seal was stuck open, leading to pressure buildup in storage tanks leading to venting. Closing the seal fixed the issue.
Water Hauling Emissions	Process Inefficiency	10 minutes	Oil Field Services company didn't connect to vapor line. OFS companies addressed by HSE Dept.

Automated reporting



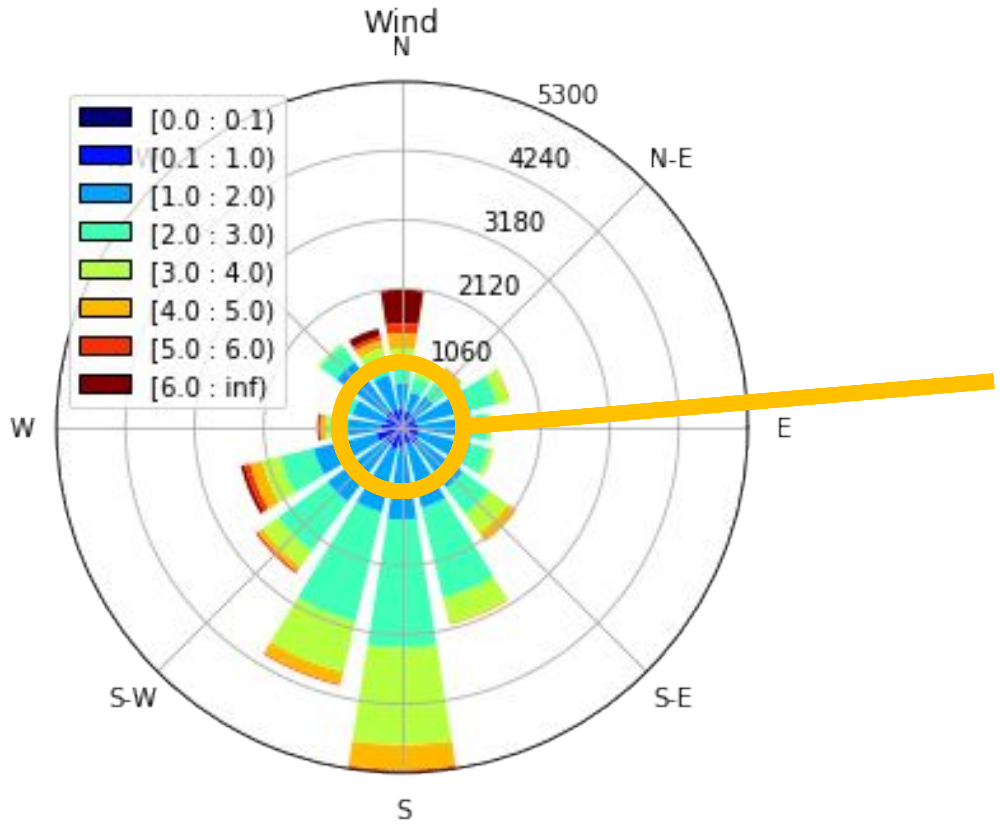
	A	B	C	D	E	F	G	H	I	J	K
1	Hour Start	Parameter	Observations	Min	Max	Mean	5th Percentile	25th Percentile	Median	75th Percentile	95th Percentile
2	3/1/21 0:00	VOC	60	0.609	1.173	0.736	0.609	0.611	0.682	0.81	1.061
3	3/1/21 1:00	VOC	60	0.607	0.617	0.612	0.608	0.611	0.612	0.613	0.615
4	3/1/21 2:00	VOC	60	0.608	1.936	0.931	0.609	0.613	0.619	1.307	1.648
5	3/1/21 3:00	VOC	60	0.62	0.632	0.625	0.621	0.623	0.625	0.627	0.629
6	3/1/21 4:00	VOC	60	0.611	0.839	0.638	0.612	0.616	0.625	0.629	0.713
7	3/1/21 5:00	VOC	60	0.611	3.331	1.178	0.611	0.611	0.641	1.524	3.029
8	3/1/21 6:00	VOC	60	0.625	1.081	0.651	0.626	0.628	0.63	0.633	0.789
9	3/1/21 7:00	VOC	60	0.633	2.939	1.049	0.634	0.643	0.657	1.364	2.638
10	3/1/21 8:00	VOC	60	0.643	0.899	0.737	0.644	0.652	0.694	0.822	0.882
11	3/1/21 9:00	VOC	60	0.633	0.645	0.639	0.634	0.636	0.639	0.642	0.644
12	3/1/21 10:00	VOC	60	0.623	0.634	0.629	0.623	0.626	0.629	0.632	0.633
13	3/1/21 11:00	VOC	60	0.618	0.63	0.624	0.619	0.621	0.623	0.627	0.629
14	3/1/21 12:00	VOC	60	0.62	0.632	0.626	0.62	0.621	0.626	0.629	0.631
15	3/1/21 13:00	VOC	60	0.625	0.632	0.629	0.626	0.626	0.629	0.631	0.632
16	3/1/21 14:00	VOC	60	0.62	0.627	0.623	0.621	0.622	0.623	0.625	0.627
17	3/1/21 15:00	VOC	60	0.62	0.632	0.624	0.621	0.623	0.624	0.624	0.626
18	3/1/21 16:00	VOC	60	0.618	0.625	0.622	0.618	0.621	0.621	0.623	0.624

Critical to program and saves hours of labor. Thanks to CDPHE for working with us!

Some lessons we’ve learned.

Sensor placement doesn't matter

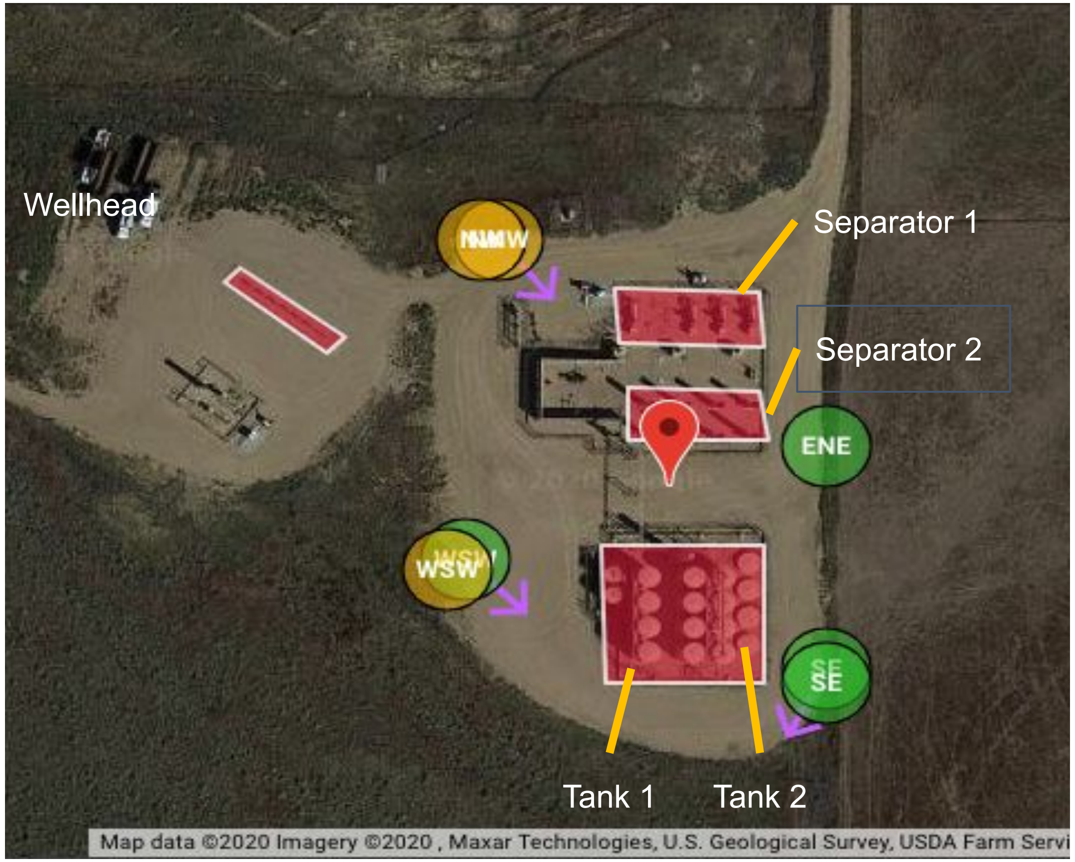
Wind shifts frequently in the field, allowing for thousands of measurements even when not in prevailing wind direction.

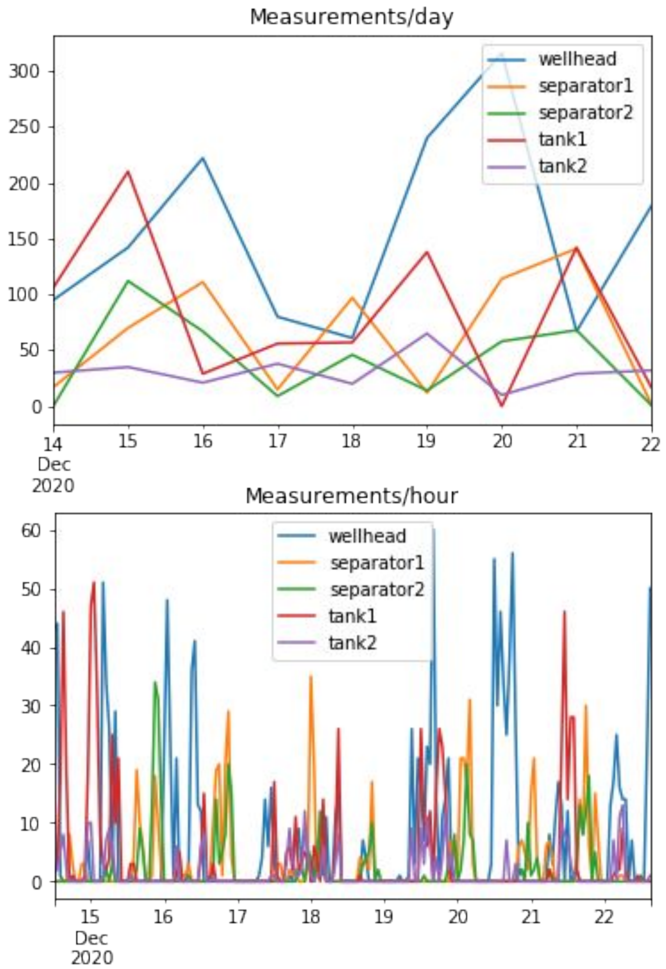


Thousands of data points from every direction

Sensor placement doesn't matter

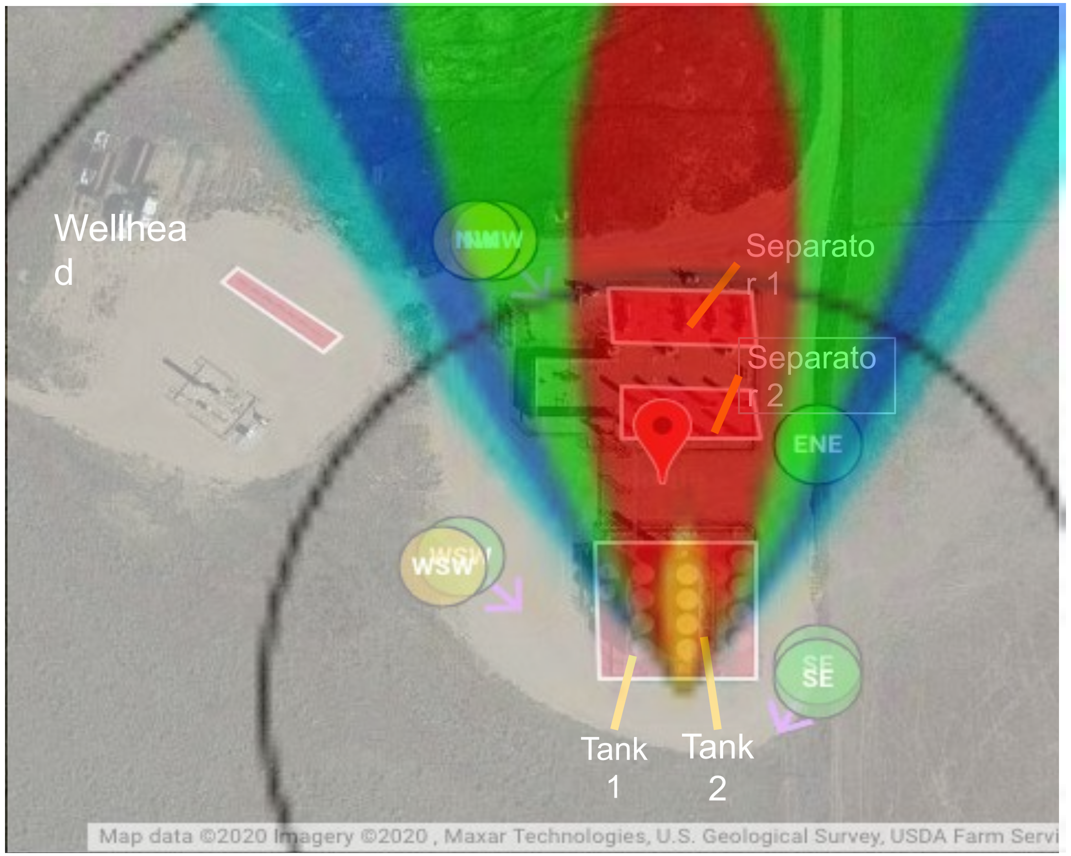
Canary methane sensors collect 376 measurements/day across multiple equipment groups

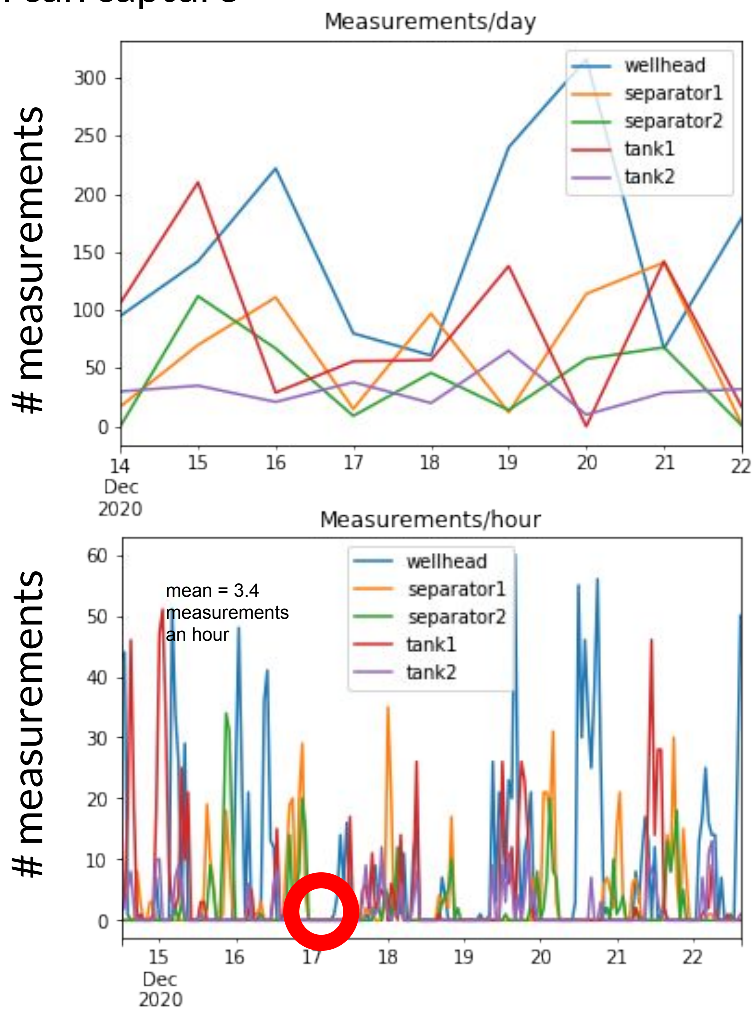




Sensor placement doesn't matter

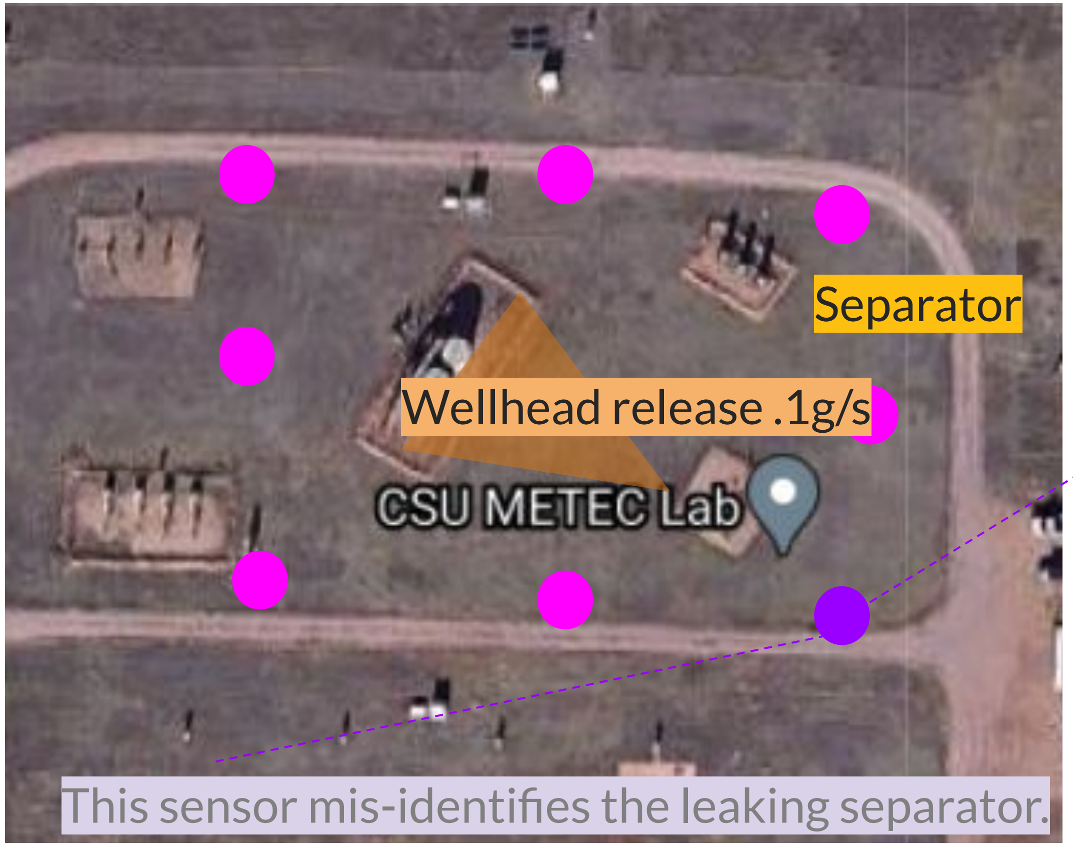
Spotlight on Dec. 17: even when wind doesn't blow directly, still can capture leaks.

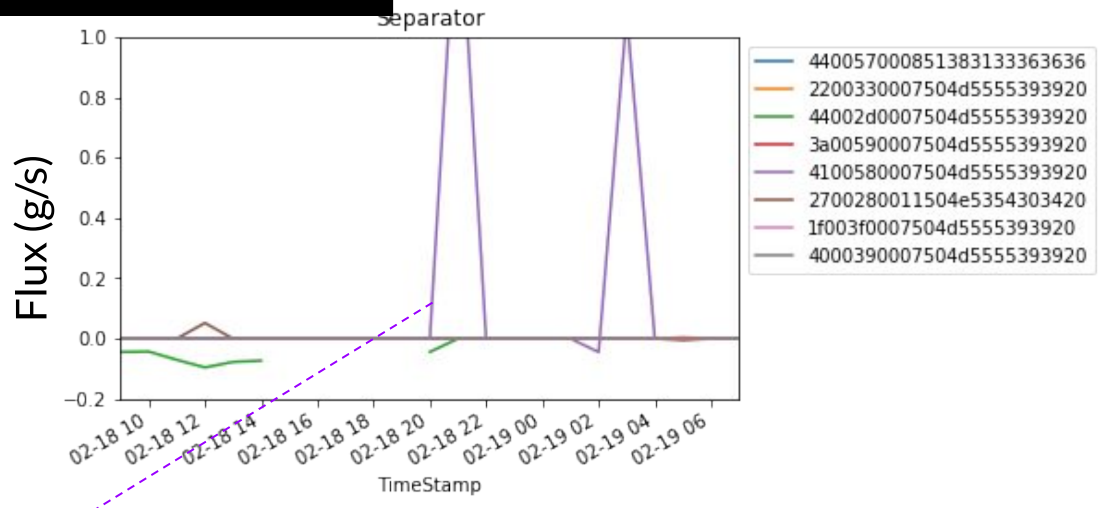


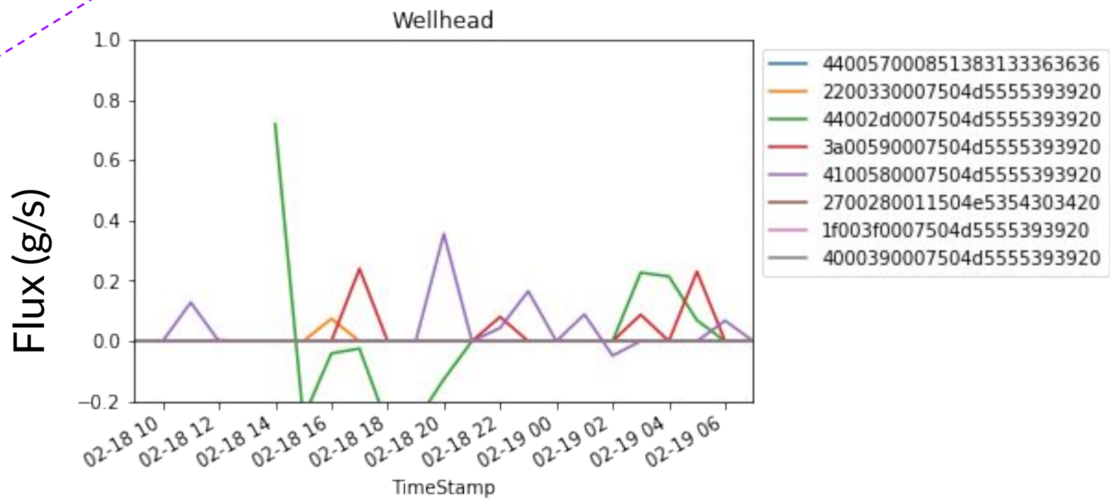


Sensor placement does matter*

*for a mass emissions flux calculation







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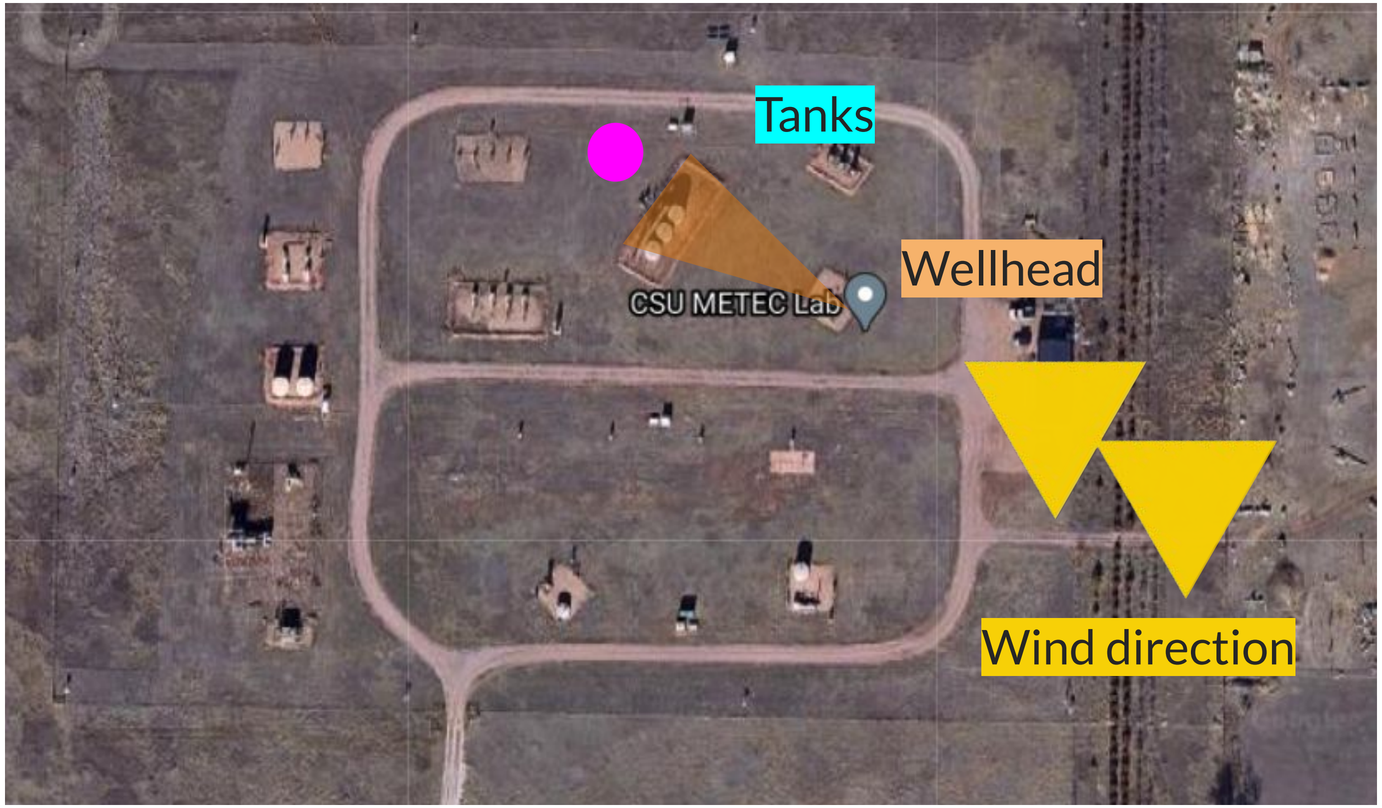
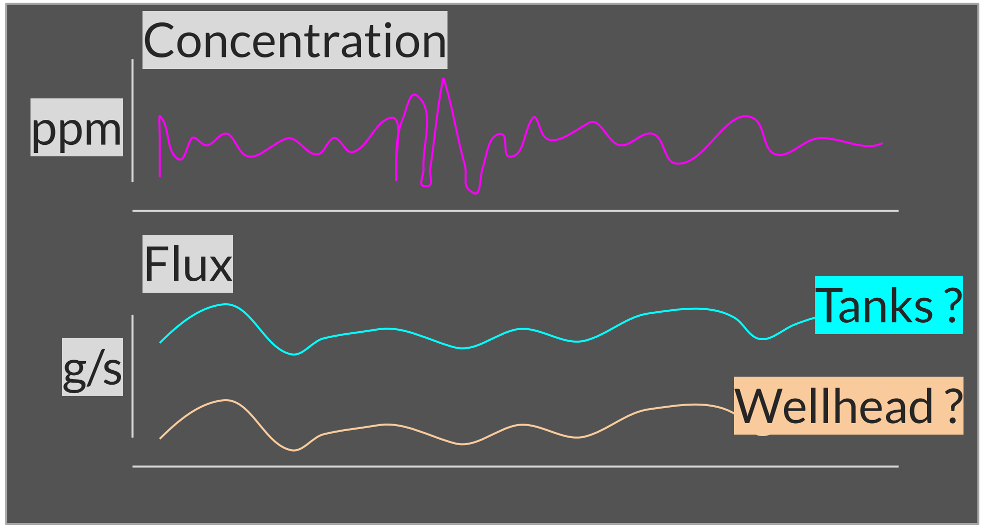
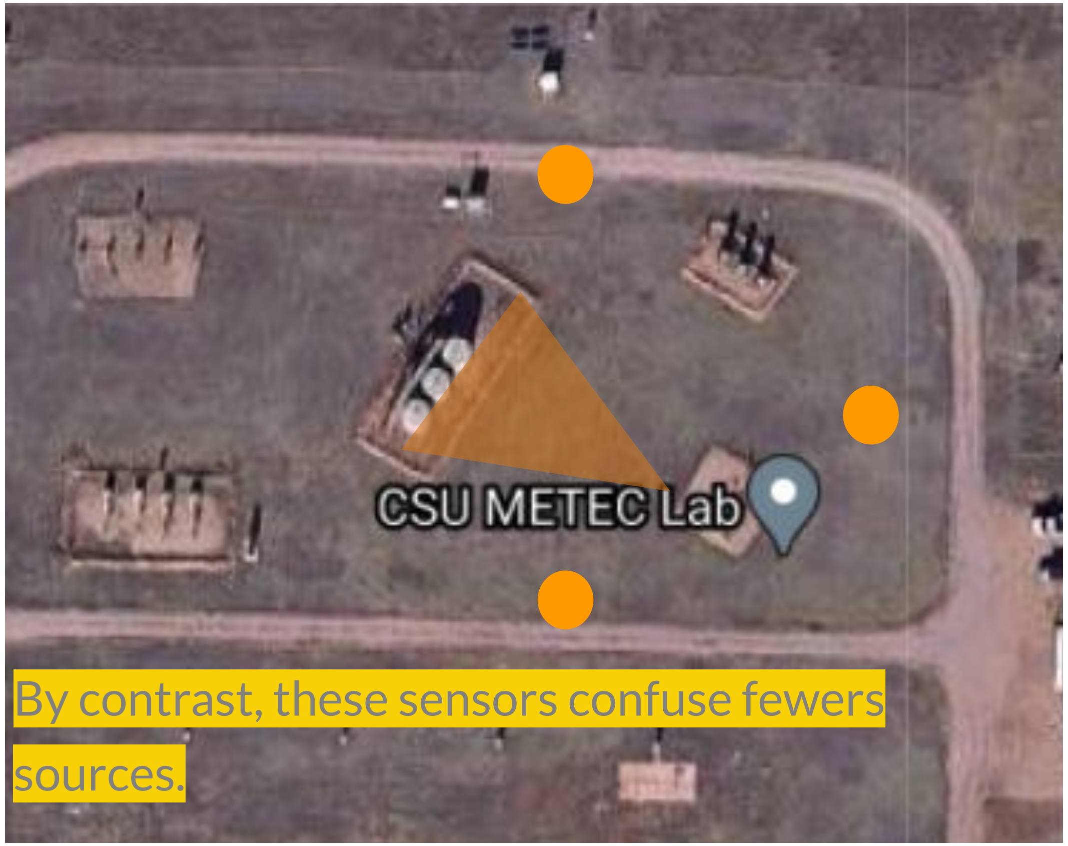


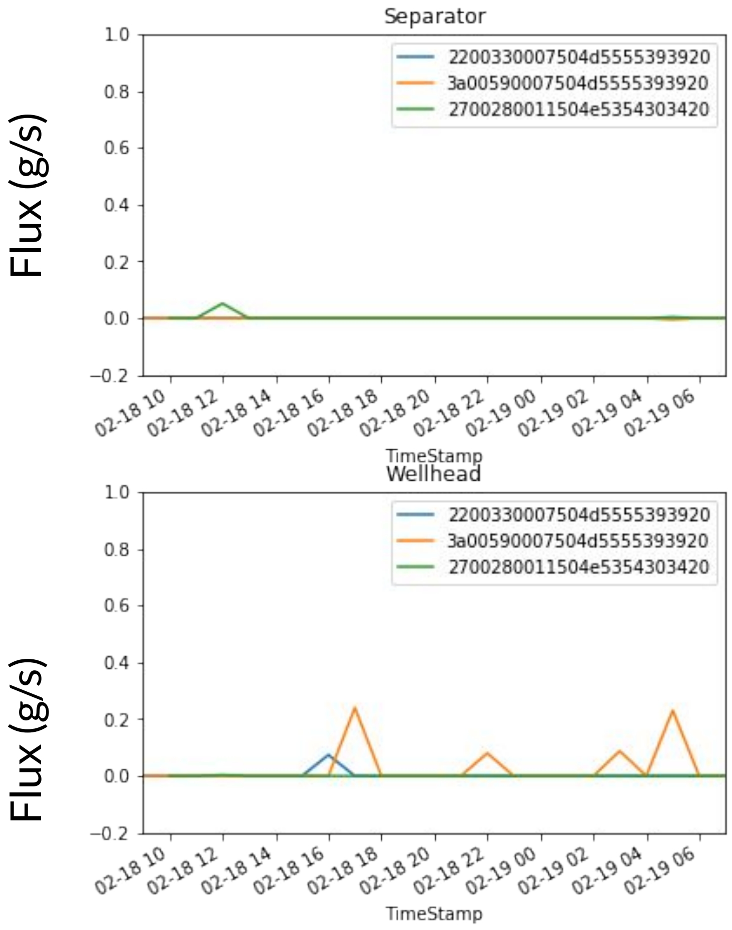


Unclear if detector is seeing a large leak from the tanks or a small leak from the wellhead.

Why placement matters



By contrast, these sensors confuse fewers sources.



Height sensitivity low

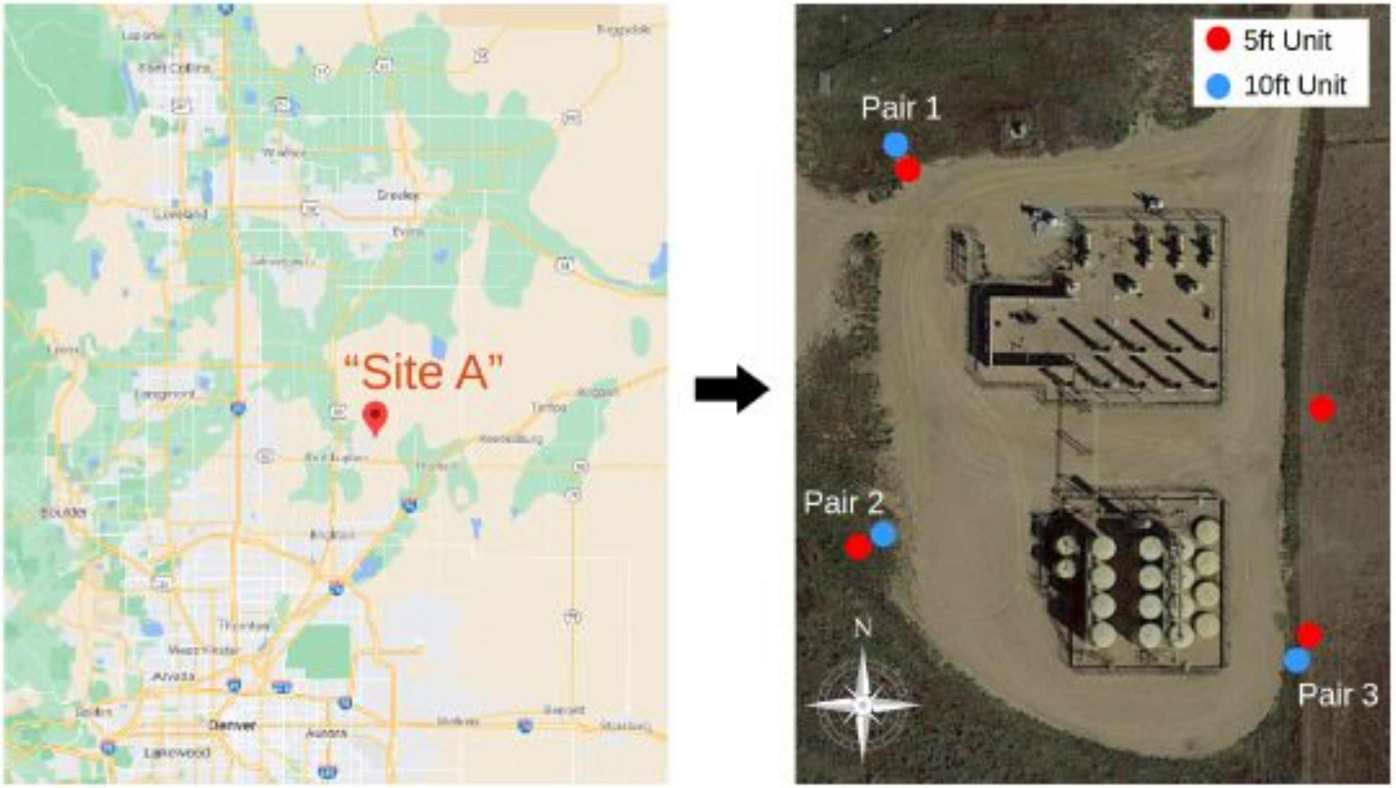


Figure 1: Location and layout of test site, with positions of 5 and 10 foot units marked as red and blue circles, respectively.

- 14 large emission events (>0.4 ppm) were analyzed across for one facility for a 6 week period
- Sensors placed at 5 feet and 10 feet were compared

Source: William Daniels and Dorit Hammerling at Colorado School of Mines with Project Canary data

Height sensitivity low

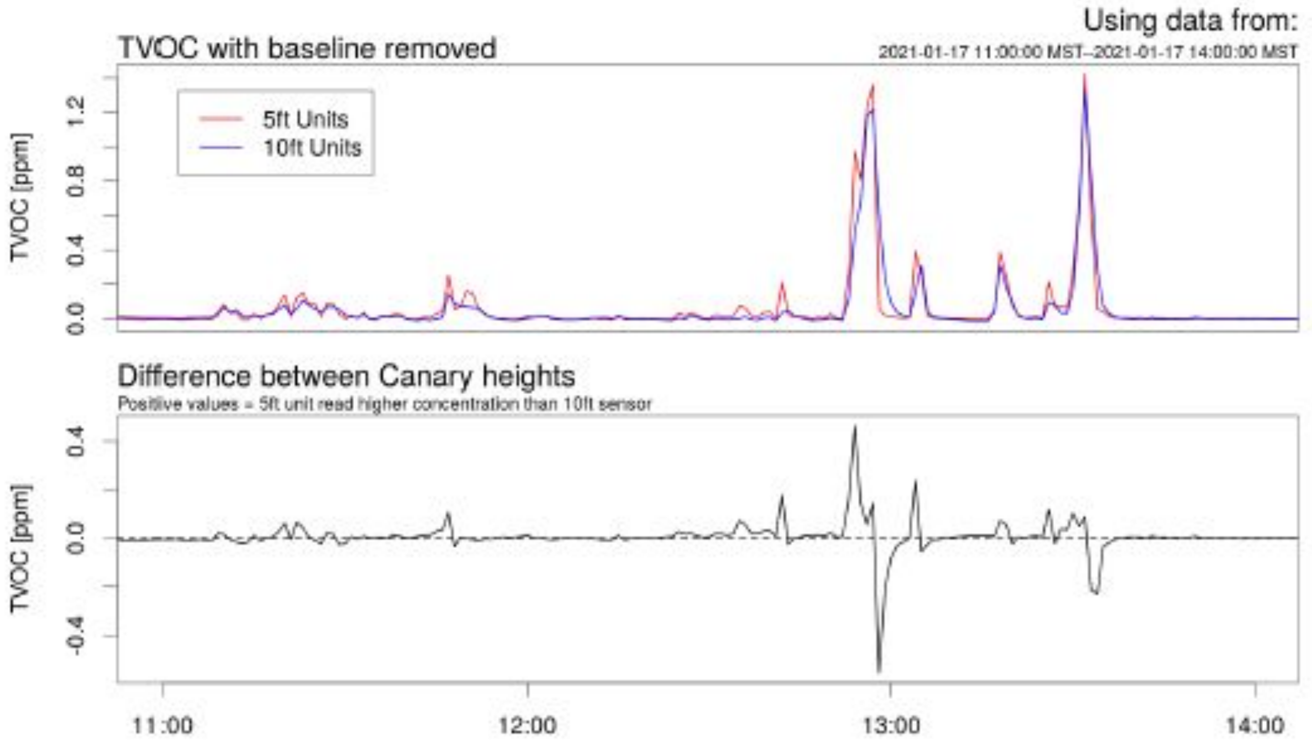
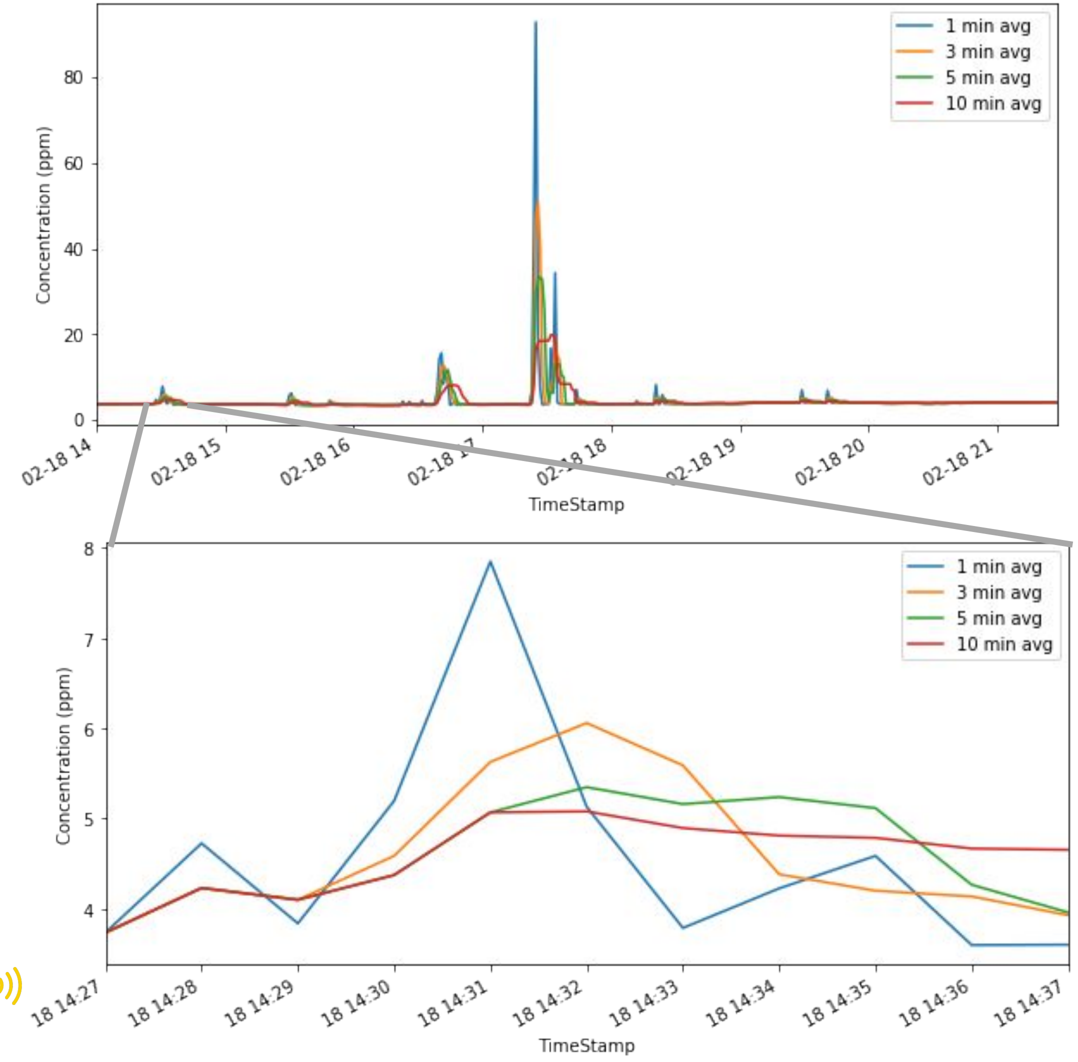


Figure 4: Baseline corrected VOC signals and their difference during the emission event shown in Figure 3.

- Higher units see higher concentrations, but these can be explained by calibration differences (average difference of 0.43 ppm)
- "5 foot **height difference** has a relatively **low impact** on observed VOC concentrations"

Source: William Daniels and Dorit Hammerling at Colorado School of Mines with Project Canary data

Sensor response time matters



For big events, a slow sensor response time may not matter (except, of course, in quantification).

For smaller events, a slow sensor response time may result in not seeing the event

Conclusions

- Market forces driving adoption of emissions monitoring technology in the natural gas supply chain
- Continuous monitoring effective LDAR method to achieve emissions reduction
- Sensor placement not as important as measuring in the first place
- Low sensitivity to height
- Mass emissions flux calculations sensitive to sensor placement, but not event detection
- Sensor response time is important

Reach out anytime at:

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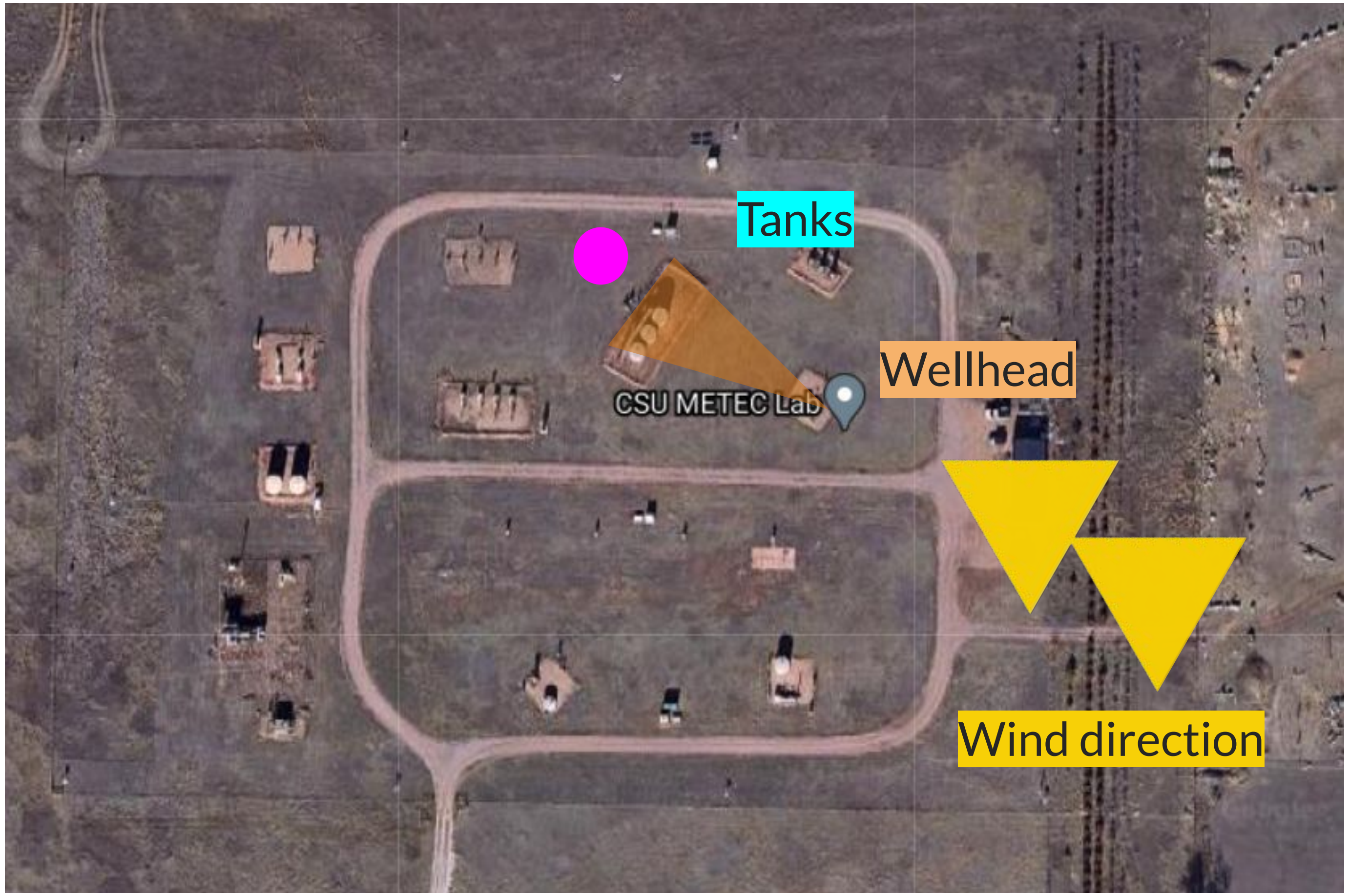
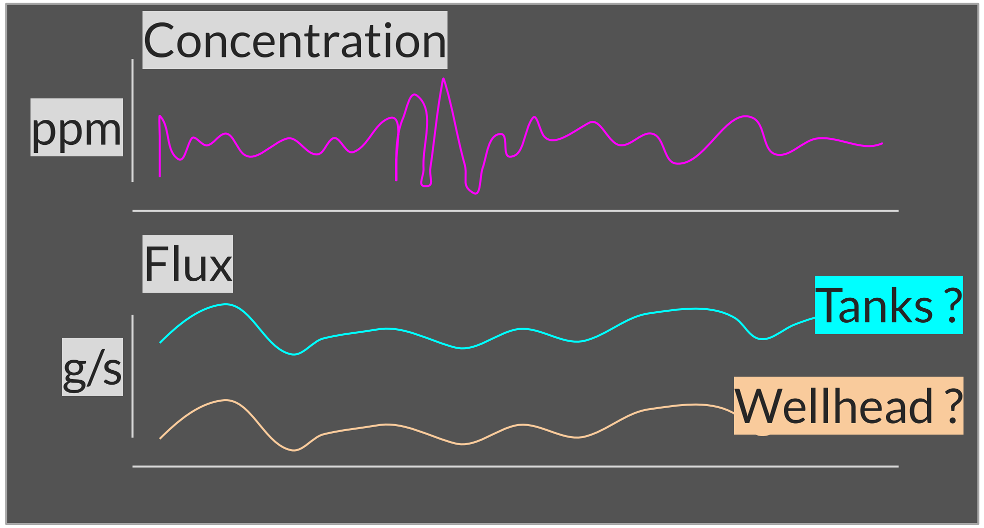
Payne Institute Report

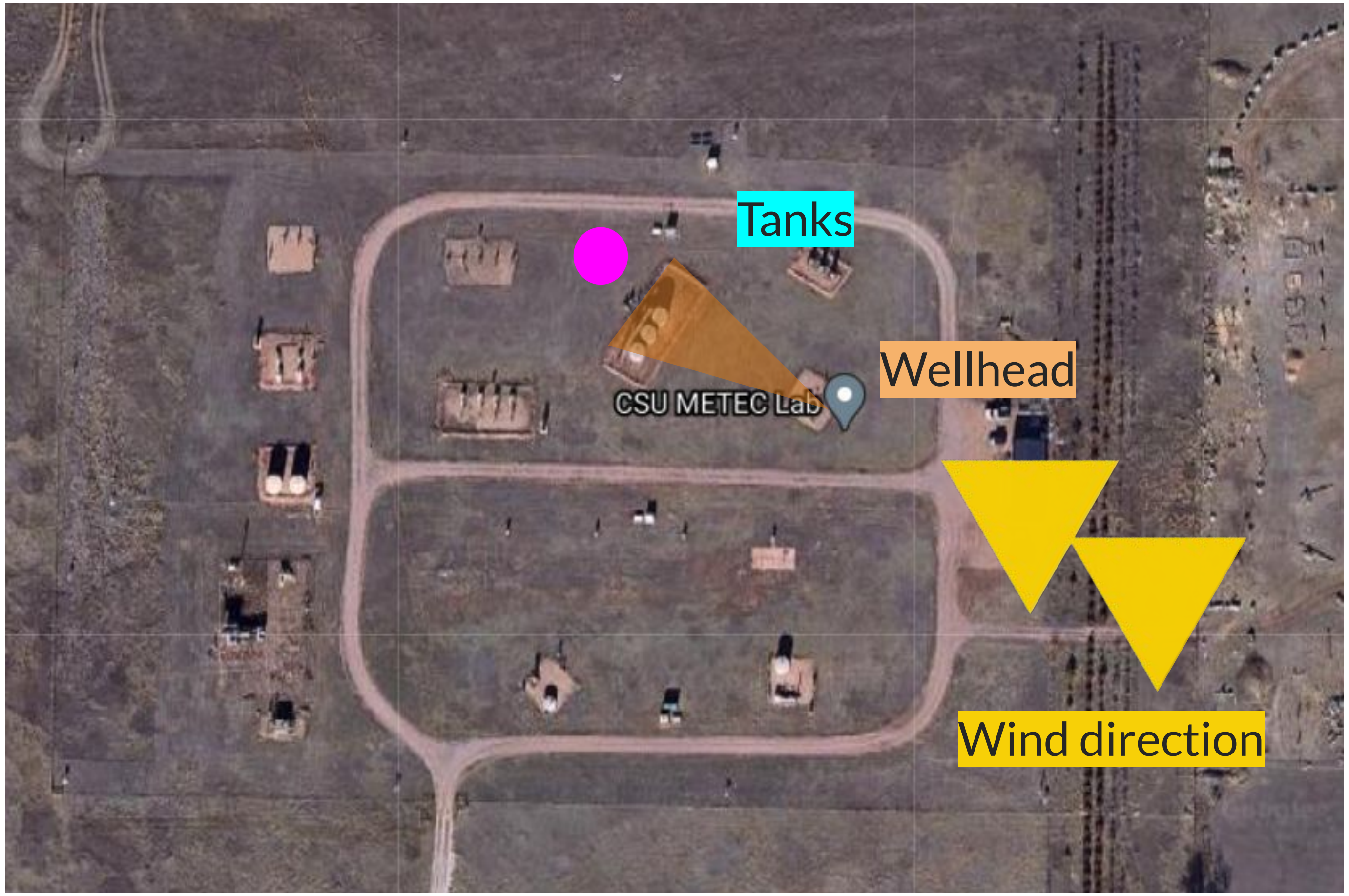
1. Localization matters

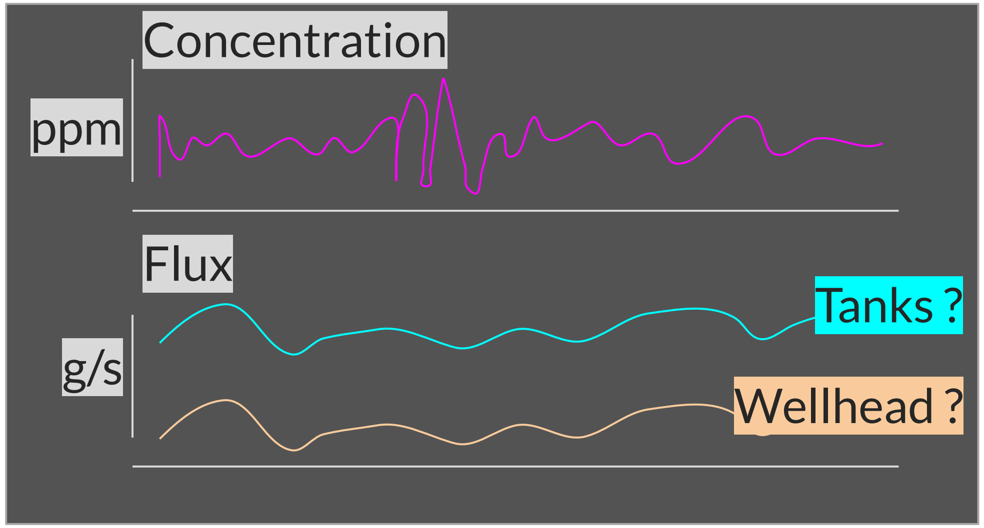




Unclear if detector is seeing a large leak from the tanks or a small leak from the wellhead.

1. Localization matters





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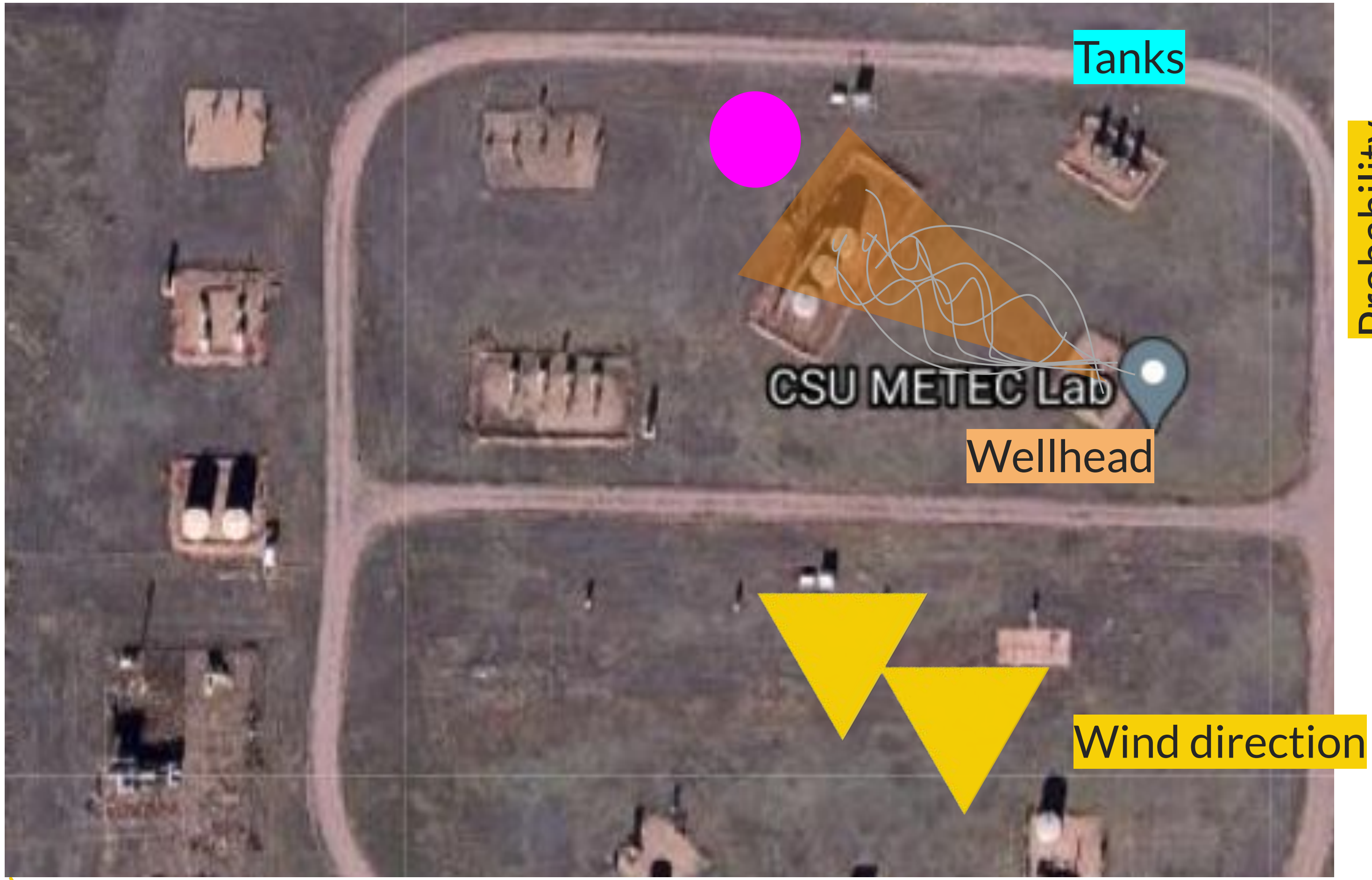
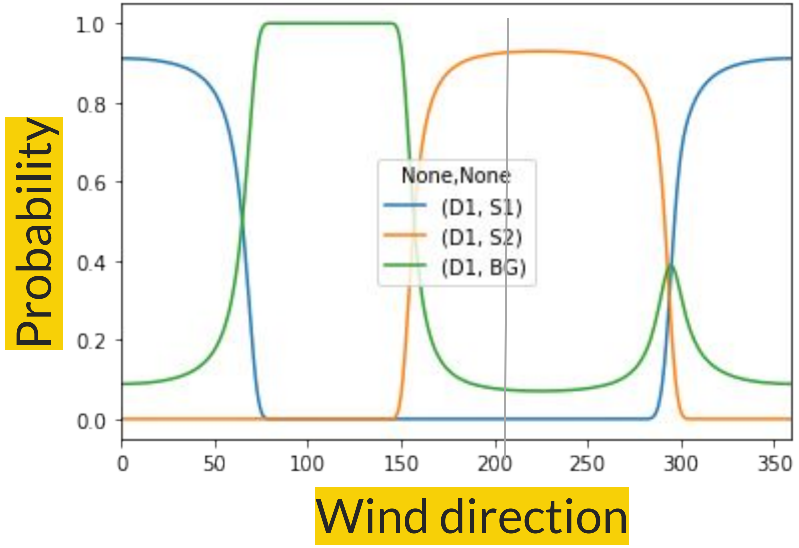
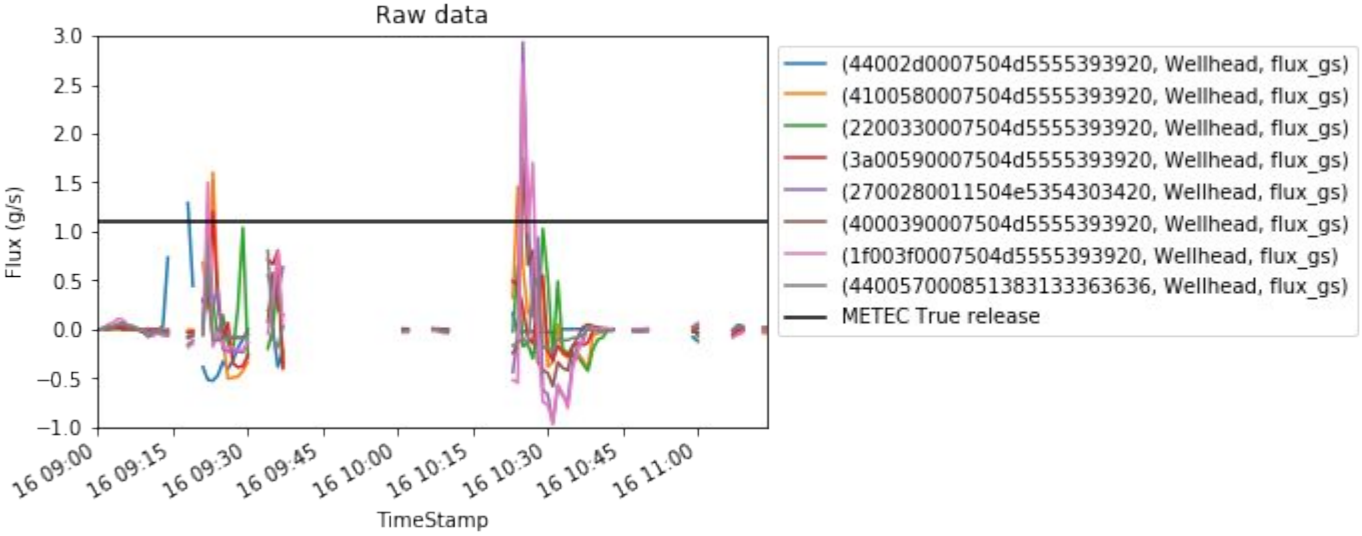




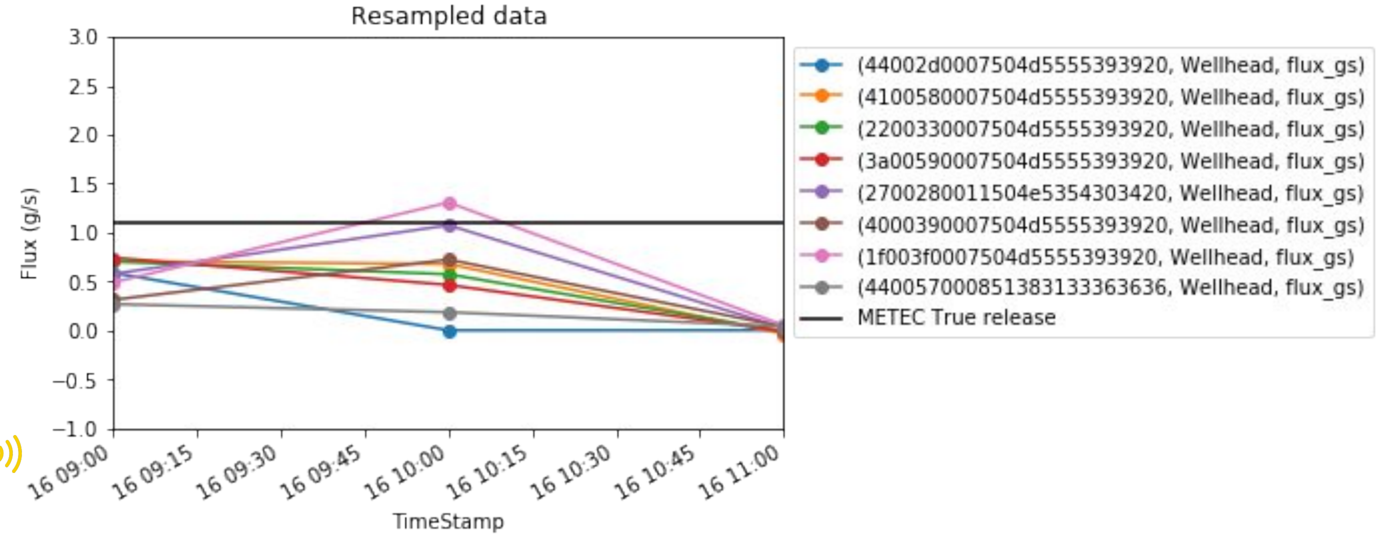
	Wellhead	Separator	Tanks
Probability	10%	5%	75%

Resampling



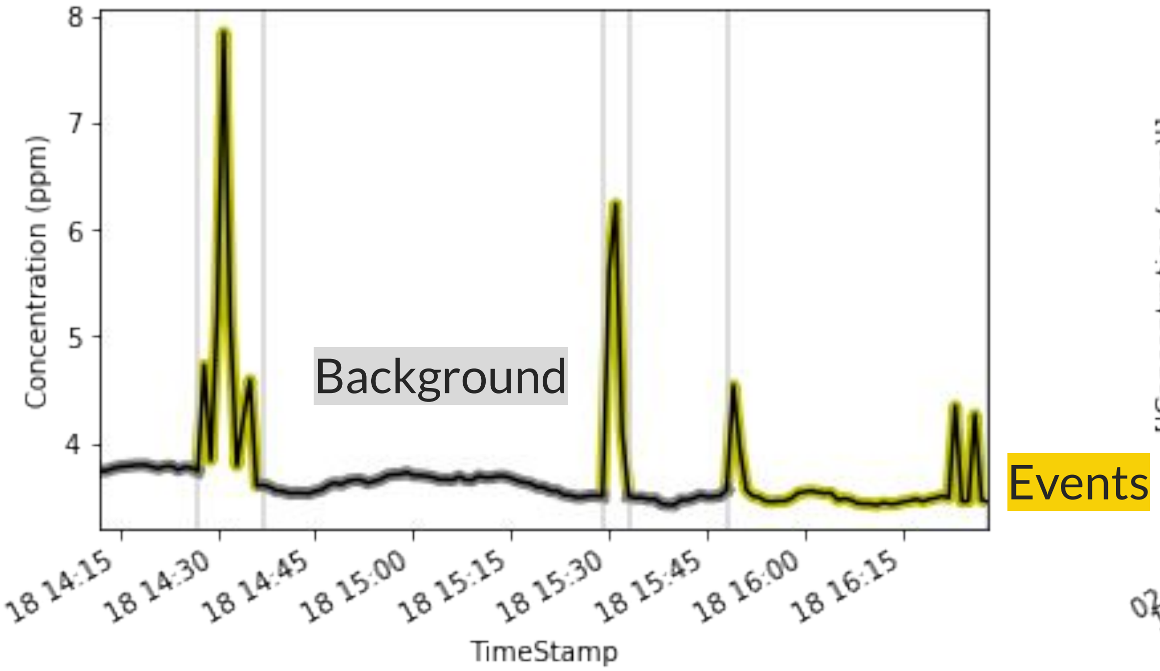
Minute data is noisy because plume moves around.

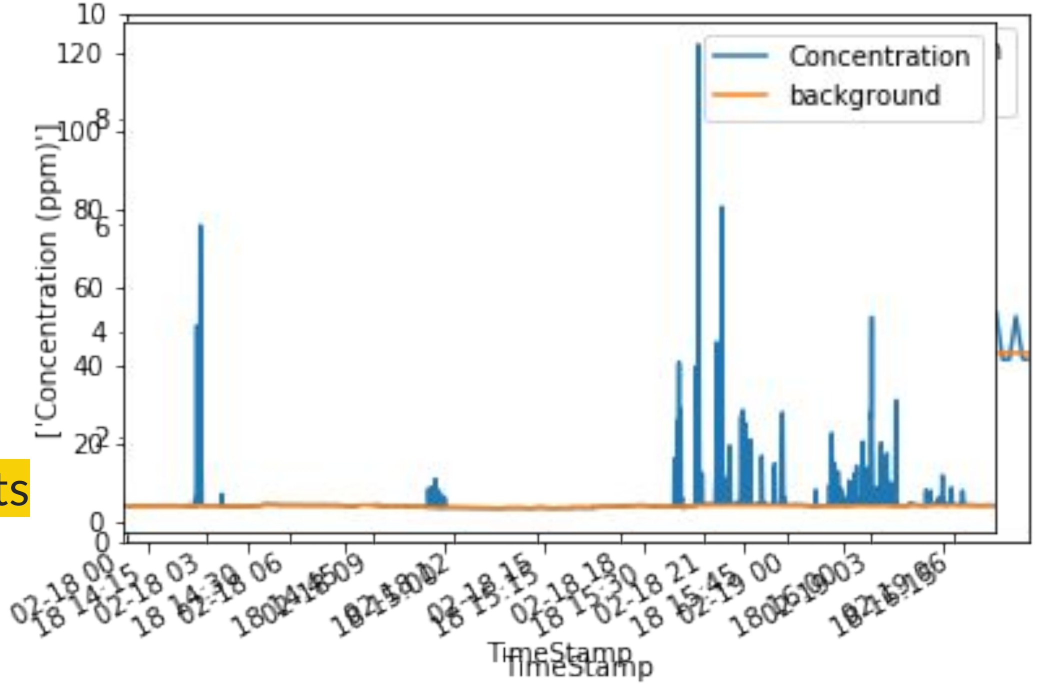
Maximum data overestimates, suggesting model incorrectly describes dispersion.



Resampled data provides better estimate, but 2 hourly is best.

2. Background calculation





Non events help calculate the background.

Project Canary

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