Fenceline and Community Sensor Applications and Comparisons

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Outline

- Difference between fenceline and community sensor applications
- Examples of fenceline measurements from 2-year EPA SPod study
- Fenceline-style baseline correction (time-series based)
- Comparison study of 5 collocated sensor pairs as seen from fenceline and community perspectives

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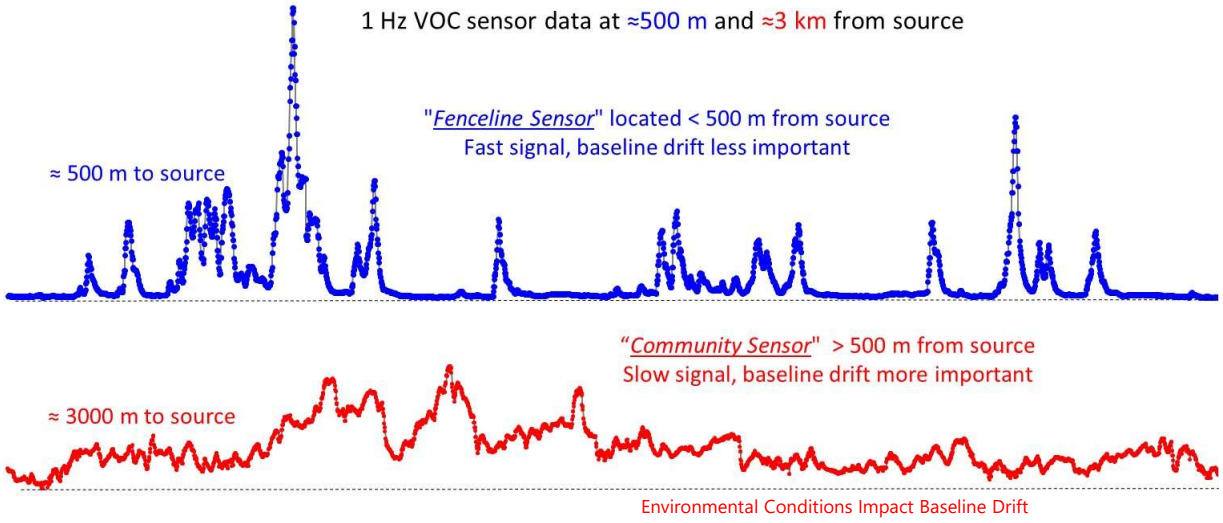
Difference in Fenceline and Community Sensor Applications



VOC = Volatile Organic Compound

Adapted from: Thoma, et al. "Rubbertown next generation emissions measurement demonstration project." Int. J. Environ. Res. Public Health 16.11 (2019): 2041.

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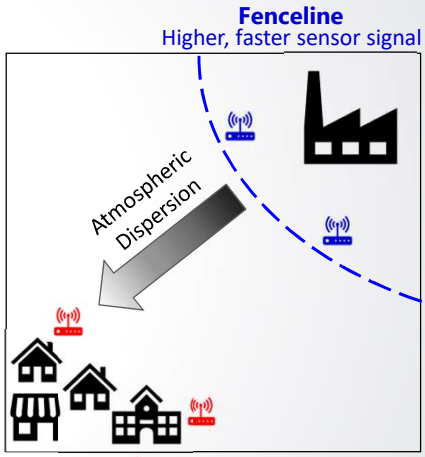
Emission Plumes Change with Distance from Source

Application	Purpose	Sensor Needs
Fenceline	Detect anomalous emissions for repair	• Fast response helpful • Accuracy and baseline drift not as important
Community	Quantify ambient VOC levels	• Fast response not as important • Precise and accurate measurements needed



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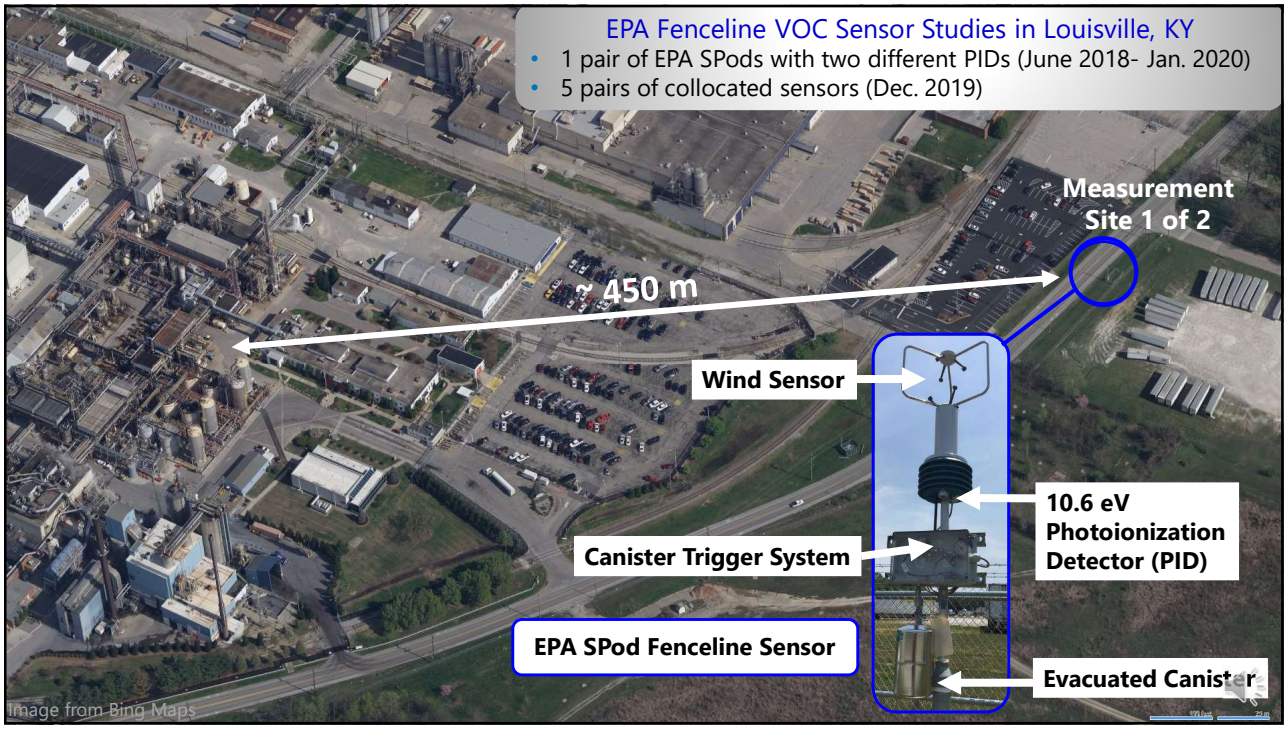
EPA Fenceline VOC Sensor Studies in Louisville, KY
• 1 pair of EPA SPods with two different PIDs (June 2018- Jan. 2020)
• 5 pairs of collocated sensors (Dec. 2019)
Measurement Site 1 of 2
≈ 450 m
Wind Sensor
10.6 eV Photoionization Detector (PID)
Canister Trigger System
EPA SPod Fenceline Sensor
Evacuated Canister
Image from Bing Maps

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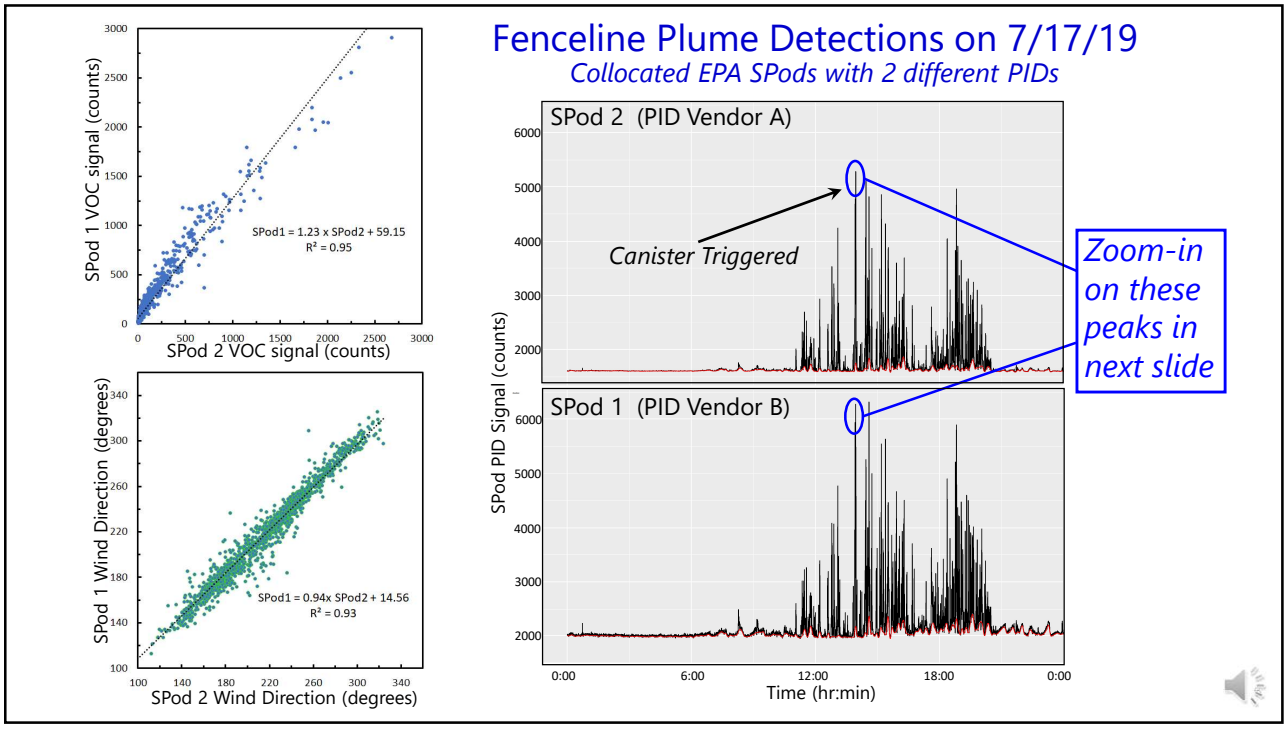
Fenceline Plume Detections on 7/17/19
Collocated EPA SPods with 2 different PIDs
SPod 1 VOC signal (counts)
SPod 2 VOC signal (counts)
SPod1 = 1.23 x SPod2 + 59.15
R² = 0.95
SPod 1 Wind Direction (degrees)
SPod 2 Wind Direction (degrees)
SPod1 = 0.94x SPod2 + 14.56
R² = 0.93
SPod 2 (PID Vendor A)
Canister Triggered
SPod 1 (PID Vendor B)
SPod PID Signal (counts)
Time (hr:min)
Zoom-in on these peaks in next slide

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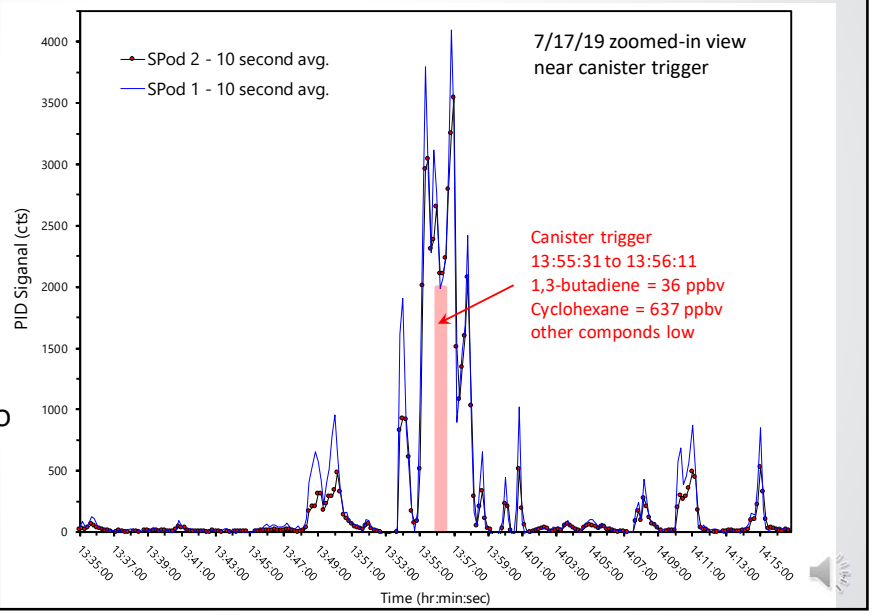
Zoom-in on Data from 7/17/19

- Near the source, the emission plume has yet to disperse
- Sensor signal changes rapidly with wind direction
- Fenceline sensors need to be fast, especially for canister grab samples



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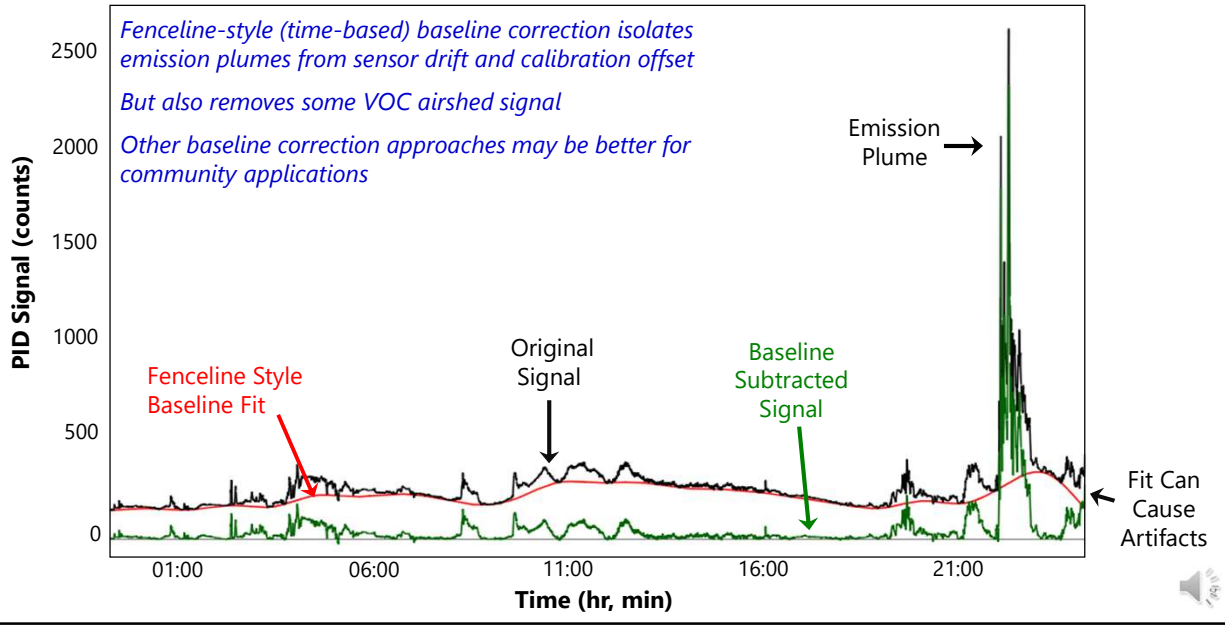
Fenceline-style Baseline Correction on 12/21/19



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VOC Sensor Comparison Study

12/15/19 – 1/5/20, Louisville, KY

- 450 m from a chemical facility
- 4 pairs of 10.6 eV PIDs
- 1 pair of metal oxide sensors (MOS)
- No baseline correction:
  - *Community perspective*
- Fenceline-style baseline correction:
  - *Near-source perspective*

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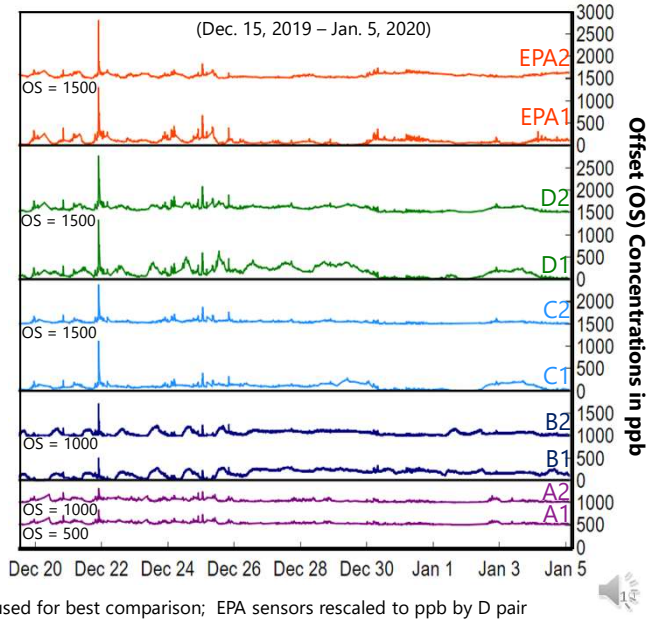
Sensor Descriptions

Device	Sensor	Heated	Time Resolution
EPA2	PID	Y	1 sec
EPA1	PID	Y	1 sec
D2	PID	N	1 sec
D1	PID	N	1 sec
C2	PID	Y	10 sec
C1	PID	Y	10 sec
B2	PID	N	1 min
B1	PID	N	1 min
A2	MOS	N	1 min
A1	MOS	N	1 min

Comparison Study Measurements



No fenceline-style baseline correction; single value offset used for best comparison; EPA sensors rescaled to ppb by D pair

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Comparison Study Sensor Signal Features

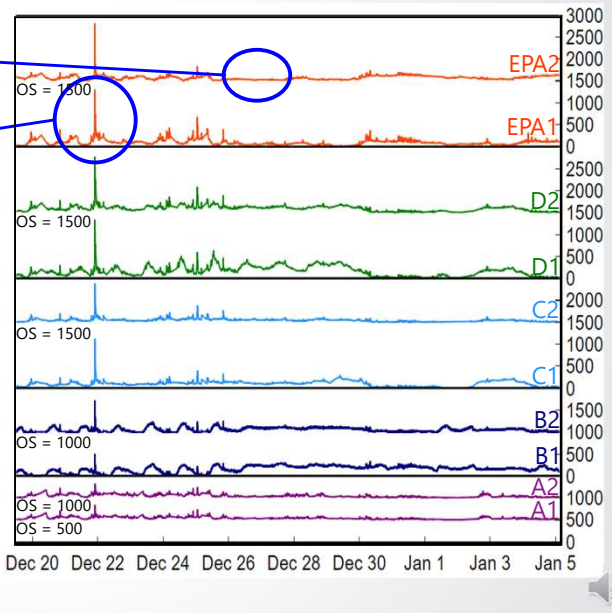
Flat baseline, no VOC plumes, not much drift

"Fenceline plume" seen by all sensors

Baseline offset after rain event

Diurnal RH, temp drift common in unheated PIDs

MOS sensor very "flat" and pair-precise



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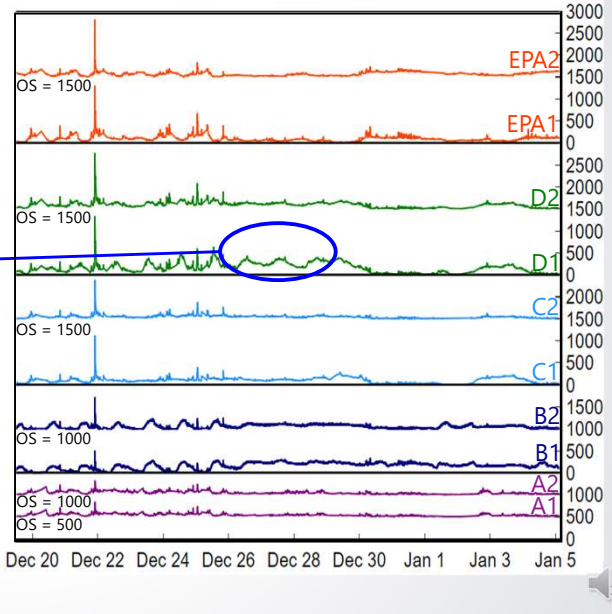

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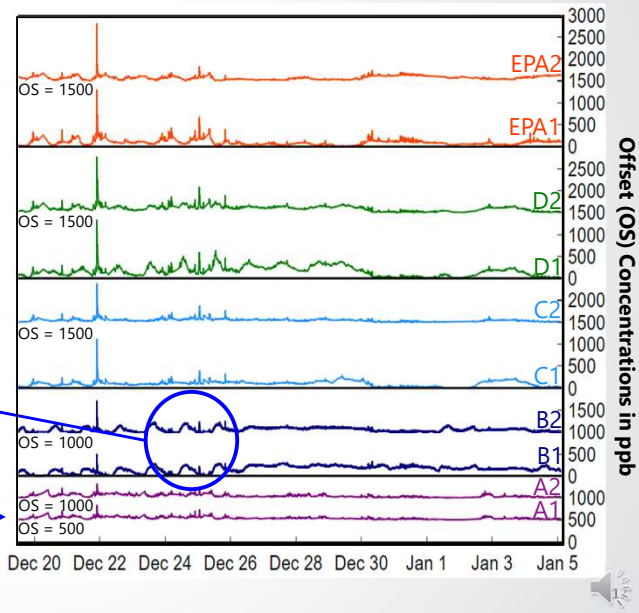

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Comparison of Sensor Pairs (Community Application)

- Compare arithmetic mean values over time (one way to do it)
- **RPD = relative percent difference of pairs**
- Like pairs should agree (precision)
- Lack of precision equals uncertainty (at least one sensor is wrong)

Mean Values:

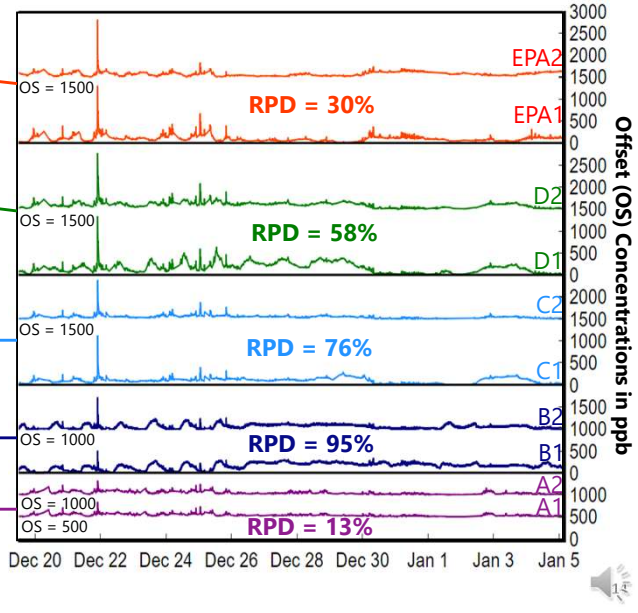
EPA 2 = 91 ppb
EPA 1 = 67 ppb

D2 = 91 ppb
D1 = 165 ppb

C2 = 98 ppb
C1 = 44 ppb

B2 = 62 ppb
B1 = 173 ppb

A2 = 41 ppb
A1 = 36 ppb



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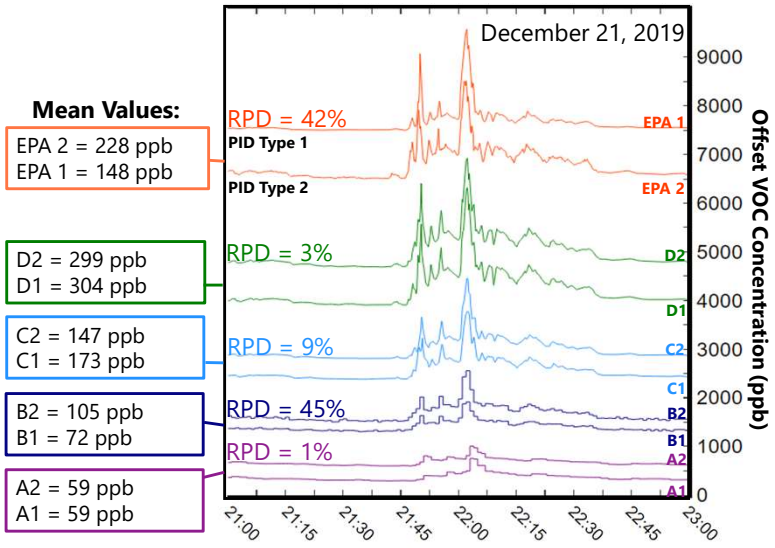
Sensor Comparison During Fenceline Plume Event

- Zoomed-in on highest peak from comparison study
- Differences in responsivity and time resolution affect plume detection capability
- Sensor pair A (MOS) has the best pair precision, but does not capture fenceline plumes well



Simple single value offset only; EPA sensors rescaled to ppb and D Sensor Peak for comparison

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21-Day Sensor Comparison Study

Mean Sensor Values and Pair Precision

No Baseline Correction

Sensor Pair	Mean Signal (ppb)	RPD (%) *Lower is better*
EPA 1	67.3	30.1
EPA 2	91.1	
D1	165.2	58.2
D2	90.7	
C1	44.0	76.3
C2	98.3	
B1	172.9	94.6
B2	61.8	
A1	36.1	12.5
A2	40.9	

With Baseline Correction

Sensor Pair	Mean Signal (ppb)	RPD (%) *Lower is better*
EPA 1	6.4	78.1*
EPA 2	14.5	
D1	23.0	24.8
D2	17.9	
C1	13.0	4.9
C2	12.4	
B1	24.7	7.3
B2	26.5	
A1	10.9	17.0
A2	13.0	

*Two different PID sensors with different noise levels partially explains this RPD.

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Summary

- **Sensors to source proximity affects performance and analysis requirements**
  - Fenceline < 50 - 500 m
  - Community > 500 m
- **Temporal response and sensitivity of VOC sensors matter**
  - Fenceline sensor need to be faster to resolve plumes and trigger grab samples
  - Community sensors can be slower (plumes are dispersed)
- **Fenceline-style baseline correction removes background VOC data and drift**
- **Collocated measurements are critical to assess VOC sensors**
  - If paired sensors do not agree, at least one is wrong
  - Baseline stability (or good drift correction) are critical for community applications

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