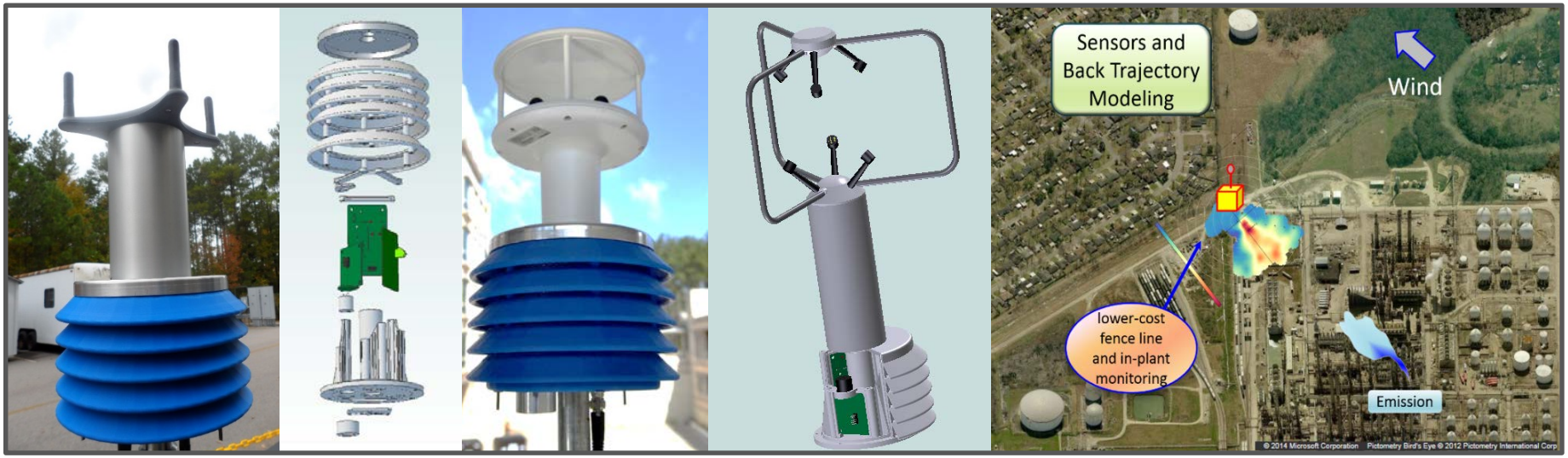
SPod Progress

EPA SPod Team - July, 2016



SPod Update Description

The purpose of these slides are to provide an update on SPod research progress. These slides will be posted on the SPod Share drive and will be updated periodically.

This information should be used in conjunction with "SPod Fenceline Sensor Draft Design Package" and associated publications to understand the device and its limitations.

The SPod is a low cost, solar-powered system that combines wind field and air pollutant concentration measurements to detect emission plumes and help locate the source of emissions. The current design works only in "near-fenceline" applications where localized source emission plumes may be present.

This presentation addresses the following topics:

- General concepts of next generation emissions measurements
- What is an SPod and what it will do
- Mobile and fixed-place applications
- A review of current SPod design
- An example application of SPods used in conjunction with passive sampling
- Baseline performance of the current design
- Upcoming field studies

EPA SPod Research Team

- Bill Mitchell - Electronics and system software design
- Bill Squier - Mechanical design and application research
- Ryan Daly - Mechanical and assembly design
- Dave Nash - Fenceline methods and software
- Halley Brantley - Analysis software
- Ingrid George - Speciated analysis
- Jason Dewees - Fenceline methods
- John Masters - Communications
- Cary Secrest - Applications research (future)
- EPA Regions - R3,R4, R5, R6, R8 applications research (future)
- Eben Thoma - Application coordination, method research

Next Generation Air Measurement (NGAM)

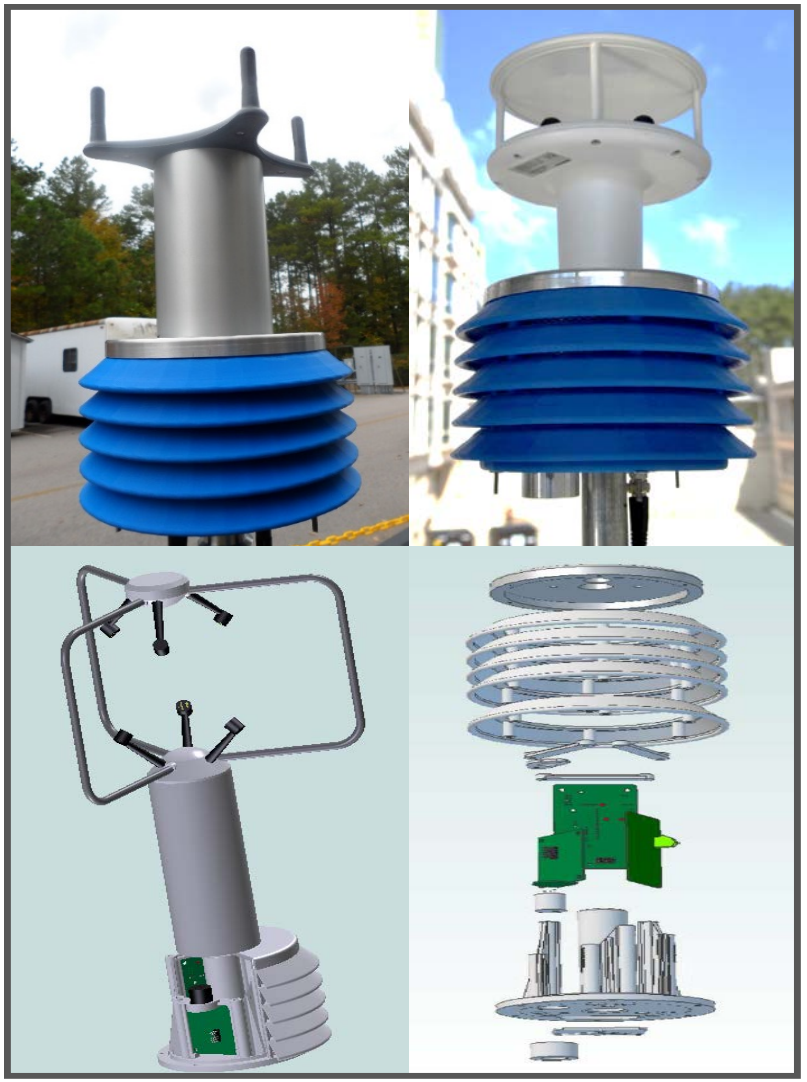
<u>Takeaways:</u>

SPods are part of the NGAM spectrum and can contribute in several ways

SPods have strengths and weaknesses

SPods work best with other approaches such as passive samplers and canisters

What is an SPod?



What is an SPod?

A lower cost mobile or fixed-place sensor system that helps detect, locate, and characterize air pollutant sources.

Where are SPods used?

Near potential emission sources, but not in hazardous zones.

Is there only one type of SPod?

No, EPA has a research SPod design (described here) but we are sharing information with system developers and we know several “SPod-like” systems are in development.

What can the EPA SPod currently measure?

Gas phase compounds detectable with a 10.6 eV PID.

Does the SPod produce a speciated measure of benzene or other compounds?

No, but it can be used with passive samplers and canisters.

Can the SPod produce a stable, calibrated measure?

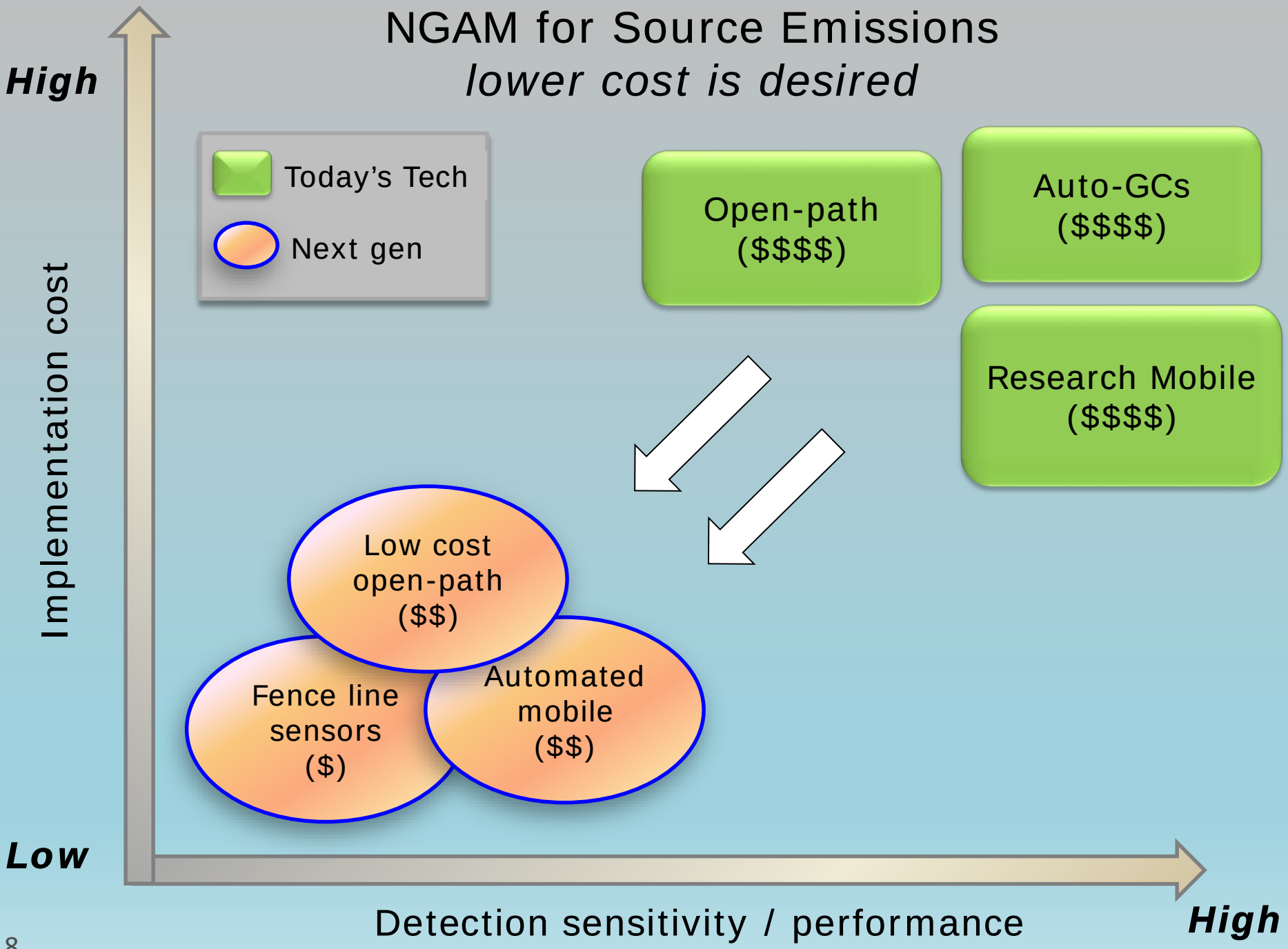
Not easily due to sensor and source effects.

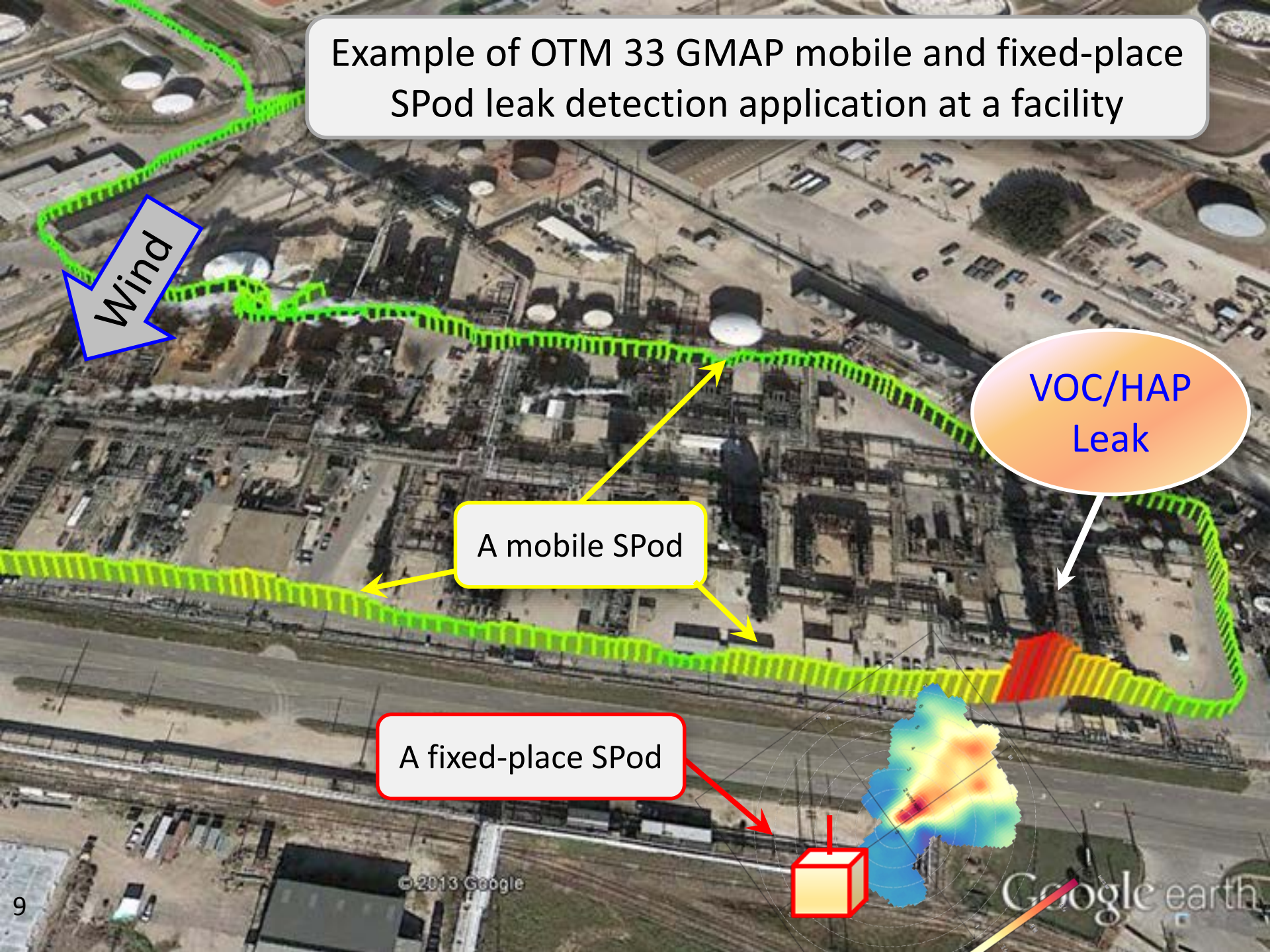
Can the SPod be used far away from sources (ambient)?

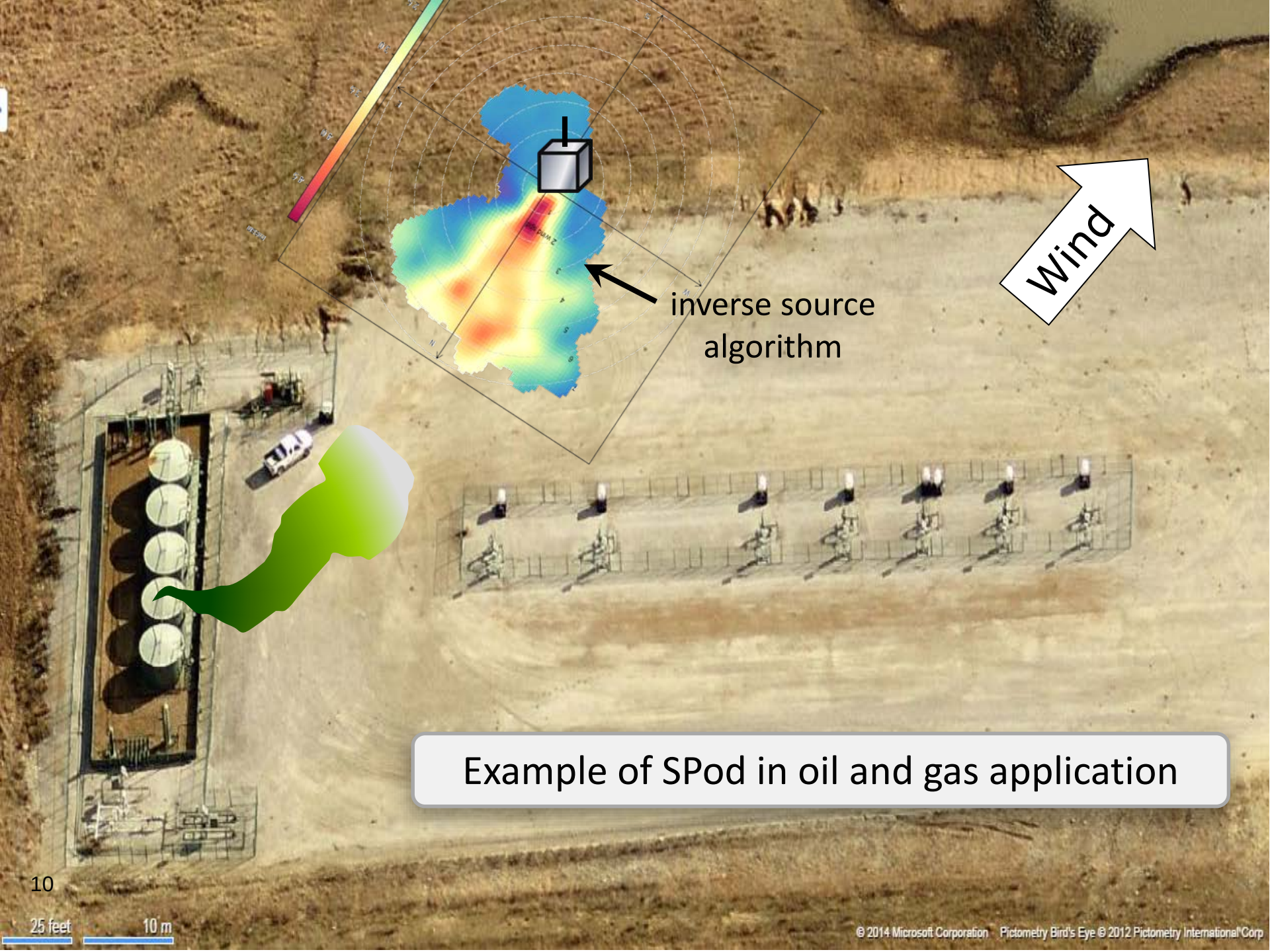
Not the EPA SPod (detection and stability-limited)

NGAM for Source Emissions

lower cost is desired



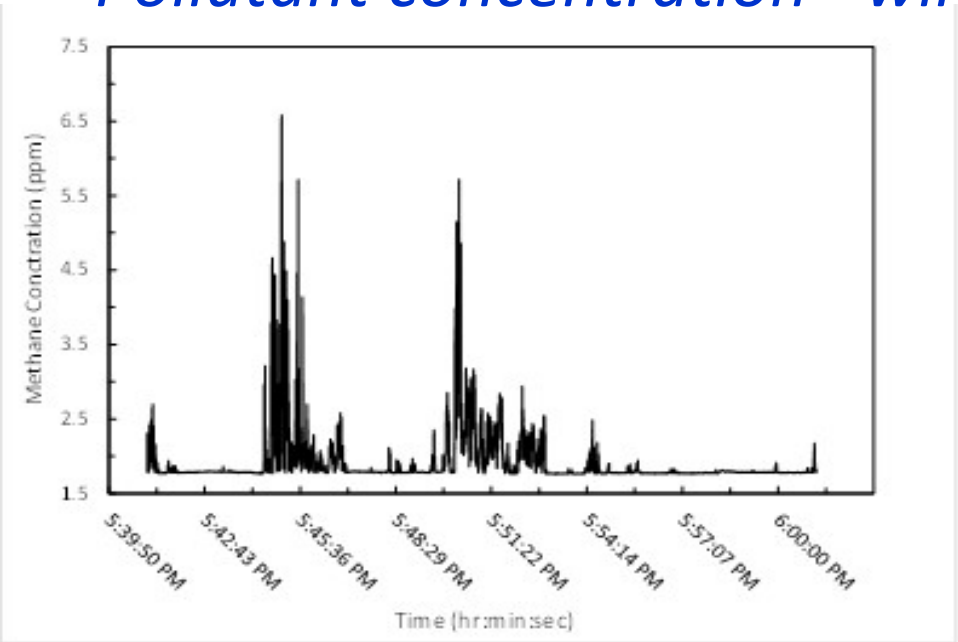

Example of OTM 33 GMAP mobile and fixed-place SPod leak detection application at a facility
Wind
VOC/HAP Leak
A mobile SPod
A fixed-place SPod
© 2013 Google
Google earth

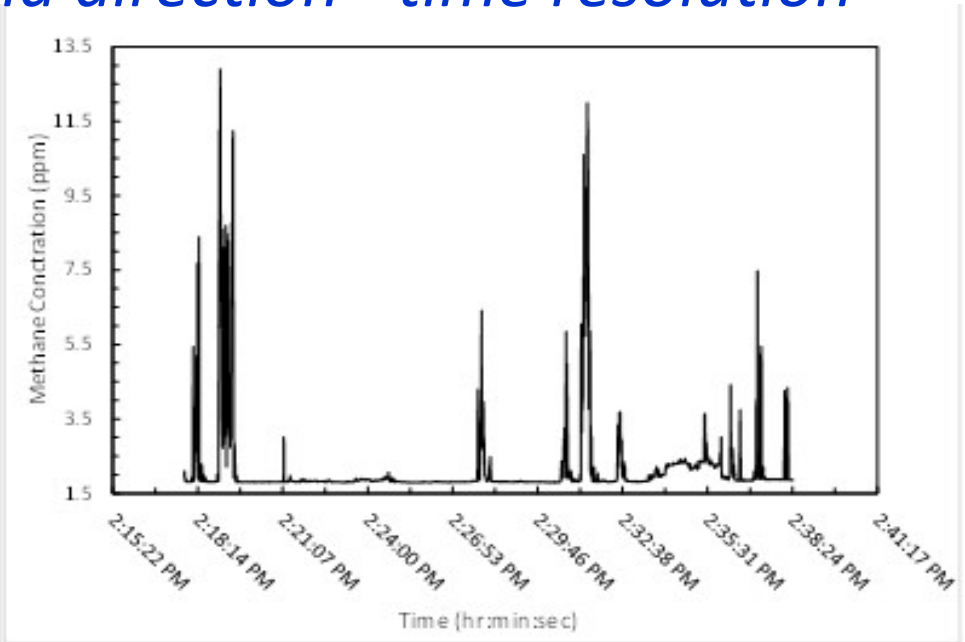


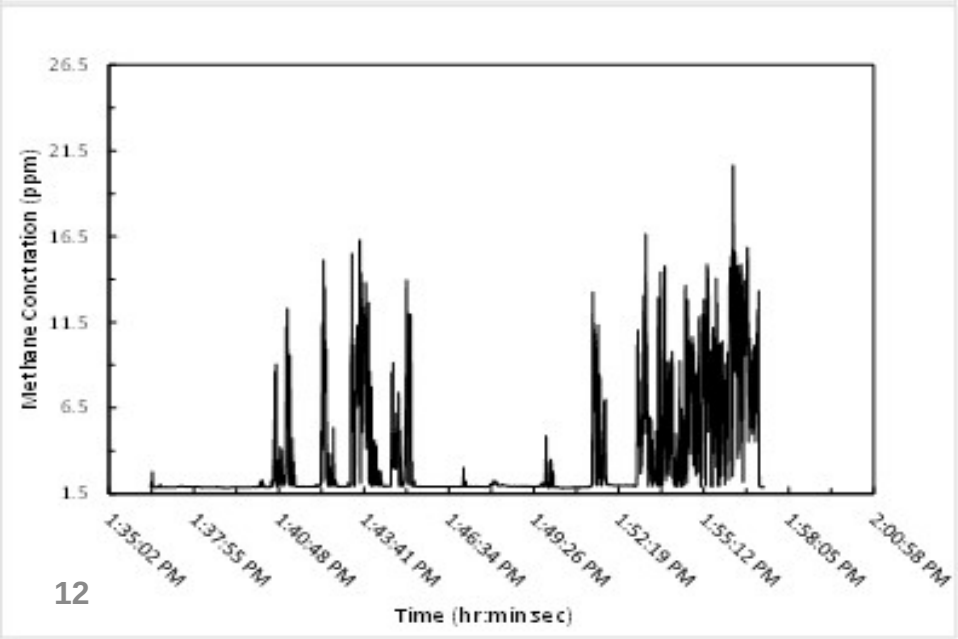
Example of SPod in oil and gas application

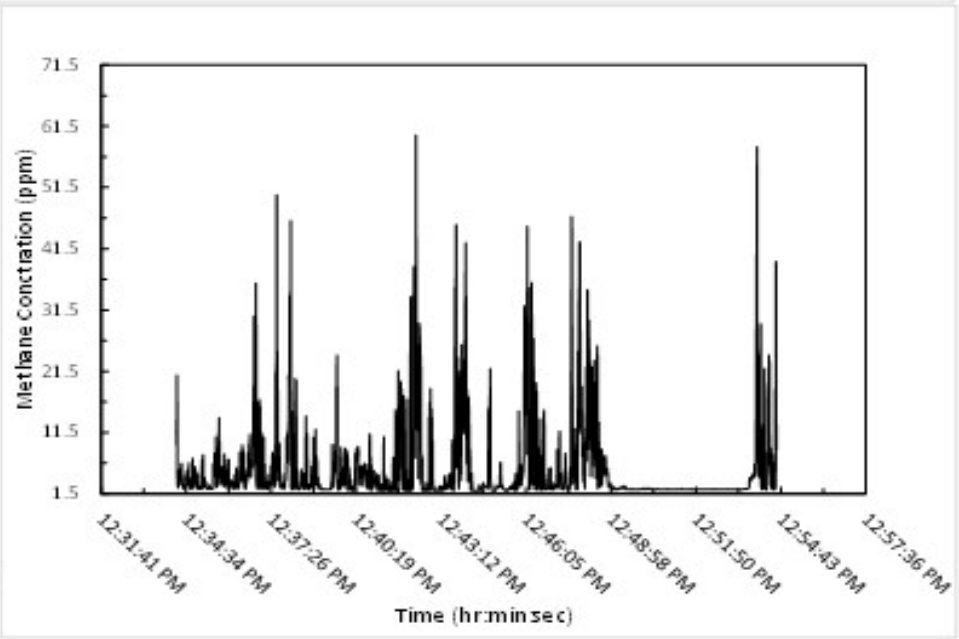
This is an infrared camera video illustrating the emission plume from an oil and gas process malfunction

SPods look at highly variable plume signals
Pollutant concentration - wind direction - time resolution





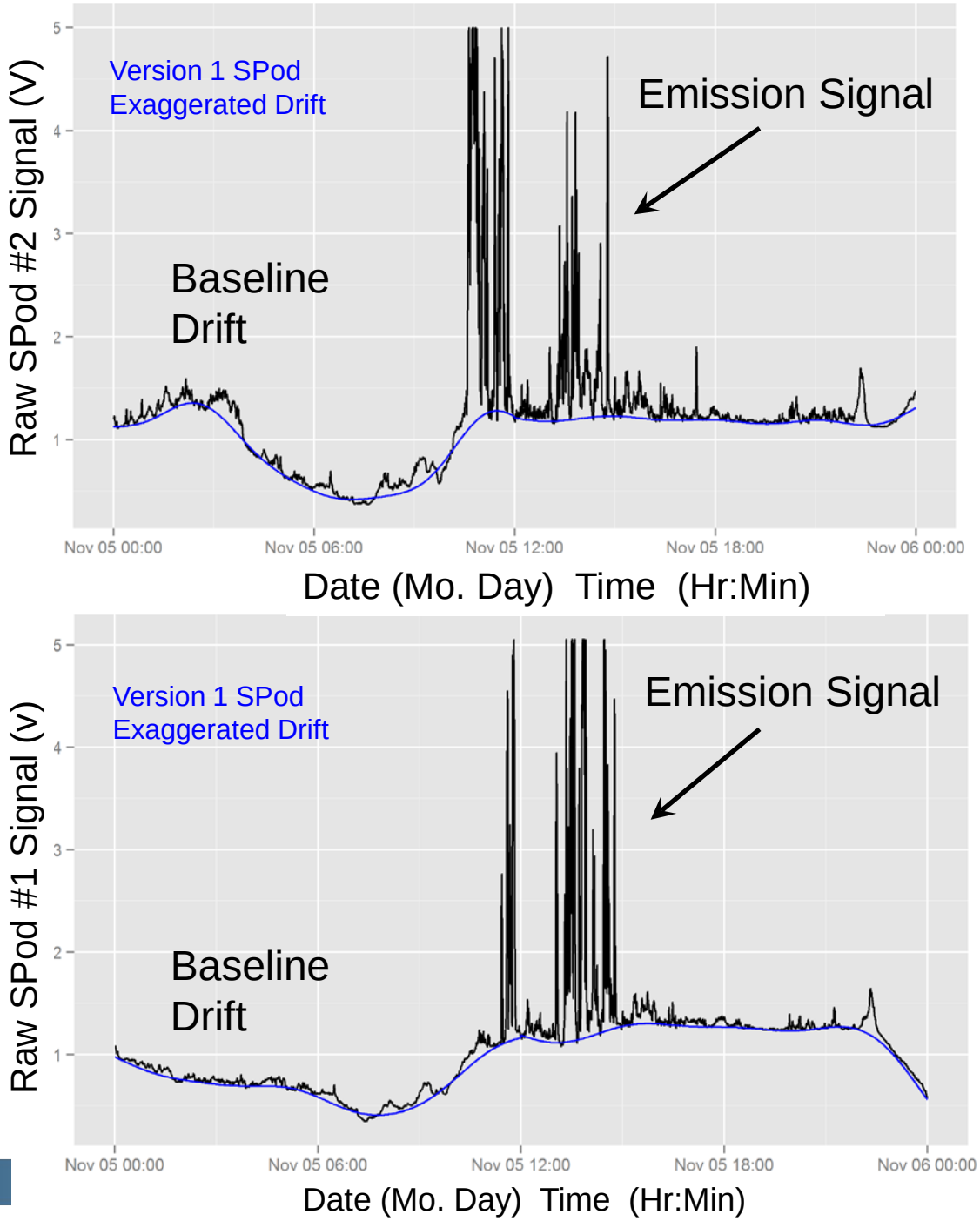




SPods are low cost, uncontrolled sensors.

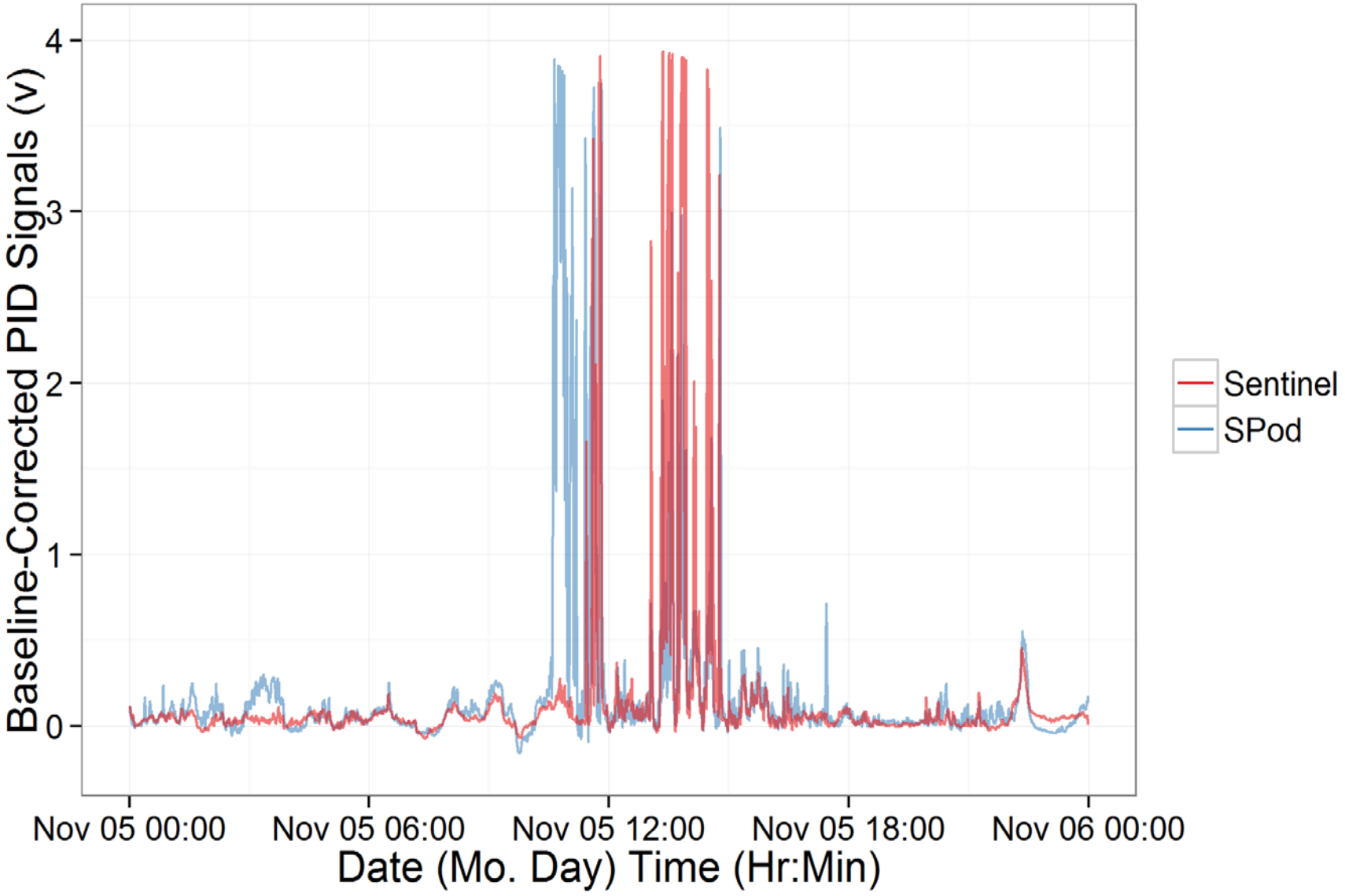
You need to decouple source signal from baseline drift

This is why SPods are only used near sources



Older versions of SPod had a lot of baseline drift

SPod Signals After Baseline Removal



A look at the SPod Sensor design

EPA ORD Open Source Draft Design
April 7 , 2016

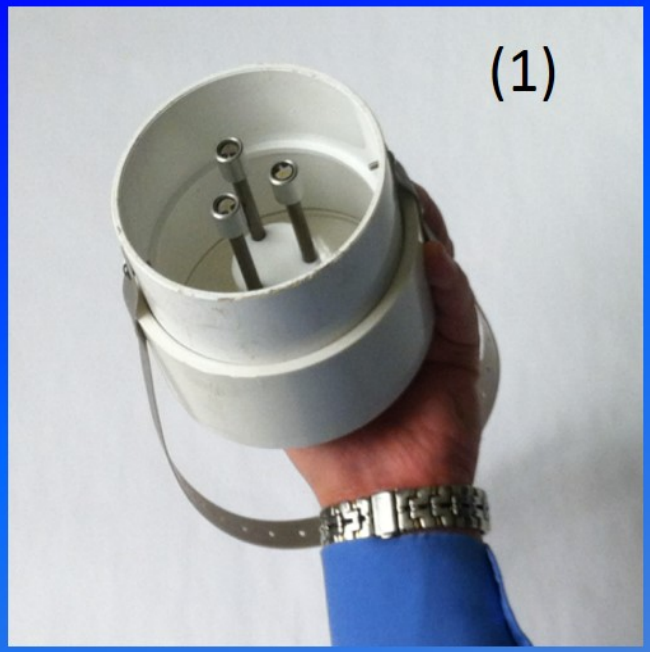
For access to the share drive, please email John Masters and Eben Thoma

The current SPod sensor is a 10.6 eV photoionization detector (PID) …..What can it see?

Let's take a look at a PID Table

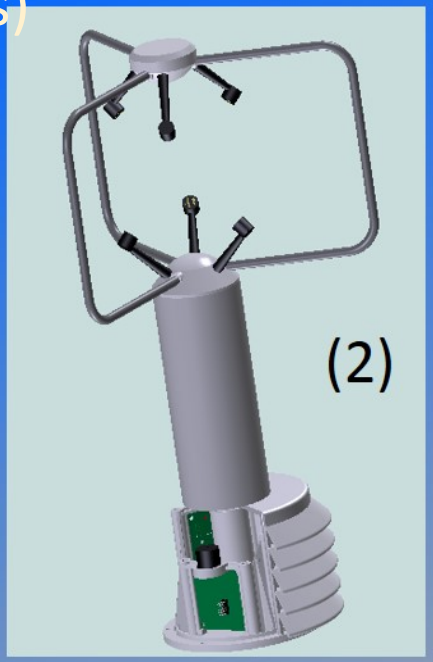
http://goodforgas.com/wp-content/uploads/2013/12/TN2004_PID_gas_table_01_16_09.pdf

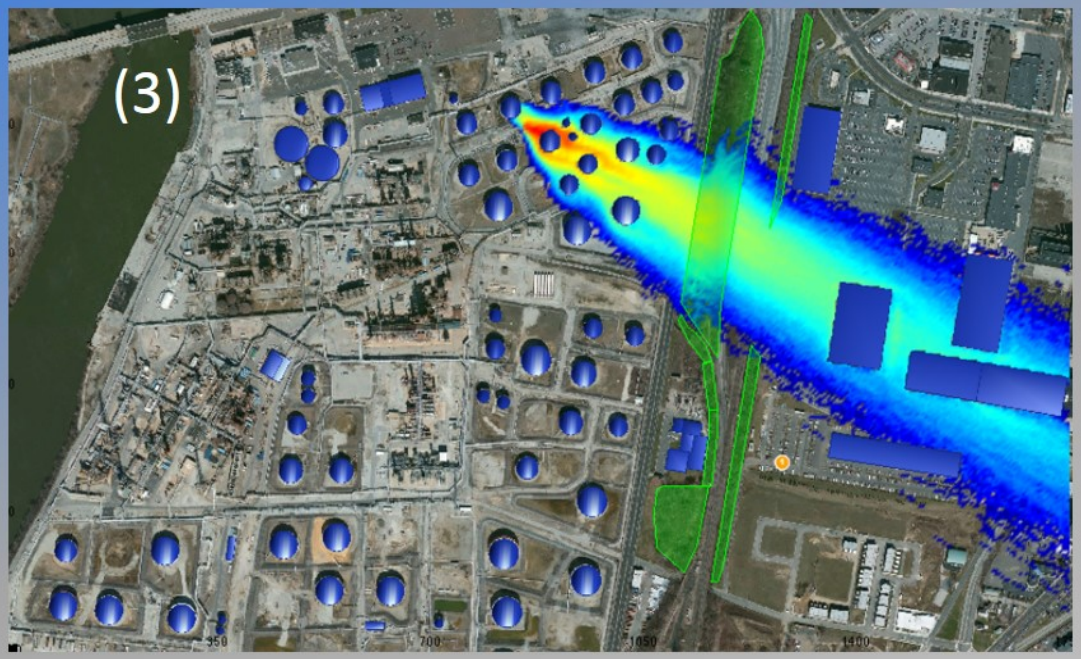
Philly Study (Version 1 SPods)



Project Elements

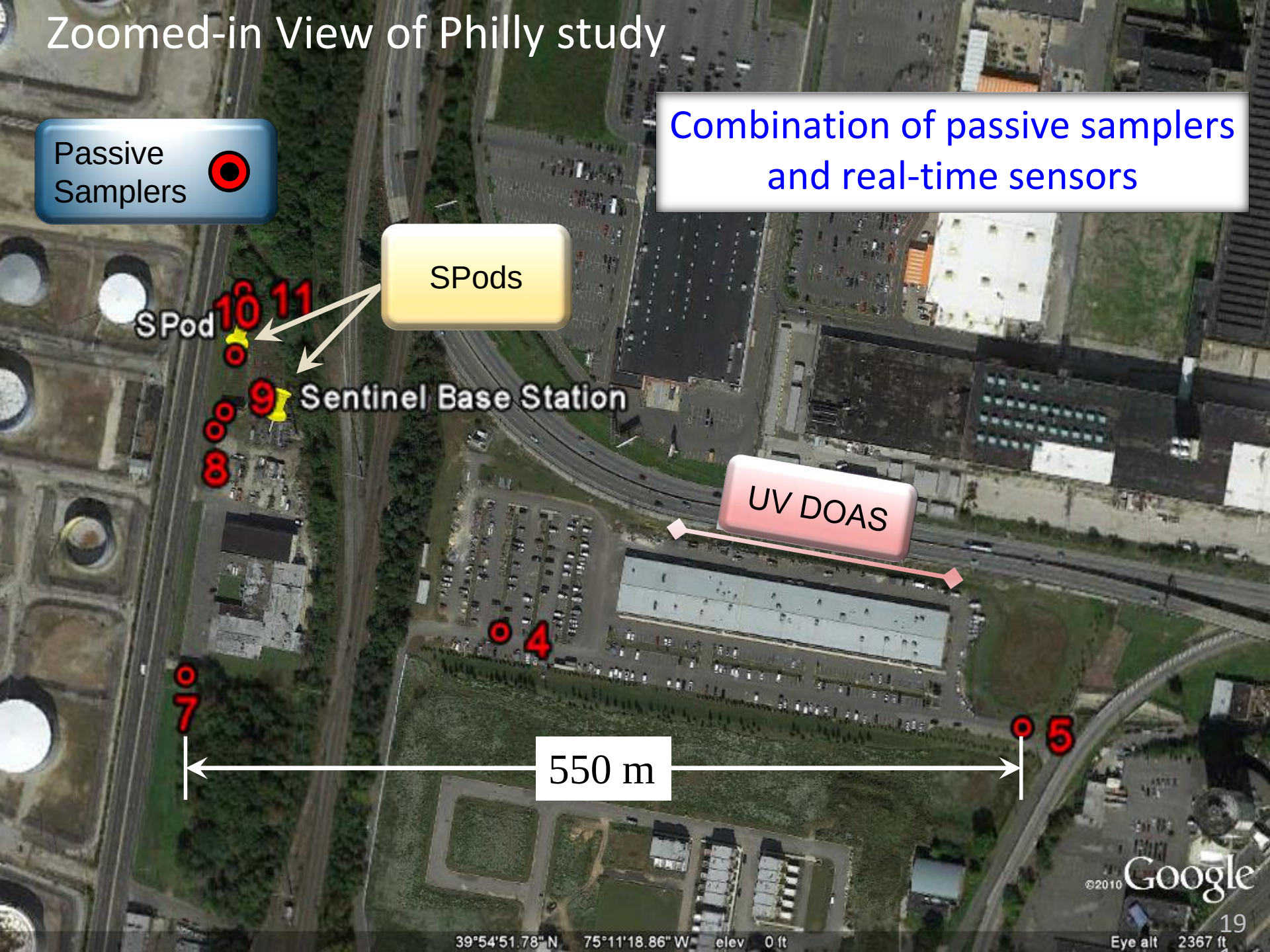
(1) Passive Samplers
(2) Fence line Sensors
(3) Advanced Modeling
(4) Optical Remote Sensing (City-AMS)



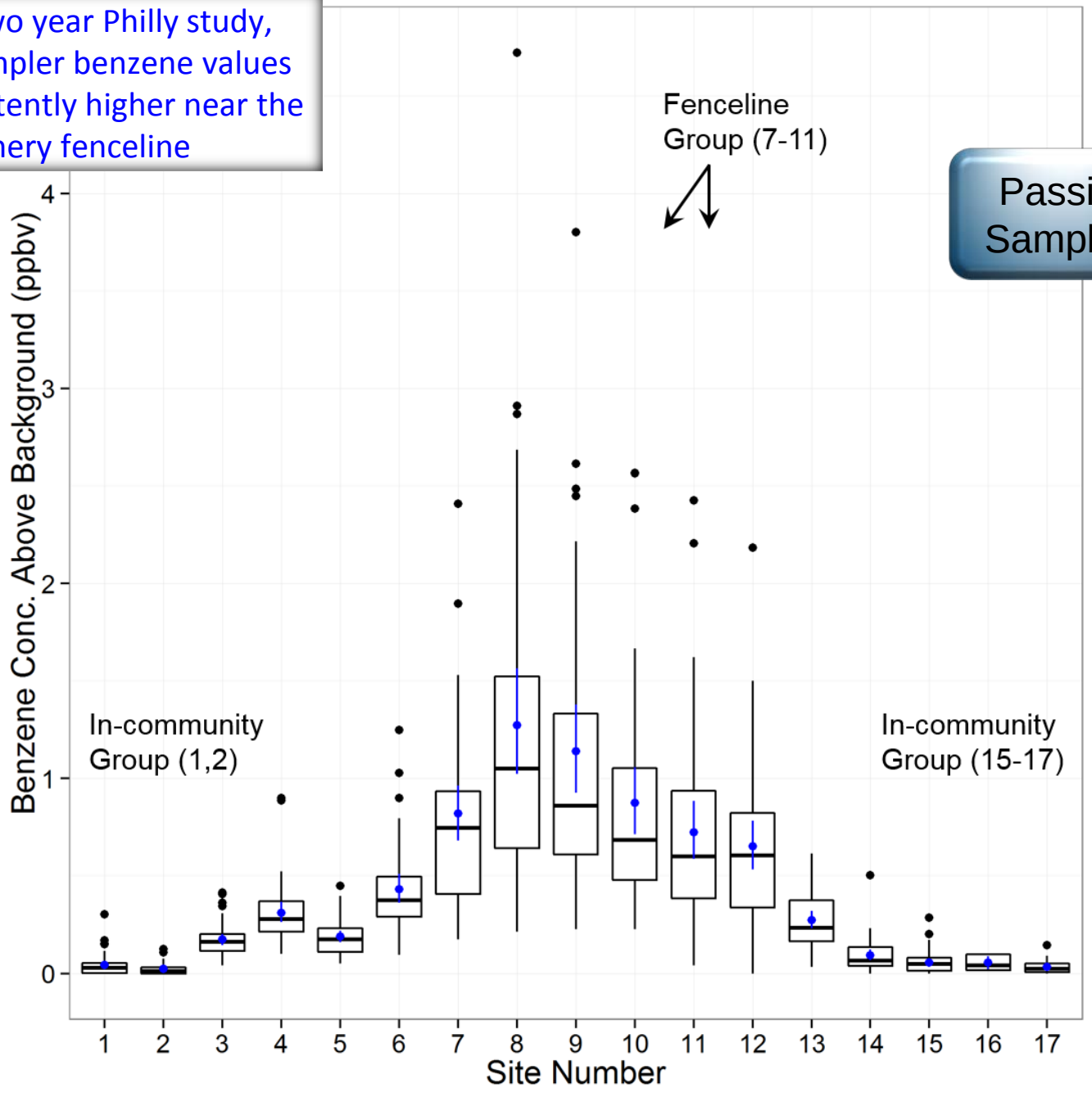


Deployment Area in South Philly

Zoomed-in View of Philly study

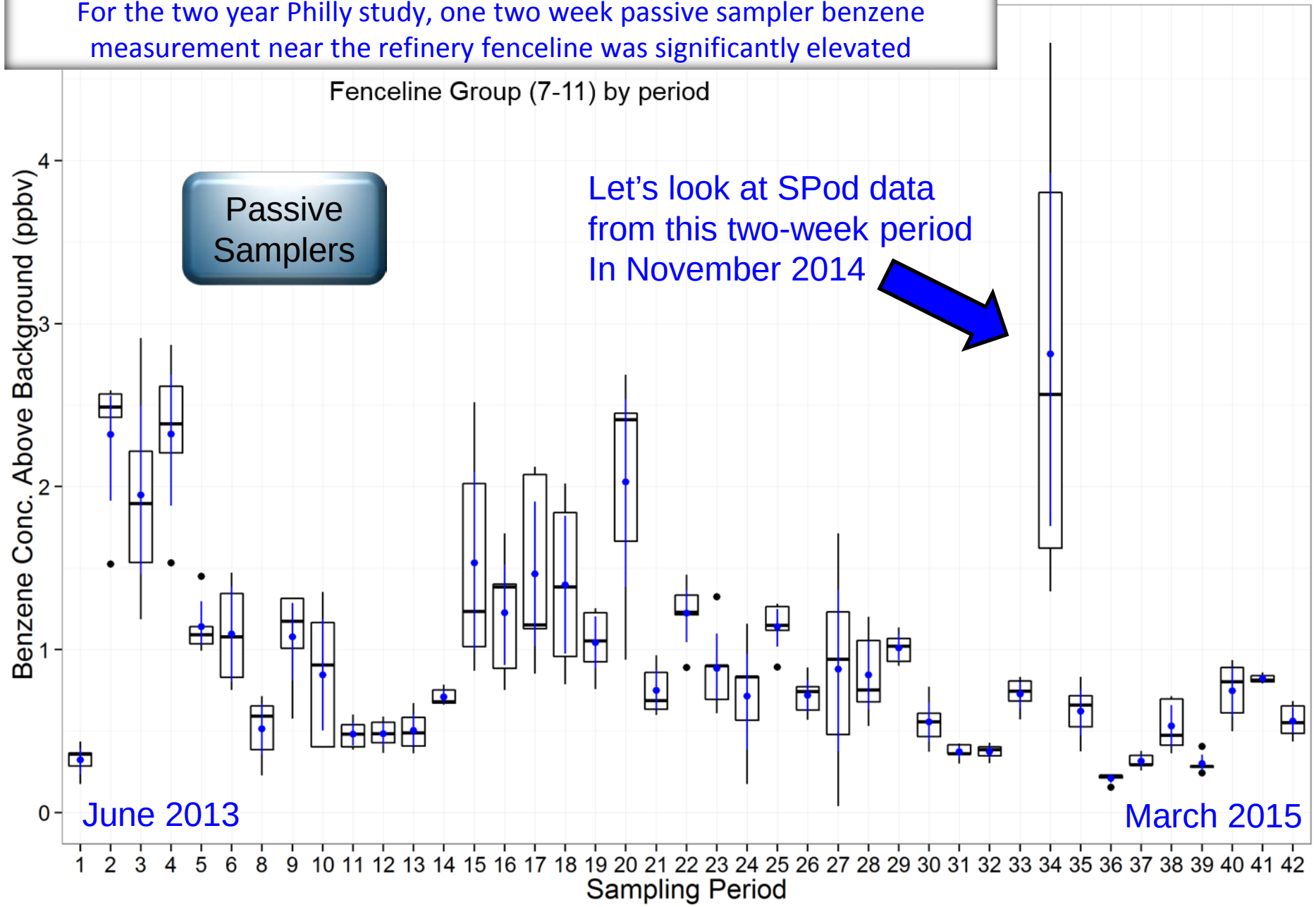


For the two year Philly study, passive sampler benzene values were consistently higher near the refinery fenceline



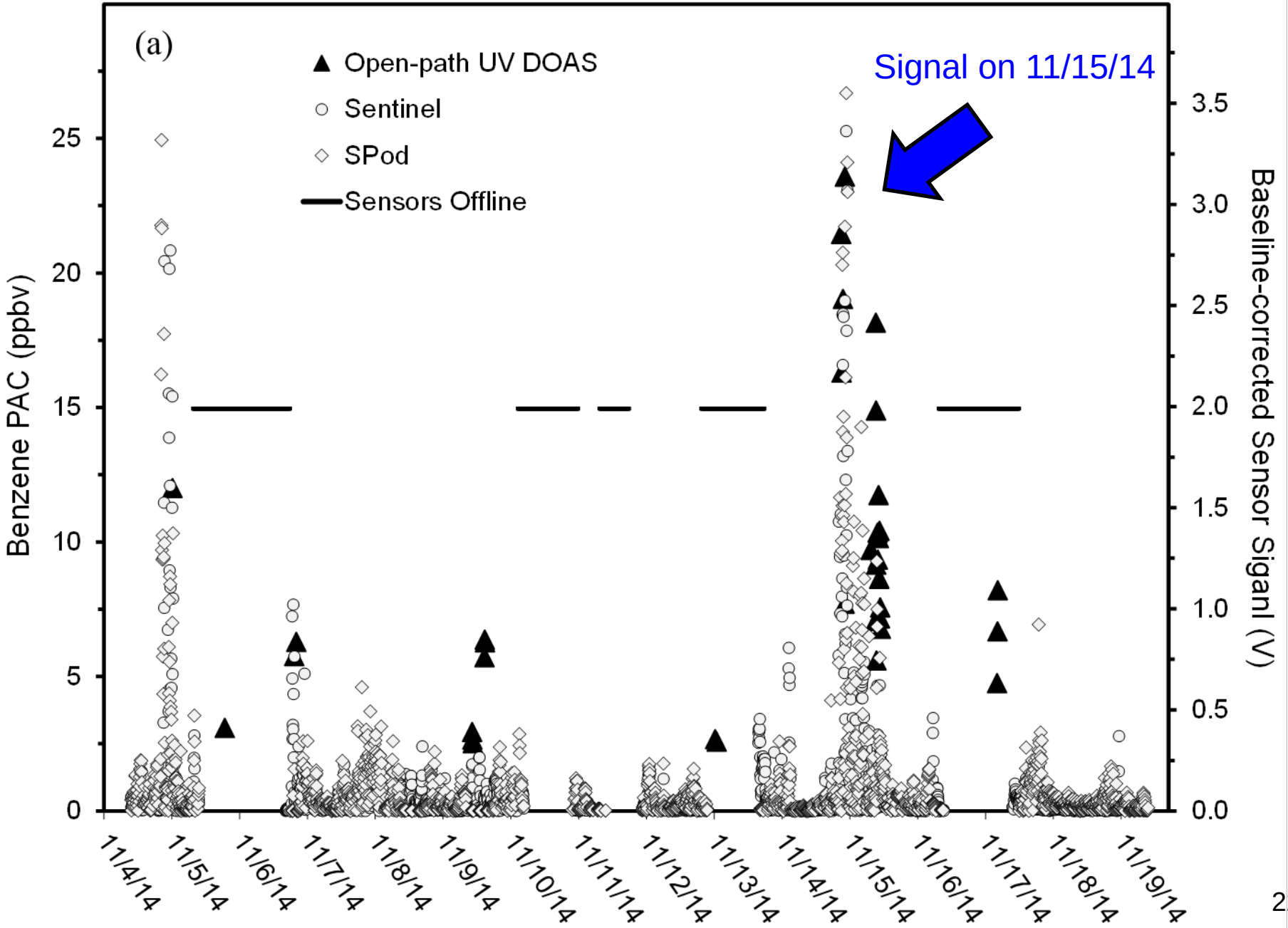
Each point is a sampling location from slides 18, 19 with all passive sampler benzene data (June 2013-March 2015)

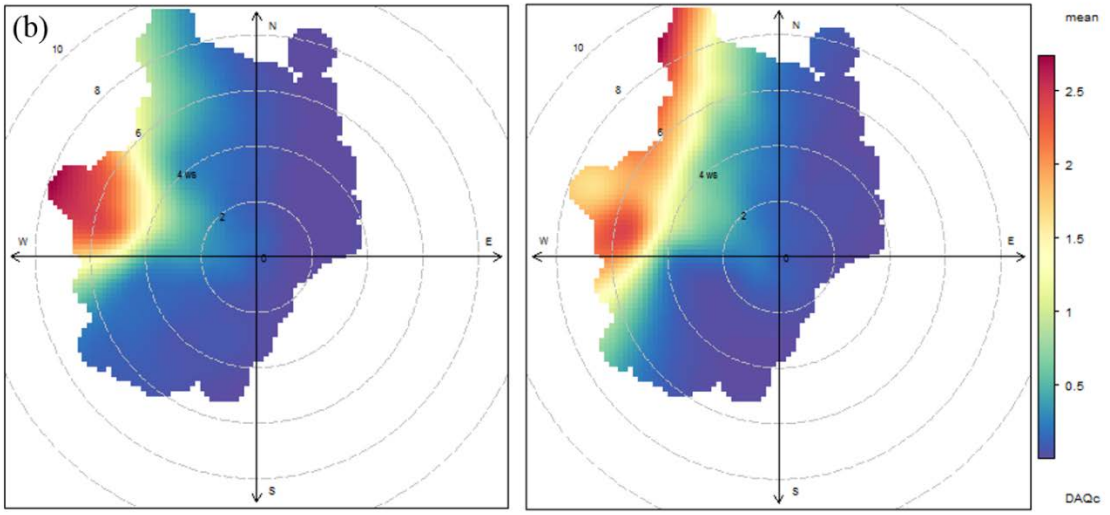
For the two year Philly study, one two week passive sampler benzene measurement near the refinery fenceline was significantly elevated



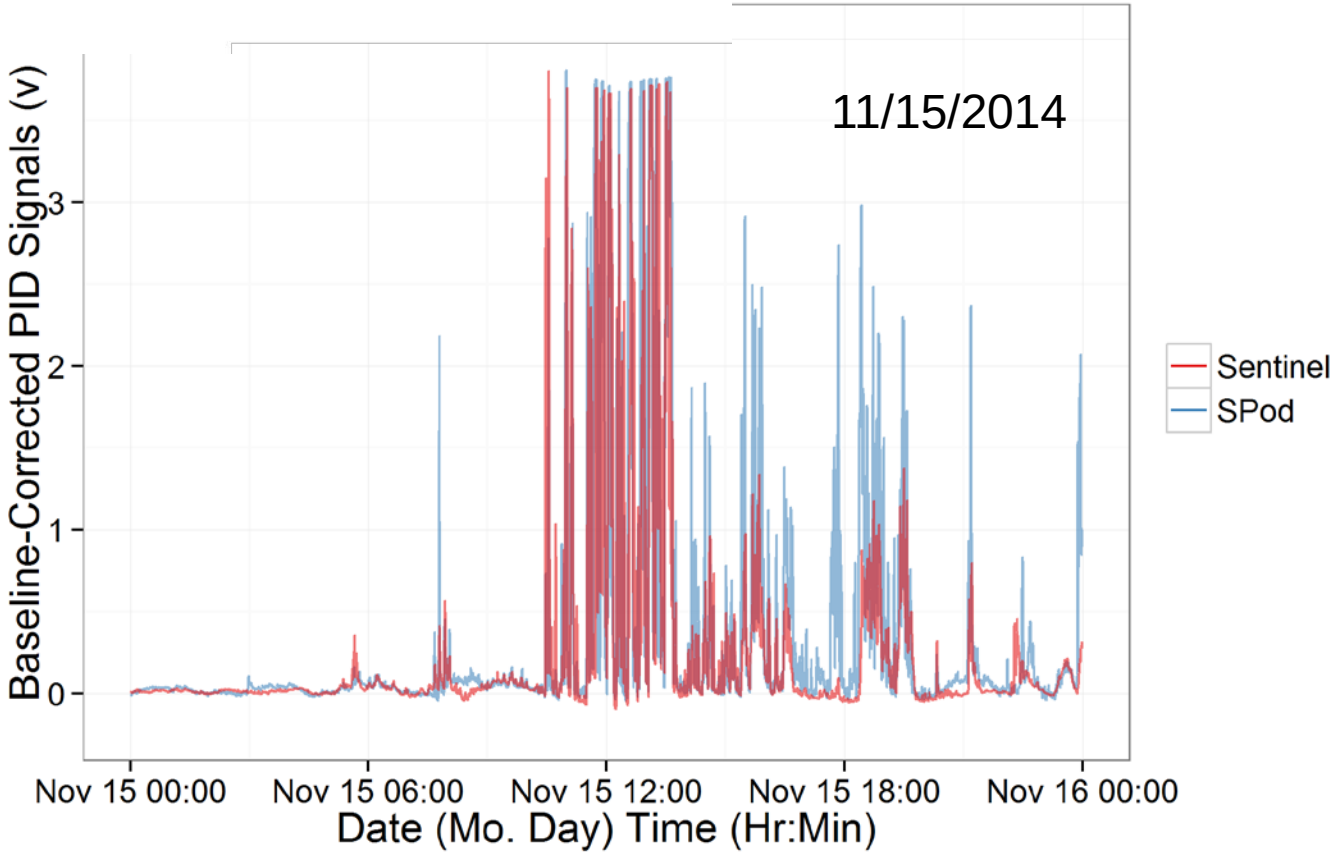
Each data point is a two-week passive sampler benzene measurement for the "fenceline group" consisting of locations 7-11. Period 1 is June2013, Period 42 is March 2015.

SPod and UV DOAS data from the elevated two-week period

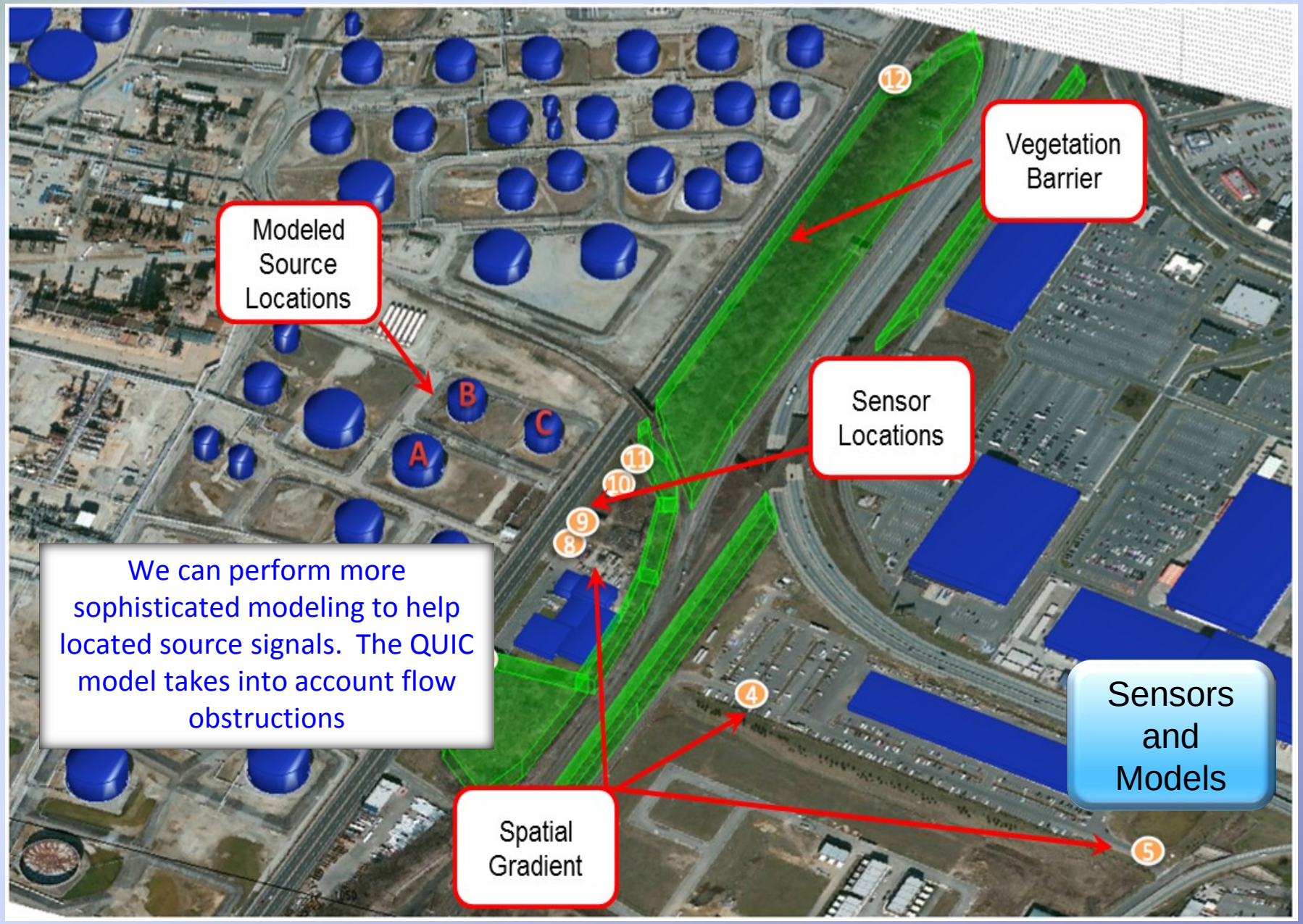




On 11/15/14, both SPods show strong signal from the refinery to the west with the inverse algorithms pointing toward the source

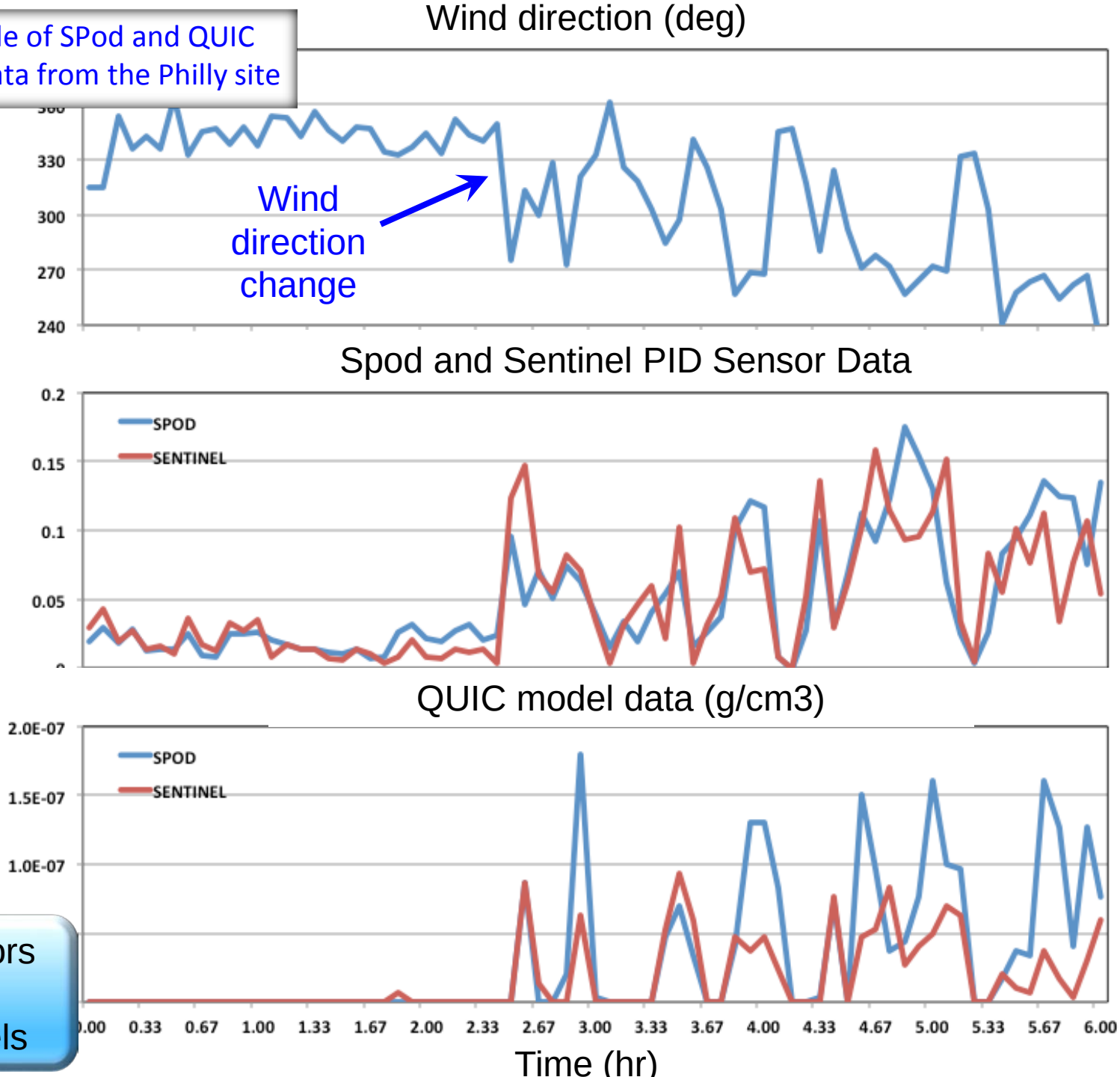


Los Alamos National Lab Quick Urban & Industrial Complex (QUIC) Model



Example of SPod and QUIC model data from the Philly site

Measured Data and QUIC model Run 7/05/14, 6 hours

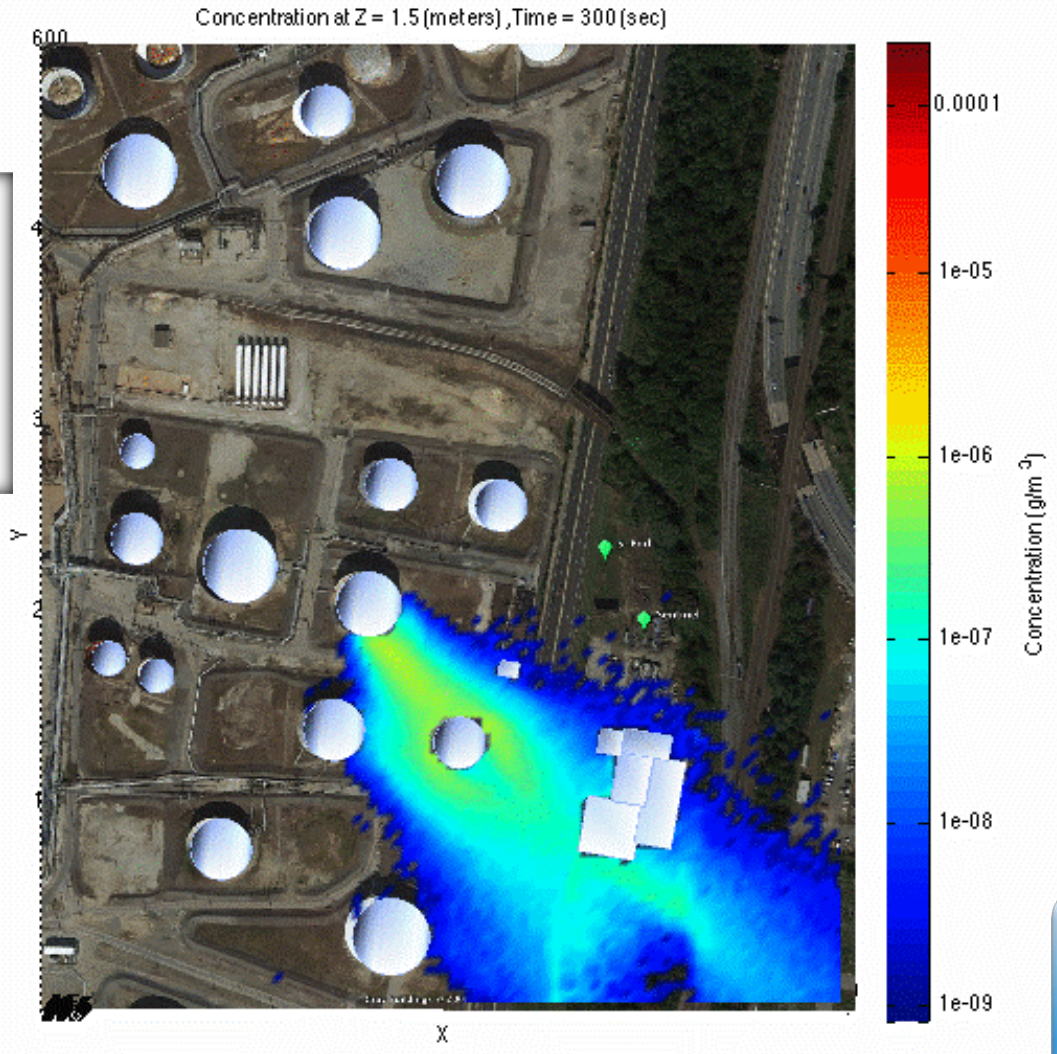


Sensors and Models

Draft 062015

QUIC model Run 7/05/14 6 hours – illustrative example
This is a simulated source at an assumed location (not a real emission plume)

Example of SPod and QUIC model data from the Philly site.
This is a QUIC plume evolution and flow movie based on SPod data

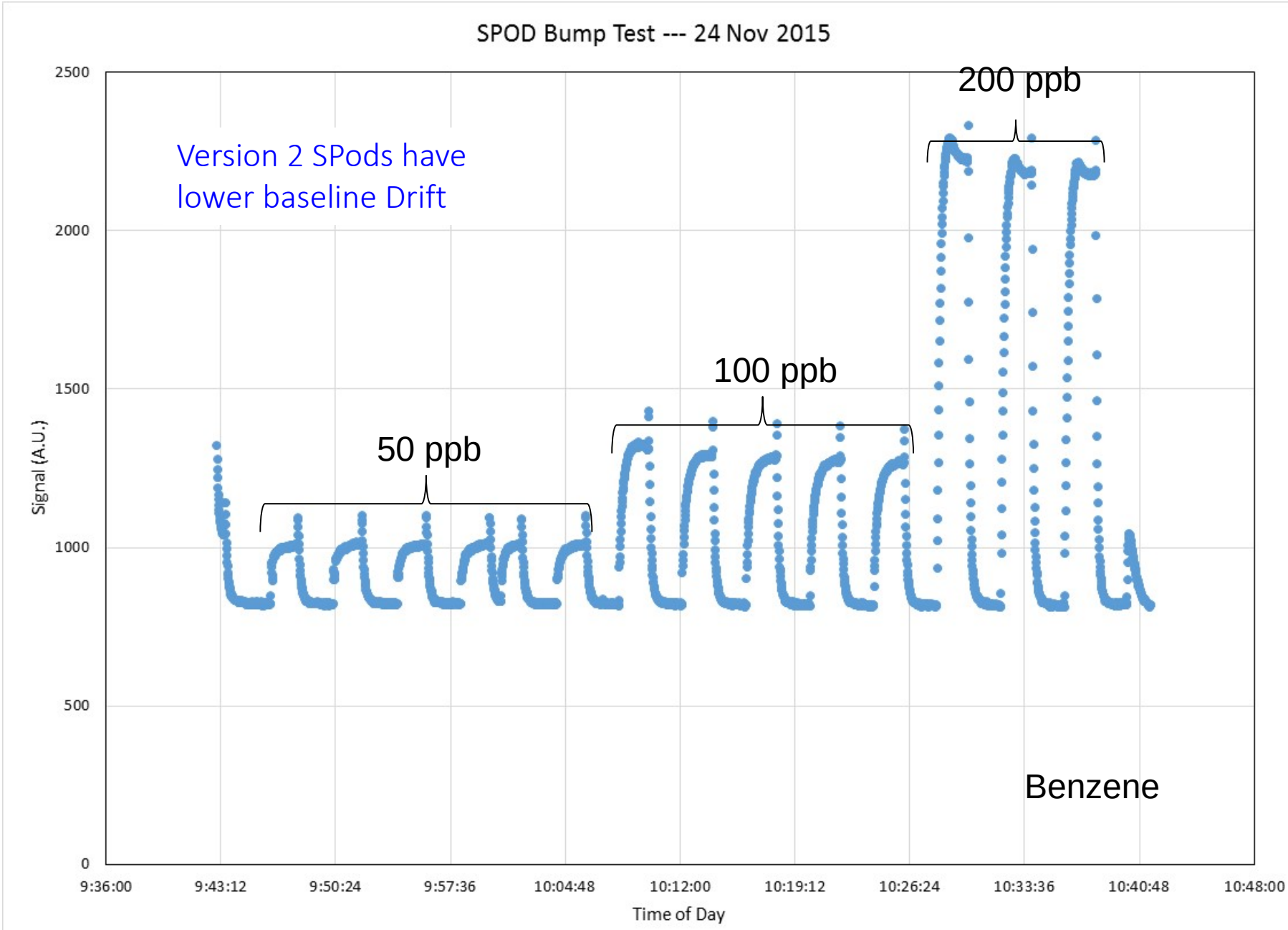


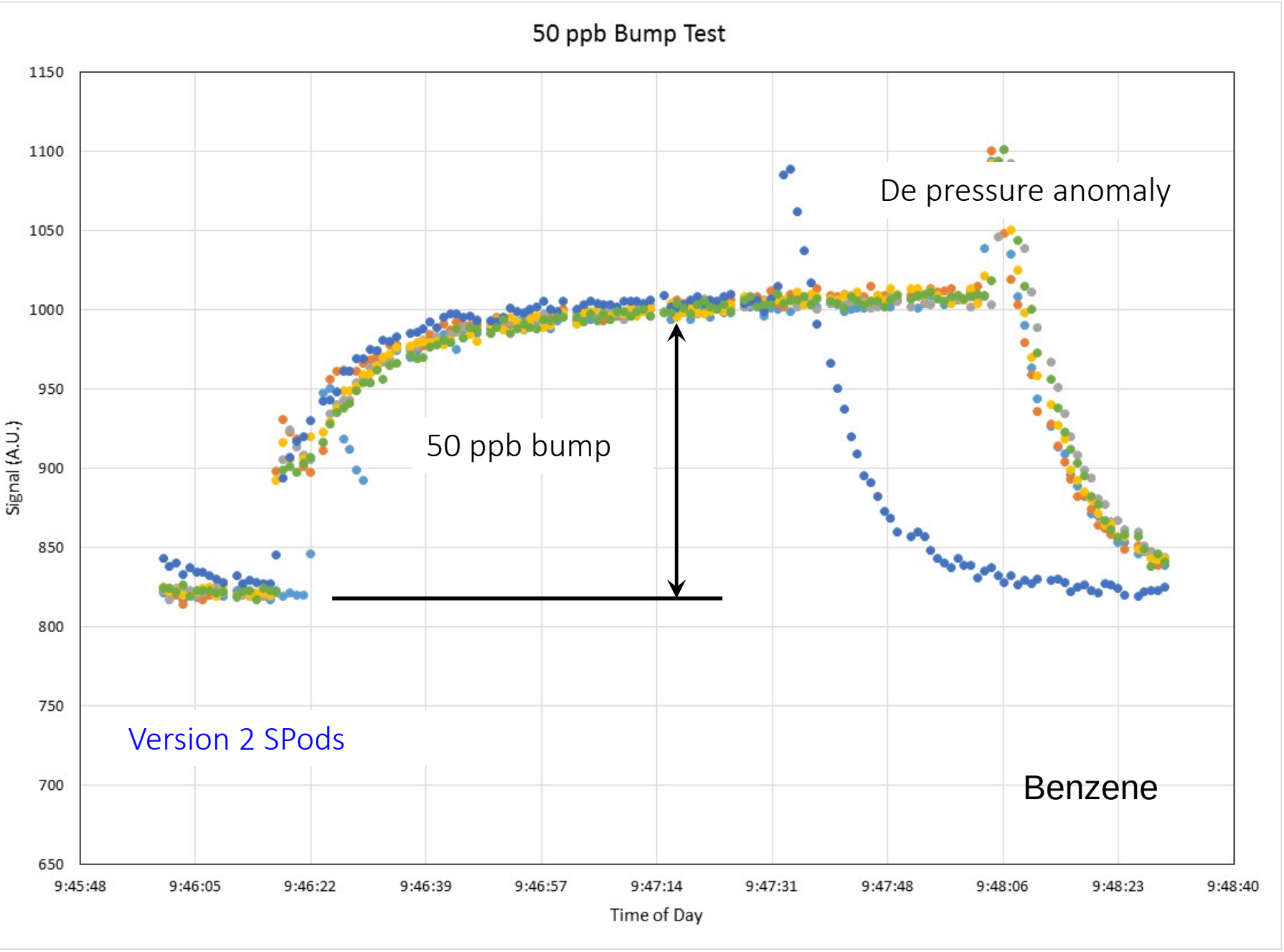
Sensors and Models

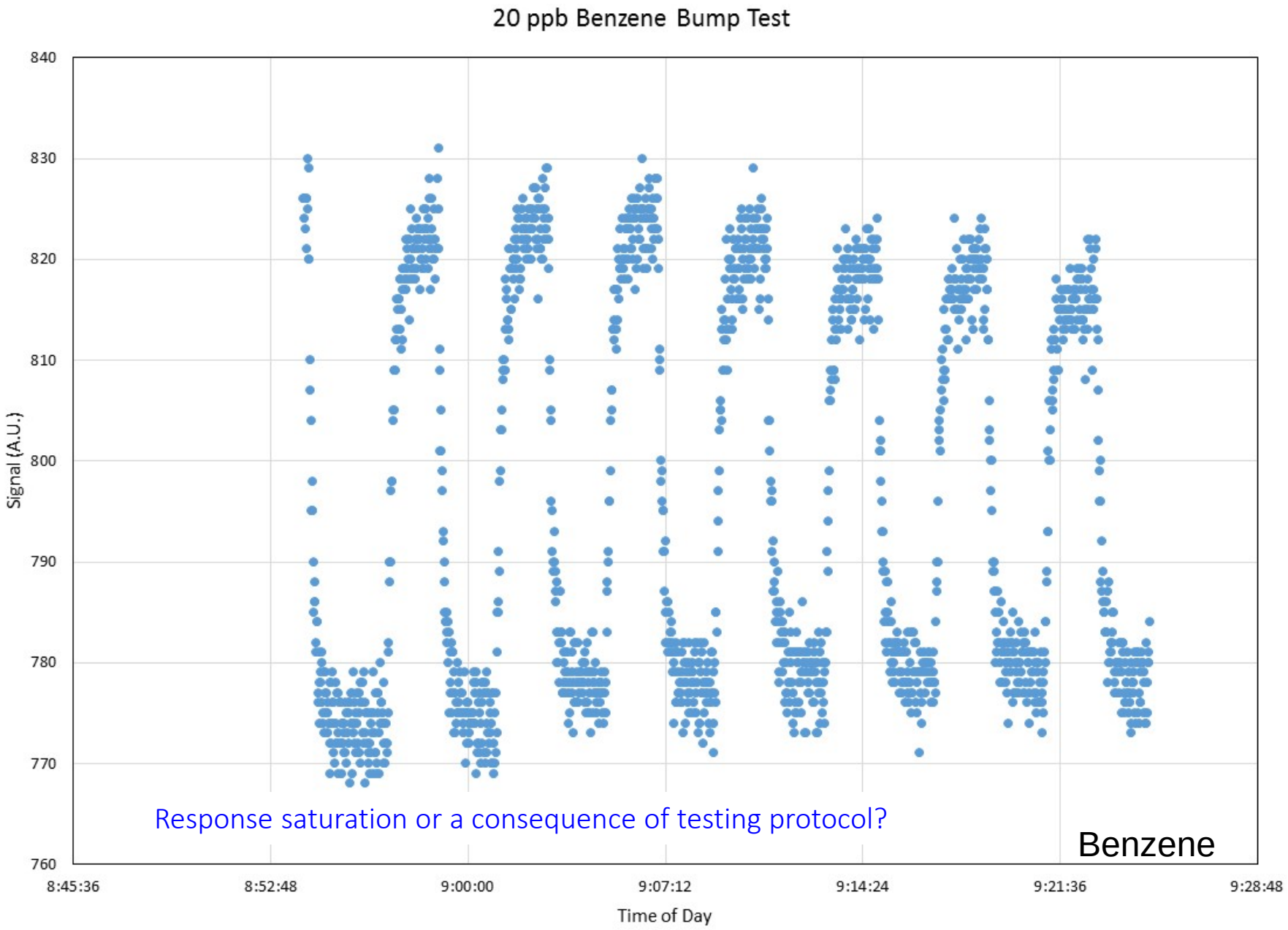
Status:

We are going back to Philly with Version 2 SPods

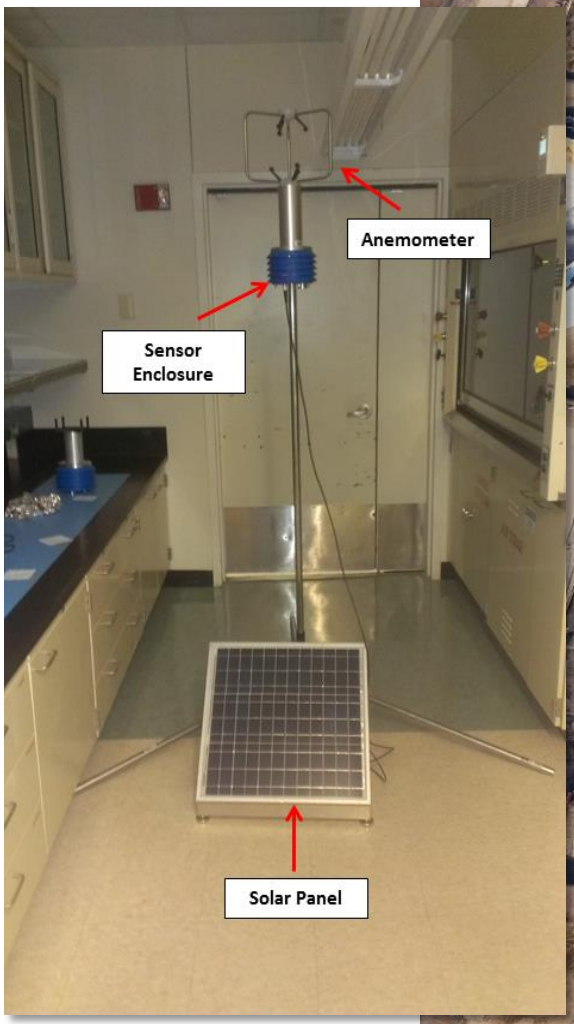
A three-node network with one base station for communication

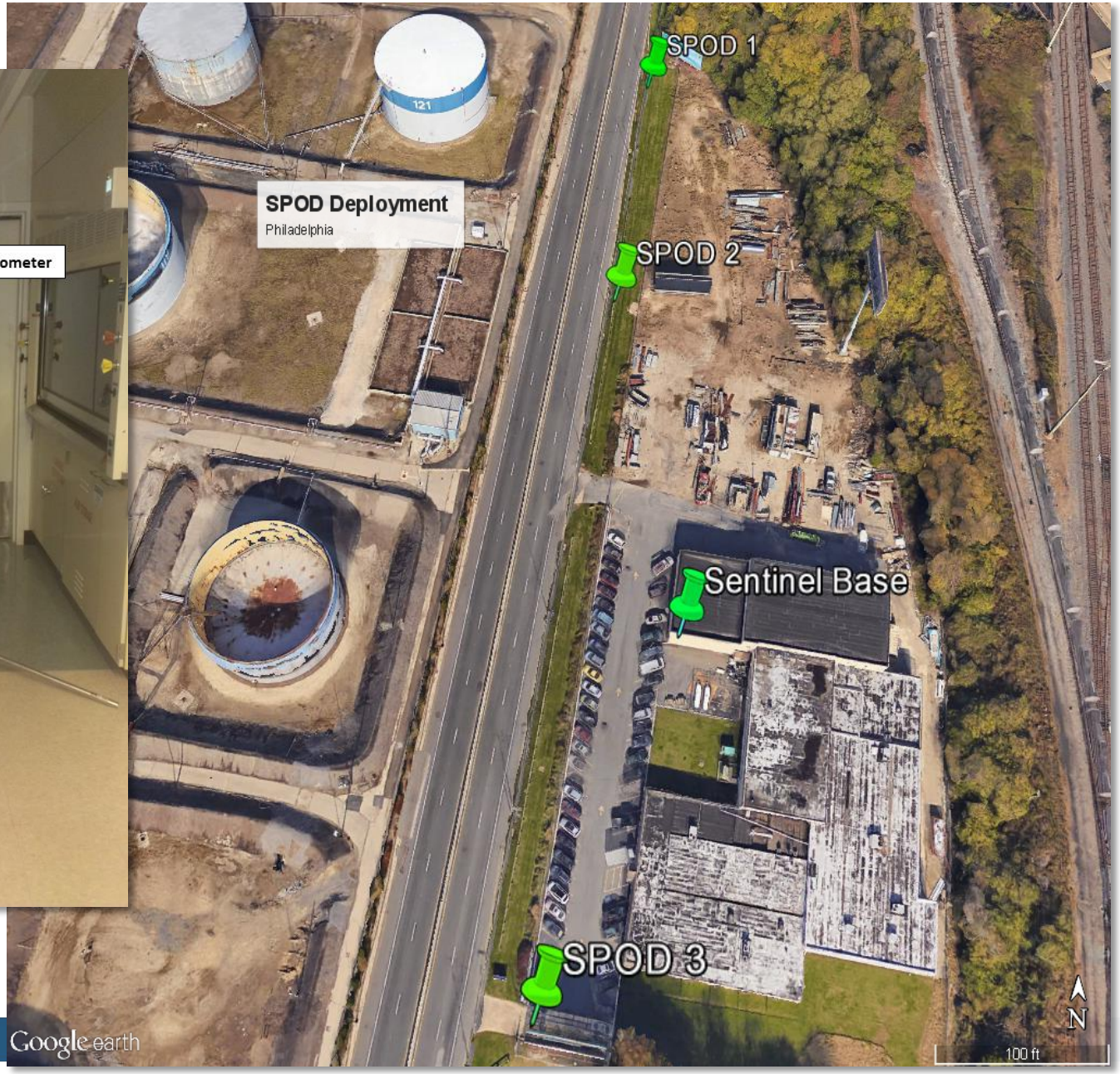

SPOD Bump Test --- 24 Nov 2015
Version 2 SPods have lower baseline Drift
200 ppb
100 ppb
50 ppb
Benzene
Signal (A.U.)
2500
2000
1500
1000
500
0
9:36:00
9:43:12
9:50:24
9:57:36
10:04:48
10:12:00
10:19:12
10:26:24
10:33:36
10:40:48
10:48:00
Time of Day

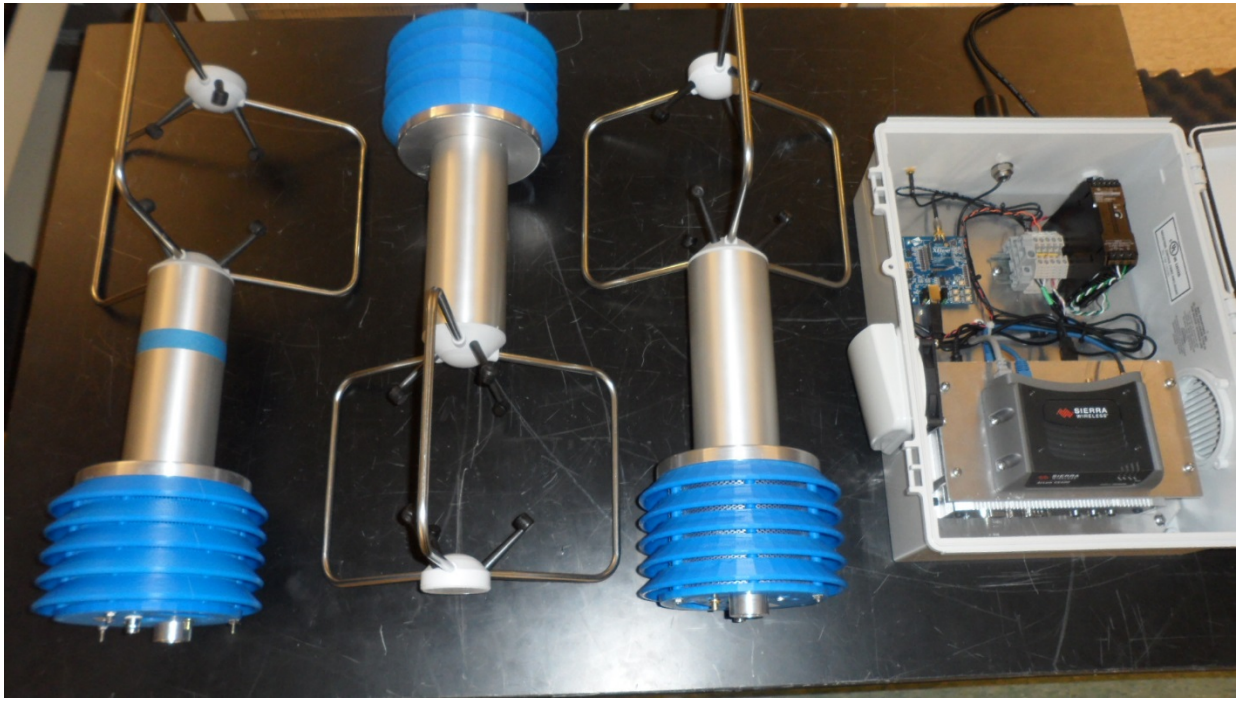

50 ppb Bump Test
De pressure anomaly
50 ppb bump
Version 2 SPods
Benzene
Signal (A.U.)
Time of Day
1150
1100
1050
1000
950
900
850
800
750
700
650
9:45:48
9:46:05
9:46:22
9:46:39
9:46:57
9:47:14
9:47:31
9:47:48
9:48:06
9:48:23
9:48:40


20 ppb Benzene Bump Test
840
830
820
810
800
790
780
770
760
Signal (A.U.)
8:45:36
8:52:48
9:00:00
9:07:12
9:14:24
9:21:36
9:28:48
Time of Day
Response saturation or a consequence of testing protocol?
Benzene

New Philly Test, 3 nodes and base station, deployment target July 2016







New Philly System, 3 nodes one base station deployment target, July 2016

These are version 2 SPods with lower baseline drift


SPods Progress
June, 2016
Thanks!
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