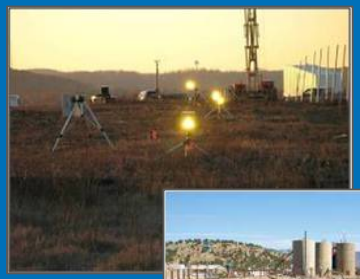
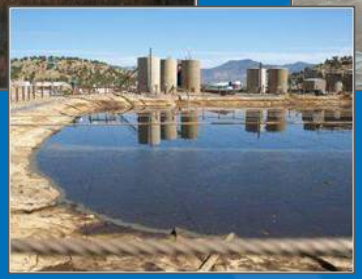
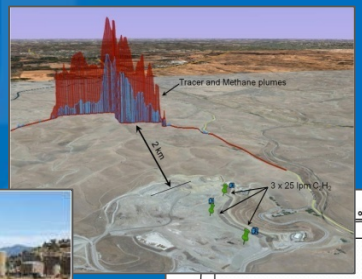
EPA United States Environmental Protection Agency

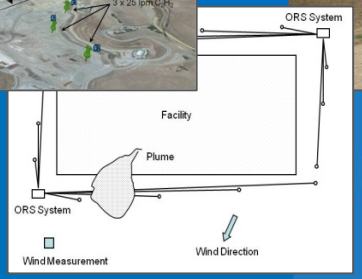
Update on Emerging Sensor Technology and Analytics

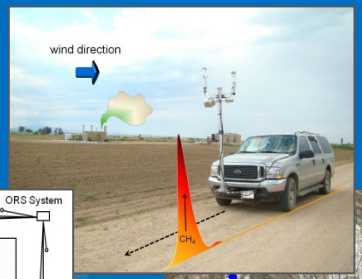
Invited Webinar Contribution

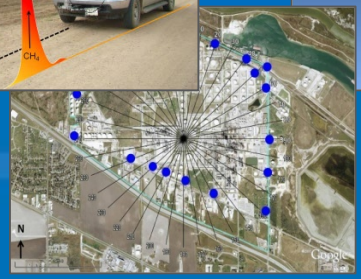
API Workshop - Use of Sensors/Software for Supplemental Fenceline Monitoring Systems, August 28, 2019, Houston TX

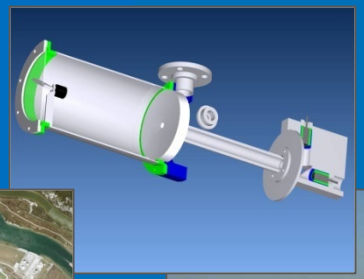
Eben Thoma: EPA Office of Research and Development, RTP, NC.
Haley Lane: Oak Ridge Institute for Science and Education (ORISE) researcher
Barry Kelley (in-plant senor network): Koch Industries, Rosemount, MN







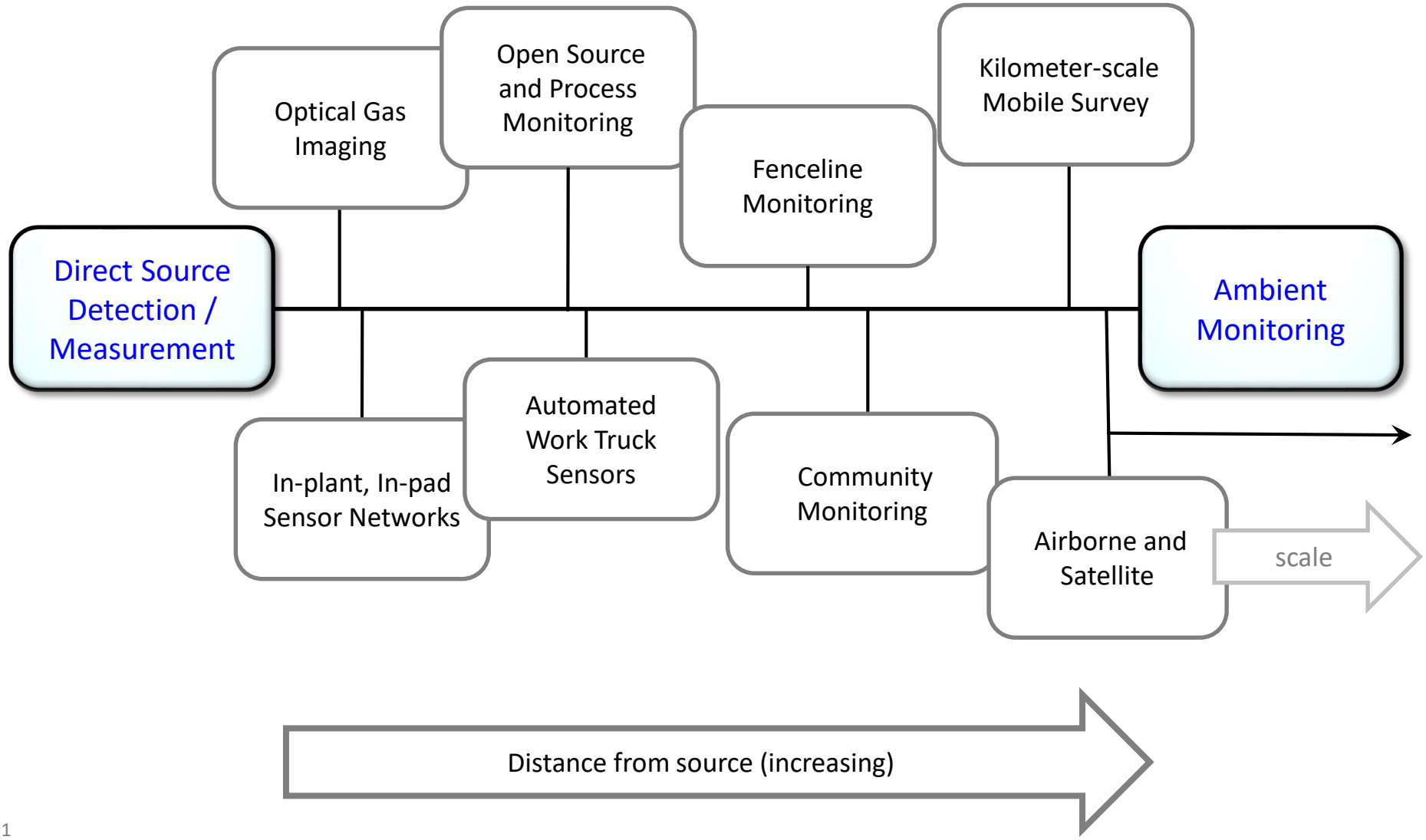


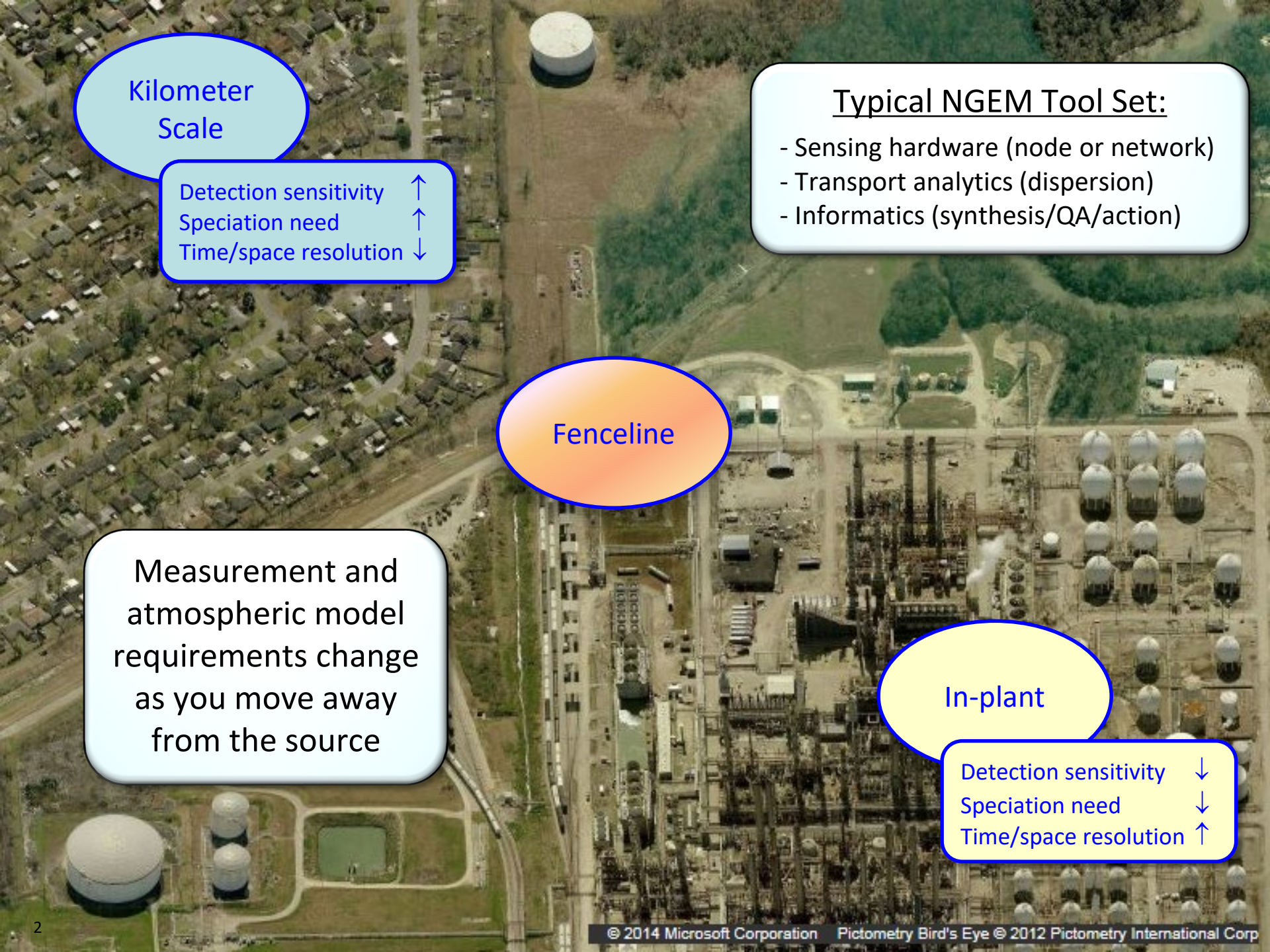

Office of Research and Development
National Risk Management Research Laboratory, Air and Energy Management Division

NRMRL Fugitive and Area Source Group
Source and Fenceline Measurements
Methods and Technology Development

Next Generation Emissions Measurements (NGEM)

Some here now but many are in the future




Kilometer Scale
Detection sensitivity ↑
Speciation need ↑
Time/space resolution ↓
Typical NGEM Tool Set:
- Sensing hardware (node or network)
- Transport analytics (dispersion)
- Informatics (synthesis/QA/action)
Fenceline
Measurement and atmospheric model requirements change as you move away from the source
In-plant
Detection sensitivity ↓
Speciation need ↓
Time/space resolution ↑
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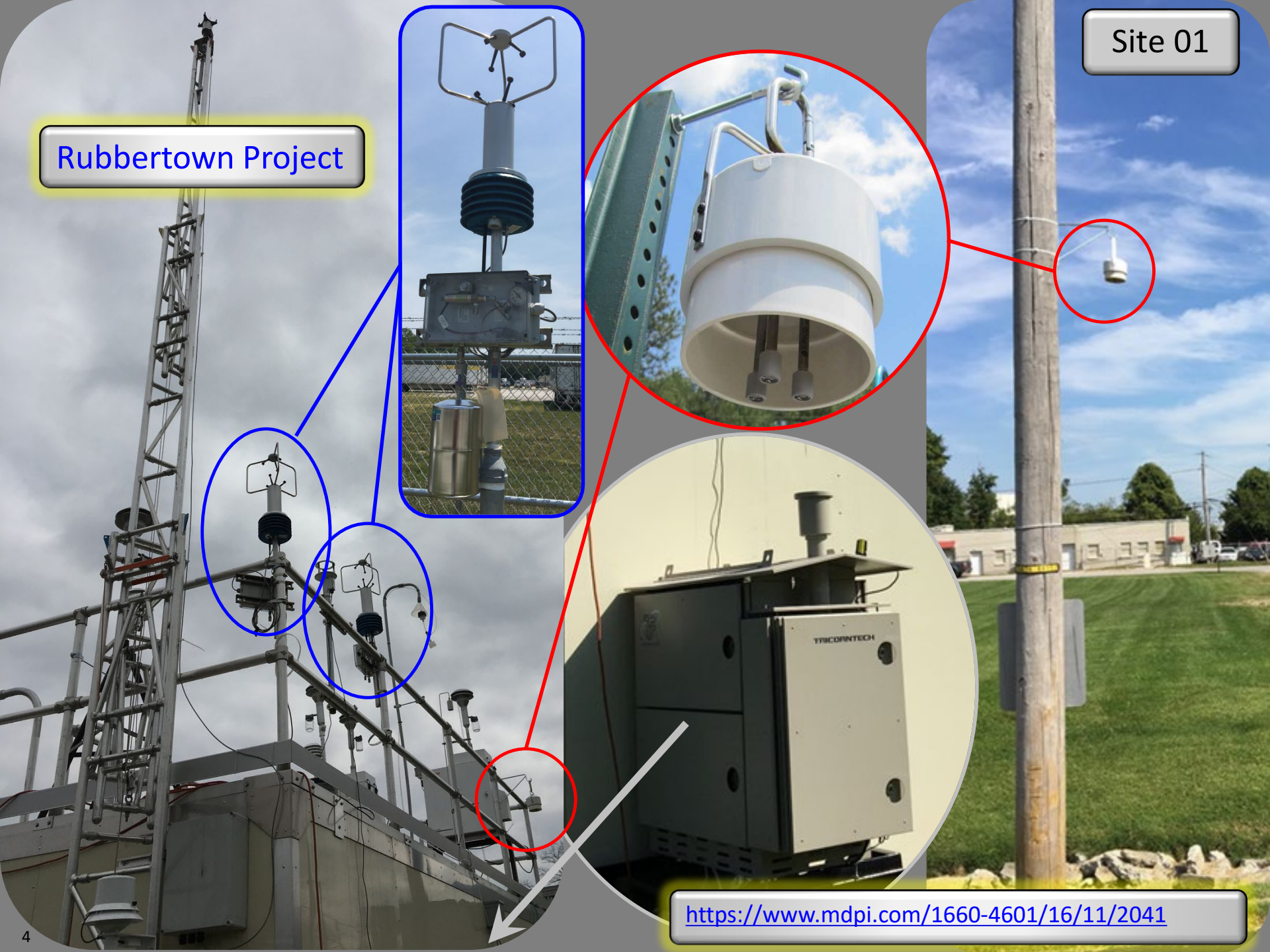
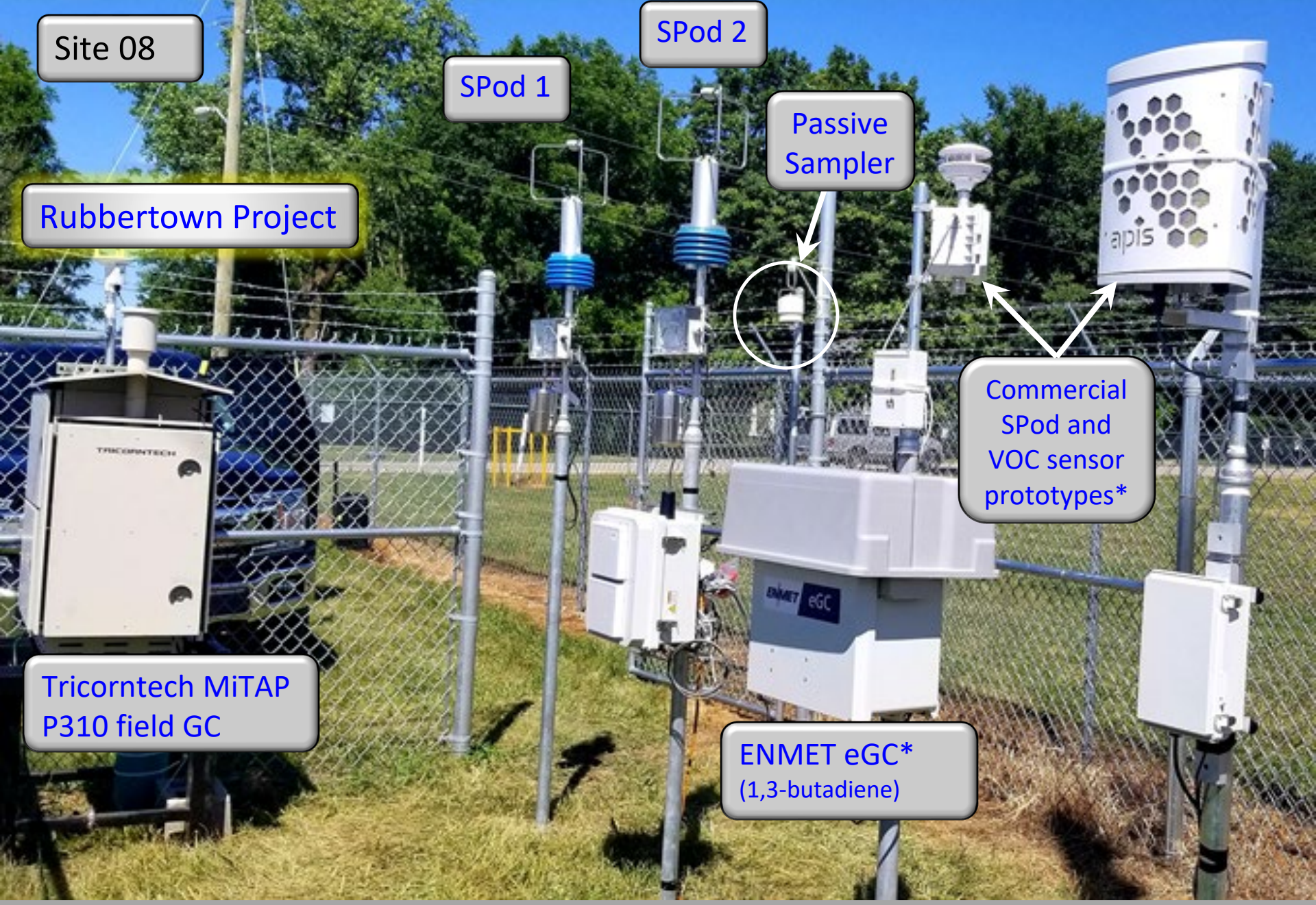
The range of available NEGM sensing hardware is increasing and covers a broad spectrum of both cost and performance

- Point sensors (non-speciating - MOS, PID, etc.)
- Point instruments (field GCs or spectroscopic)
- Open-path sensors (OGI, NDIR, Deep UV)
- Open-path instruments (UV DOAS, TDL, etc.)

Images of commercial products do not constitute endorsement or recommendation for use

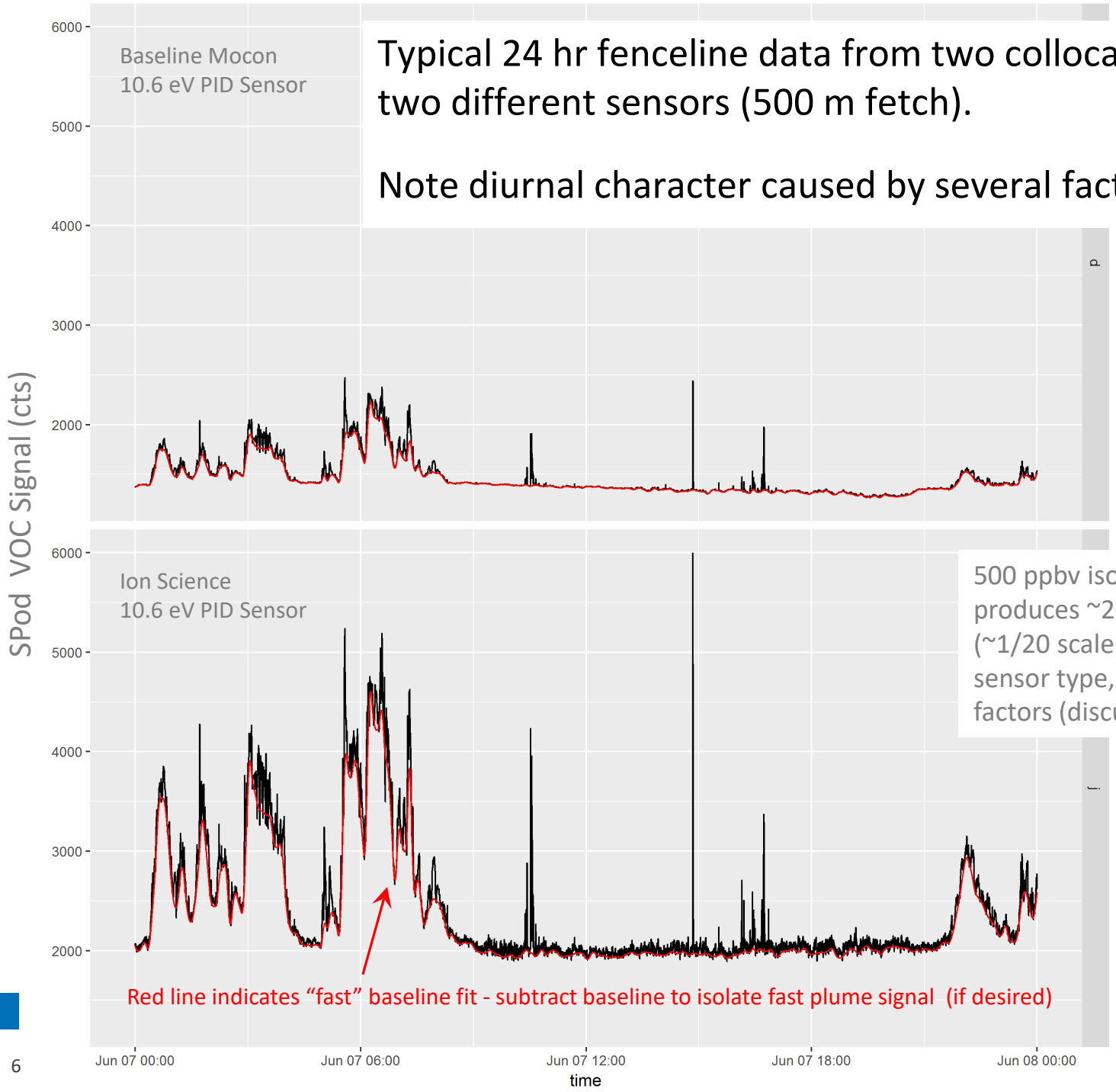

Rubbertown Project
Site 01
TISCORNTECH
https://www.mdpi.com/1660-4601/16/11/2041



*Experimental sensors for development comparisons only (not official data until QA approval)

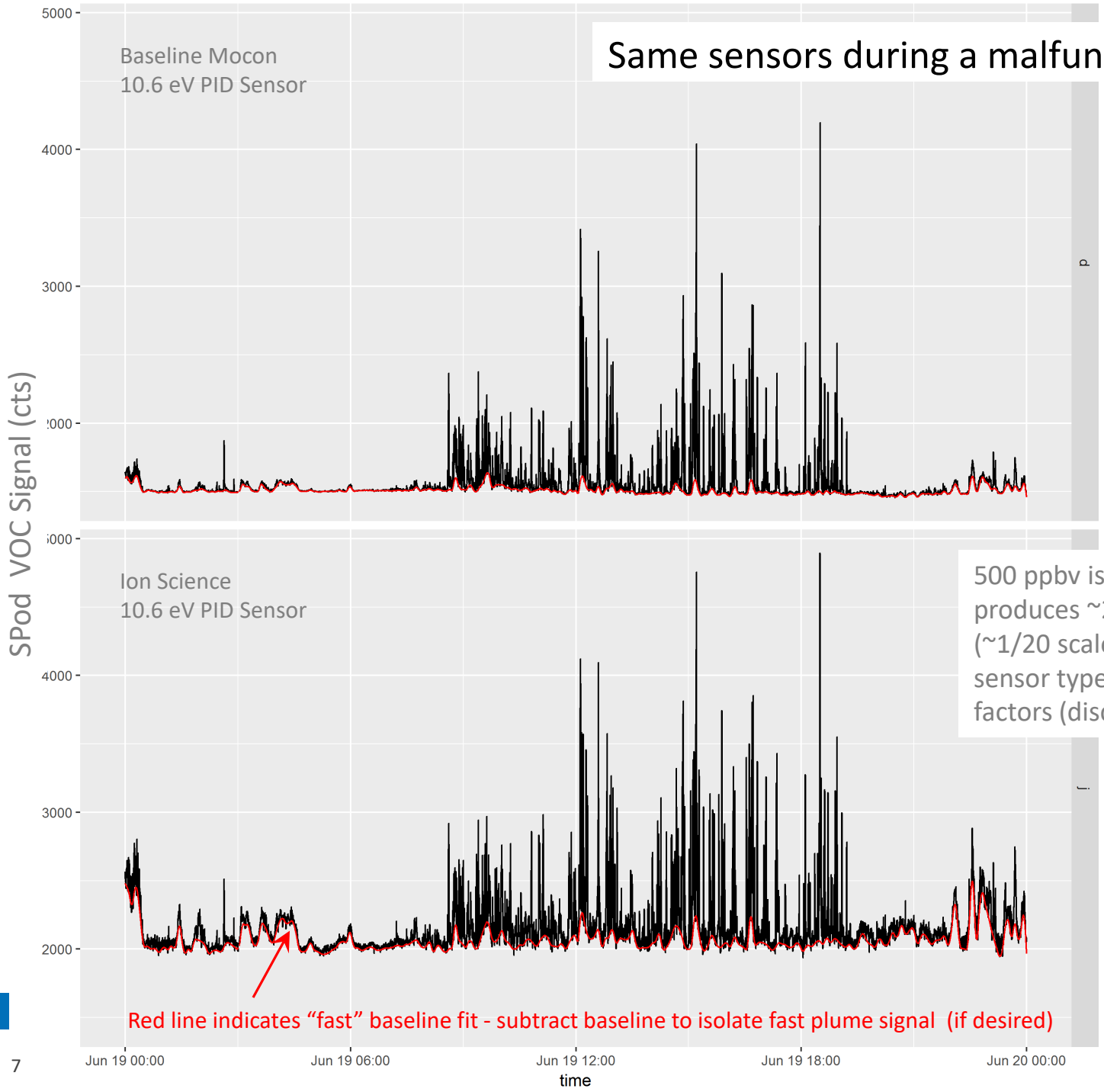
Typical 24 hr fenceline data from two collocated SPods using two different sensors (500 m fetch).

Note diurnal character caused by several factors (discussed).



500 ppbv isobutylene spike test produces ~2000 cts to 4000 cts (~1/20 scale), depending on sensor type, age, and other factors (discussed)

Same sensors during a malfunction event.



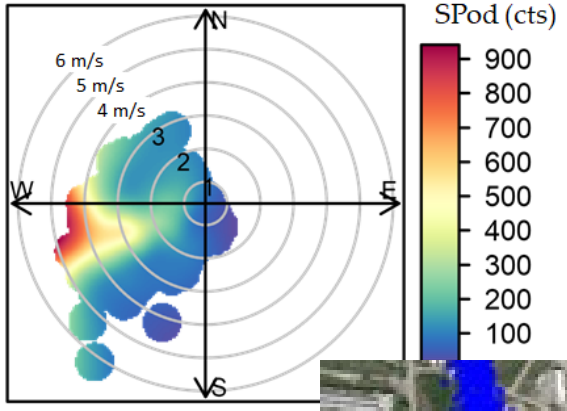
500 ppbv isobutylene spike test produces ~2000 cts to 4000 cts (~1/20 scale), depending on sensor type, age, and other factors (discussed)

Transport Analytics - Source Location Models

United States Environmental Protection Agency

Source direction indicator (SDI) plot

from SPod Fenceline sensor



Back trajectory model (BTM)

EnviroSuite 5-min prototype Calmet/Lagrangian

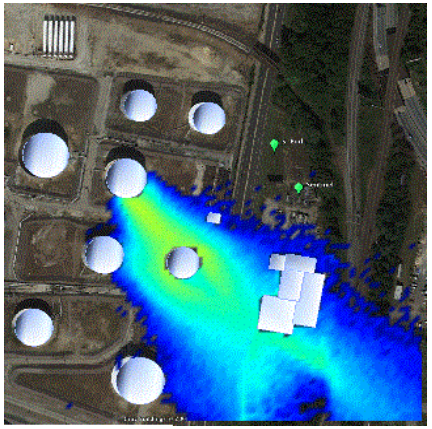
Temporally-combined trajectory analysis (TCTA)

Compare fast BTM with concentration time series

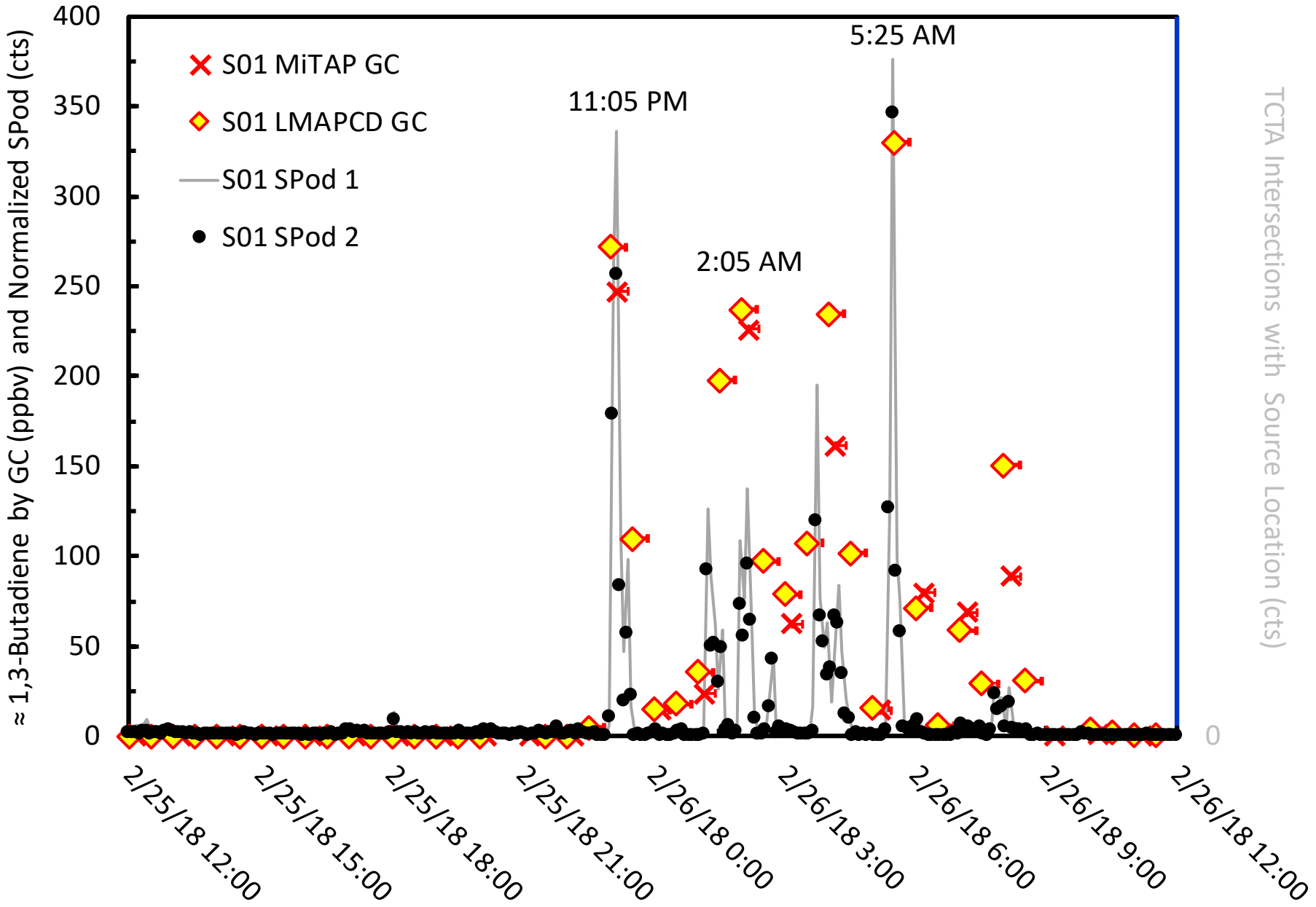
Forward model with obstructed flow

Quick Urban & Industrial Complex (QUIC) model

Compare with measurements

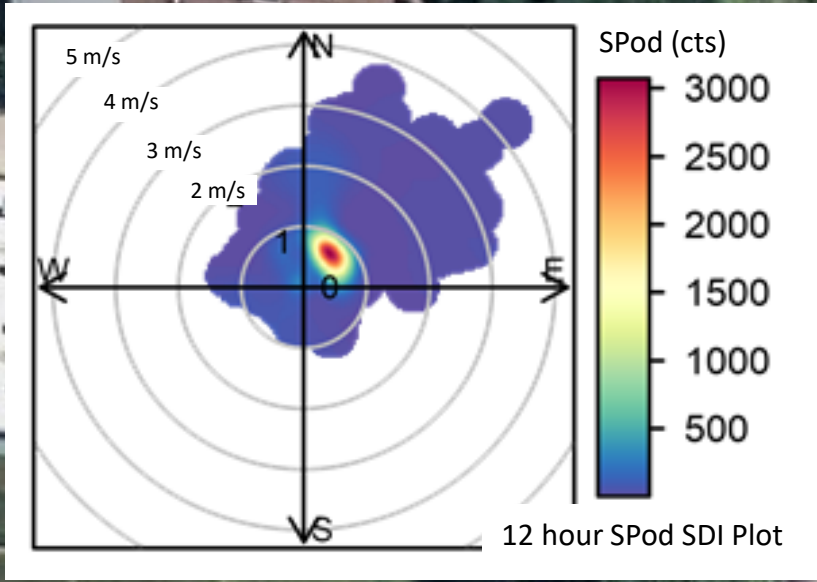


1,3-Butadiene Rubbertown on February 25-26, 2018



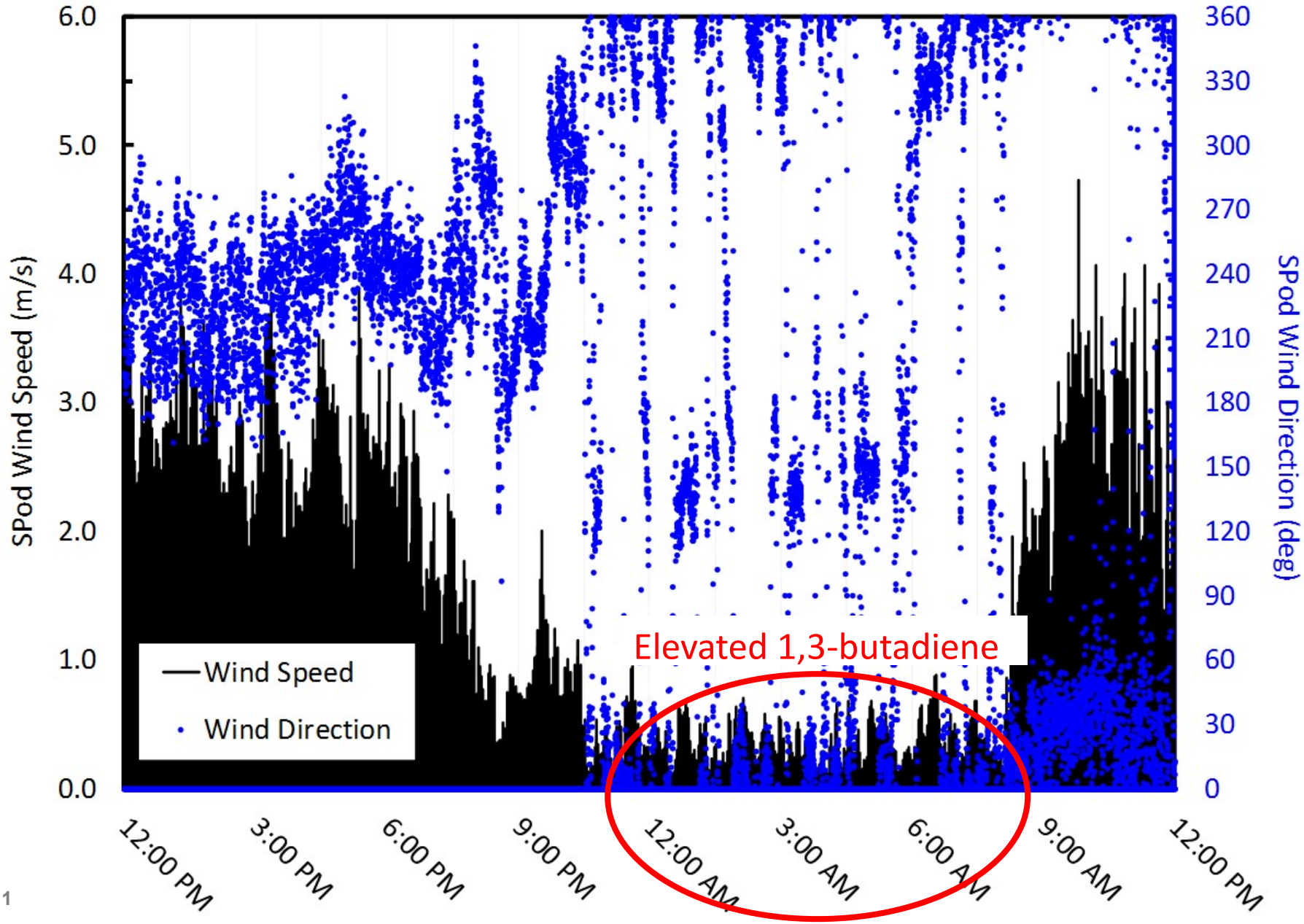
GC data above cal. range and is approximate
SPod signals divided by 9 and 12, five-minute avg.

Site 01

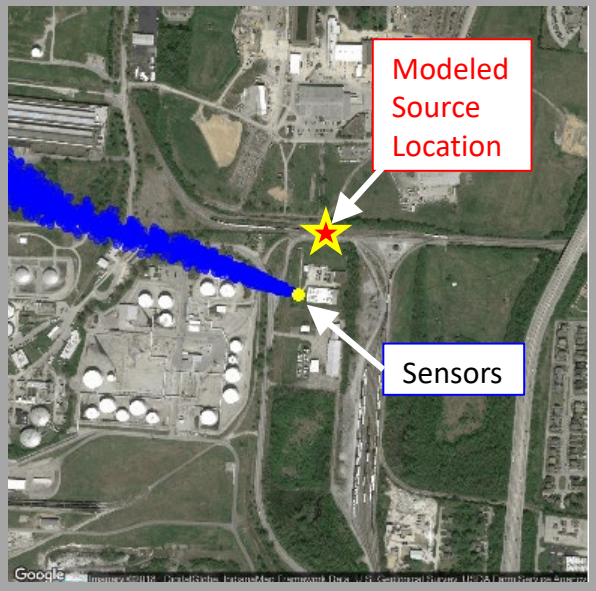


12 hour SPod SDI Plot

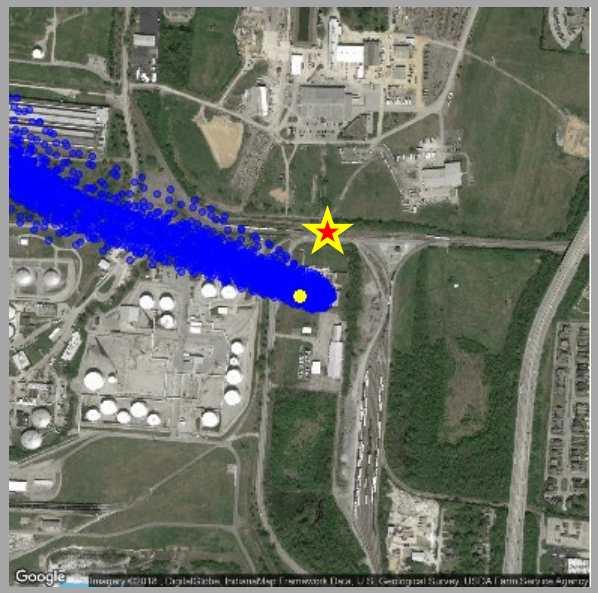
SPod High Resolution Wind Data at Site 01 on 2/25/18 and 2/26/18



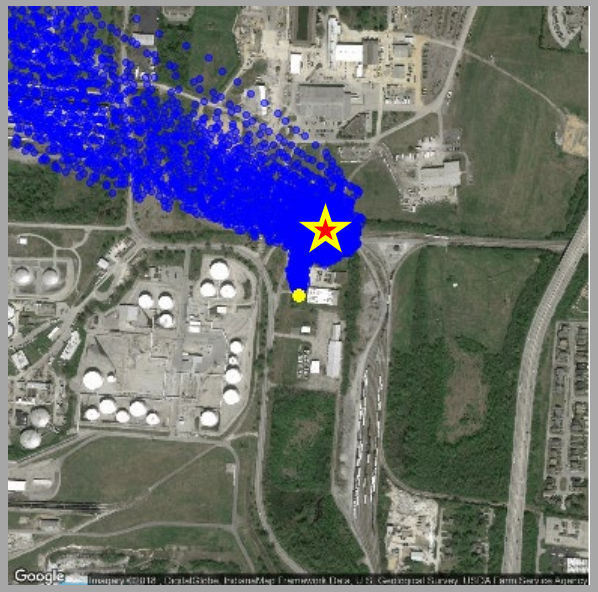
10:30 PM before event



10:45 PM before event (stagnant at Site 01)



11:05 PM event start (stagnant at source)



11:55 PM (no signal)

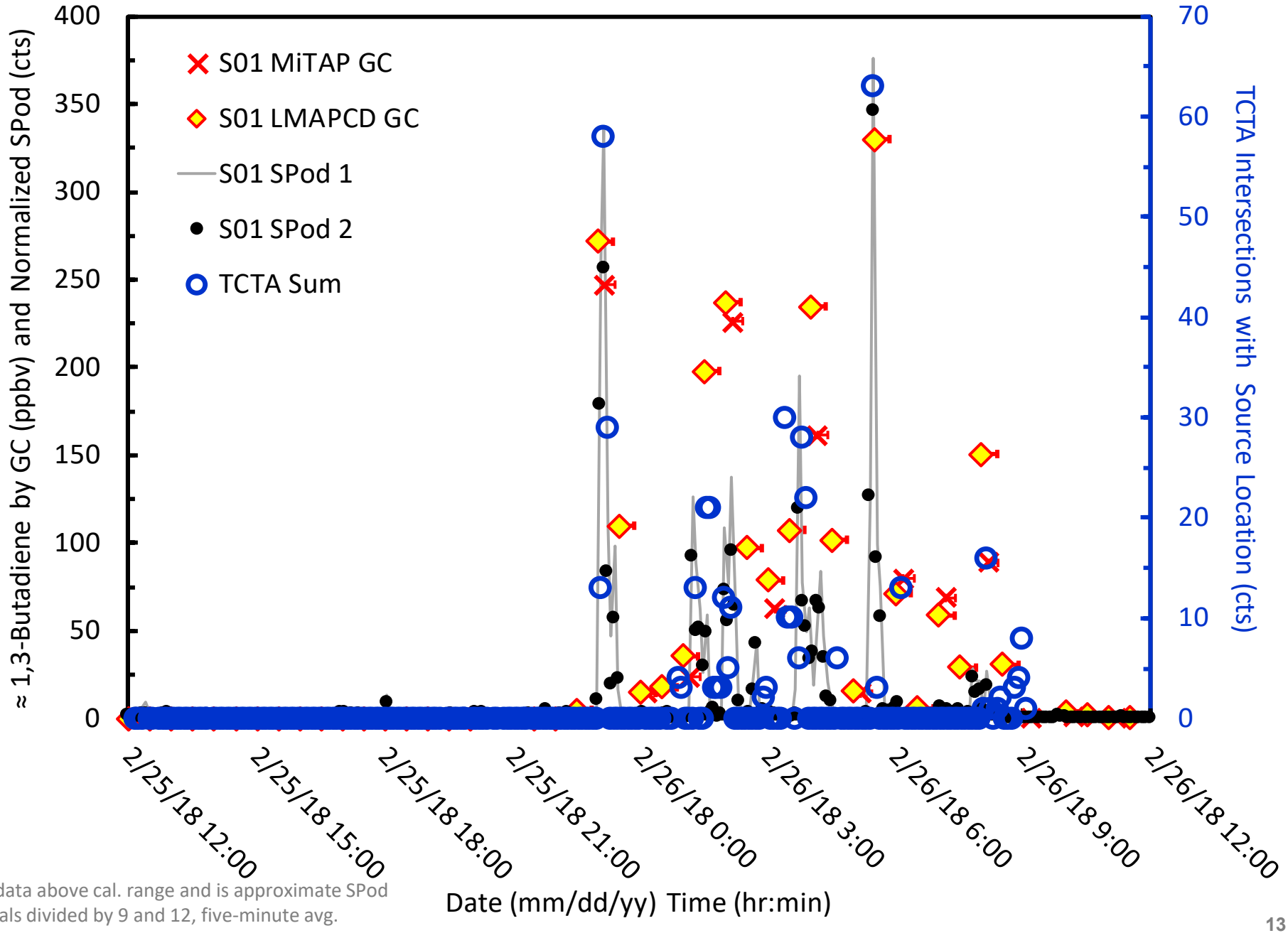
2:05 AM high reading

5:25 AM high reading

EnviroSuite average BTMs for Event 1

N = 99 trajectories for each 5 minute modeled period

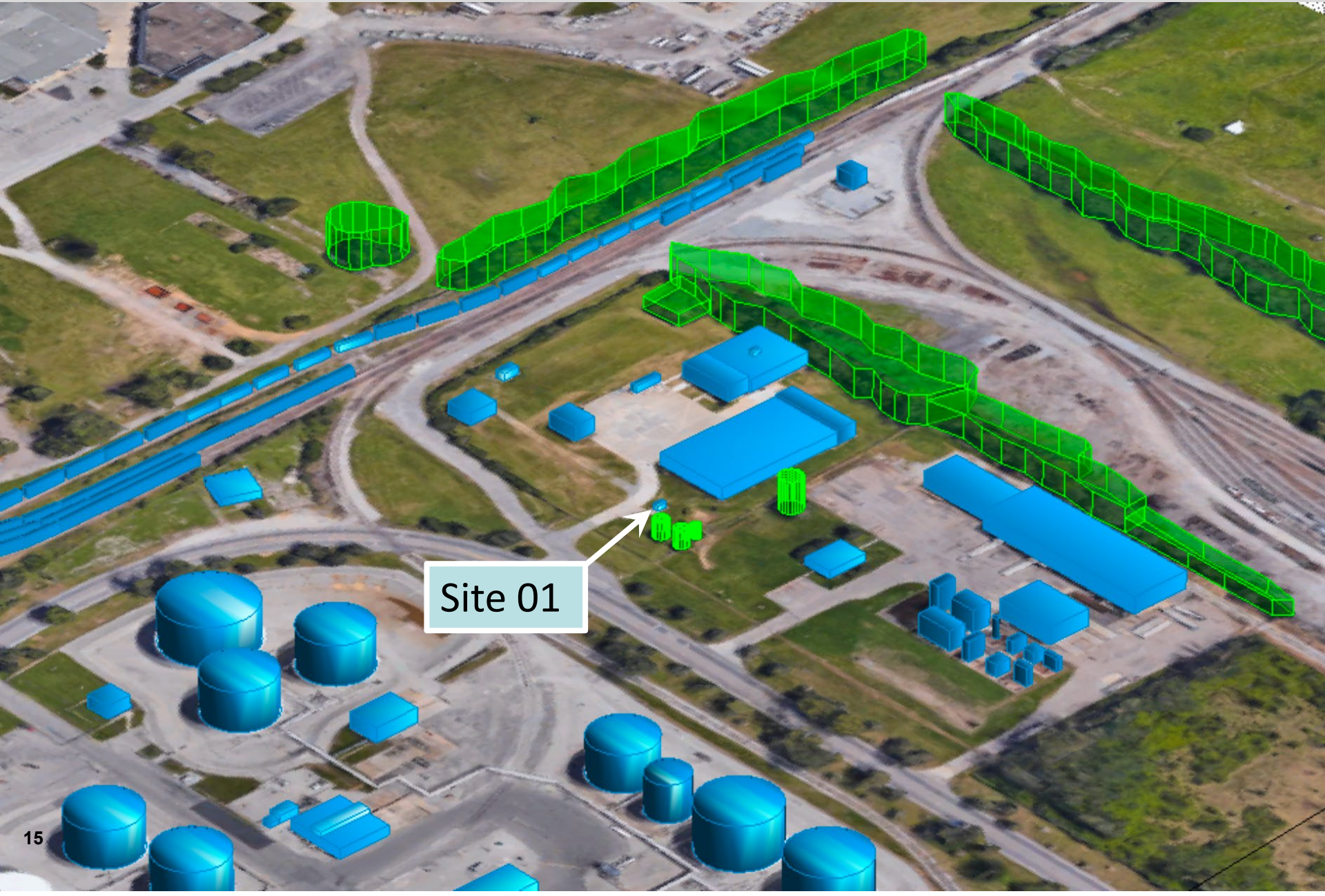
1,3-Butadiene Event 1 at Site 01 with TCTA Data



GC data above cal. range and is approximate SPod signals divided by 9 and 12, five-minute avg.

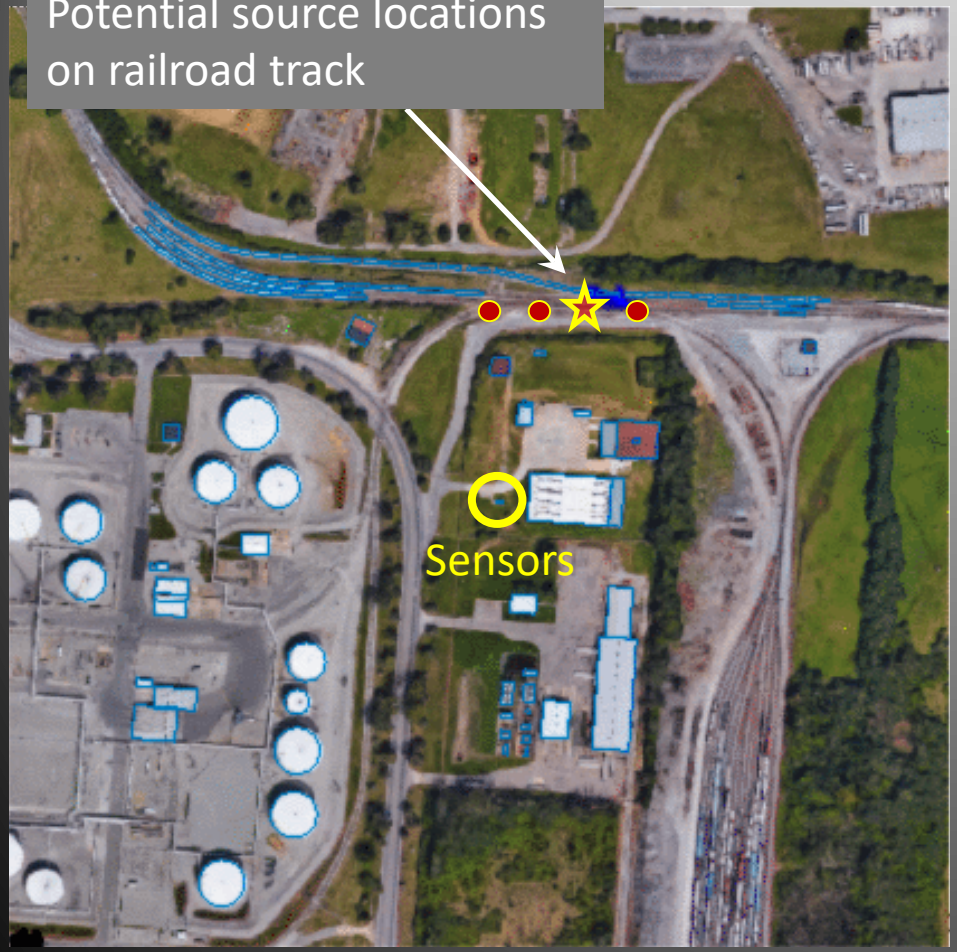
Quick Urban & Industrial Complex (QUIC) Dispersion Model

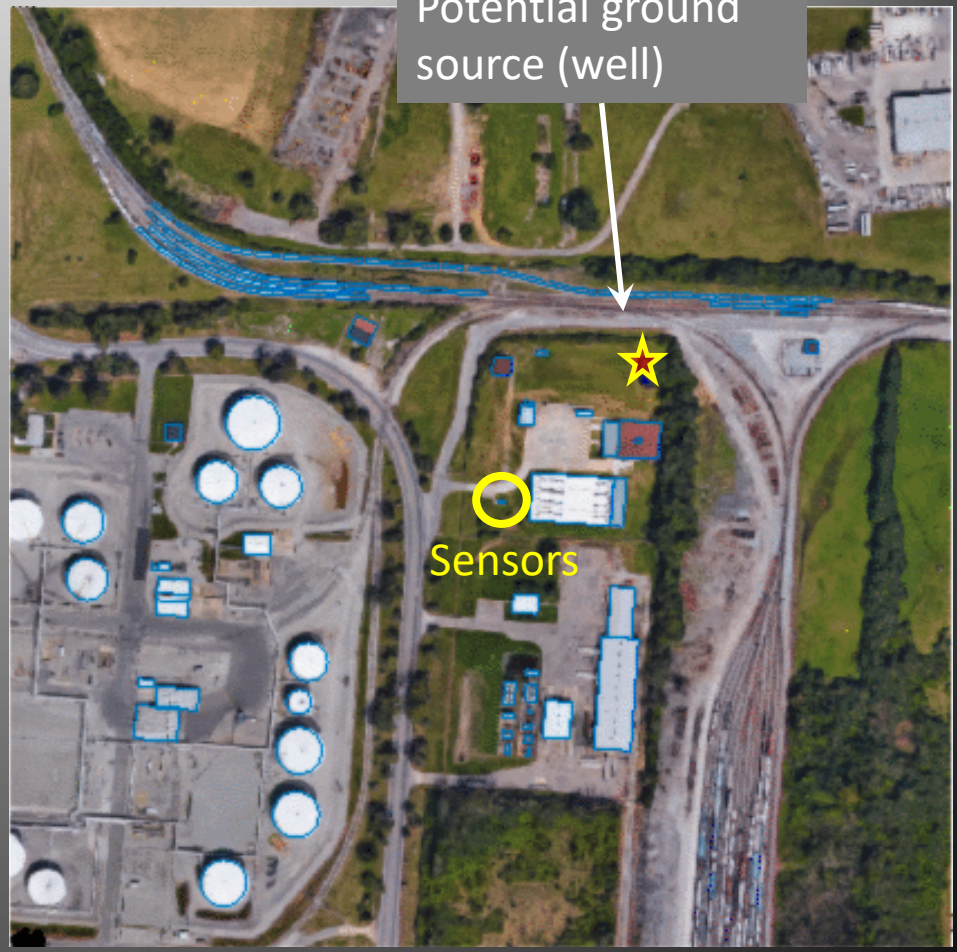
Developed by Los Alamos National Lab [http://www.lanl.gov/projects/quic/]



QUIC Model of Two Different Modeled Source Locations

1.5 hrs of Event 1 on 2/25/18





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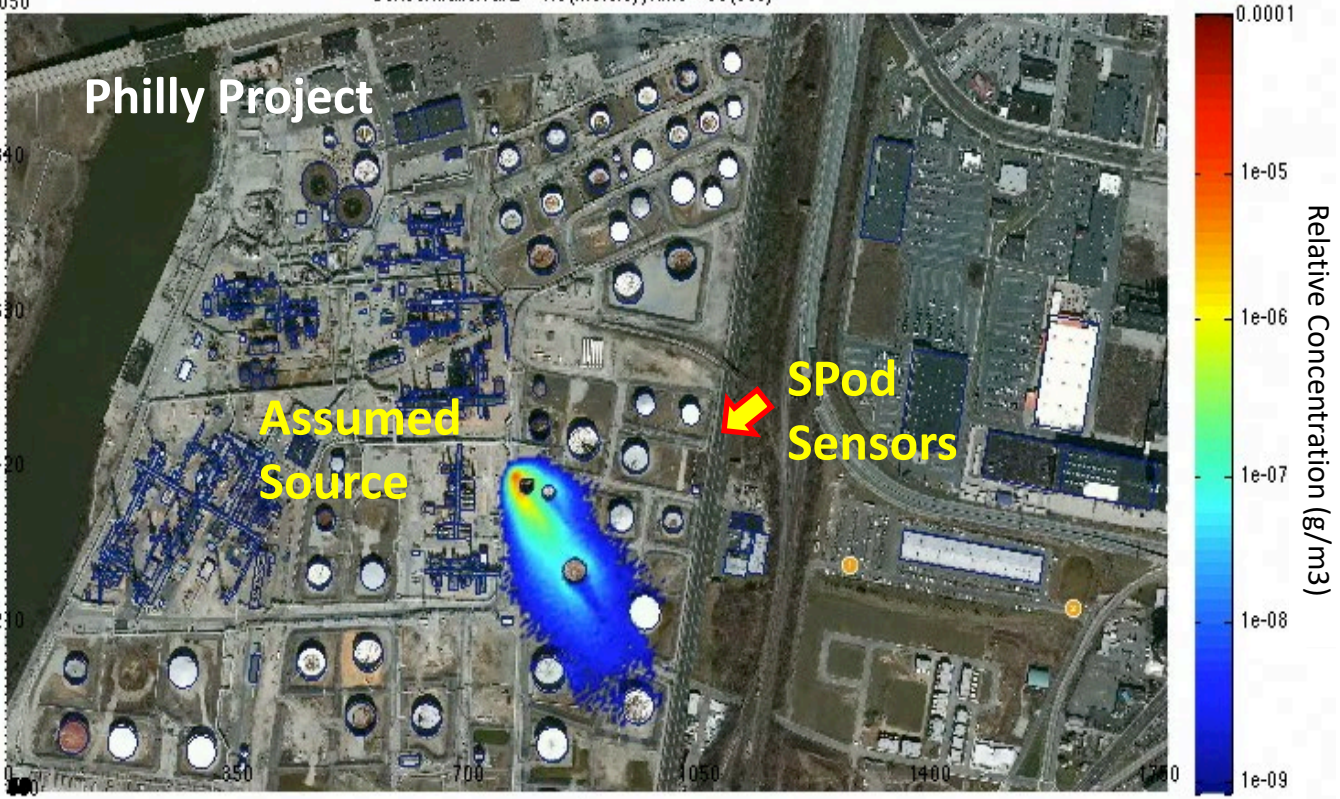
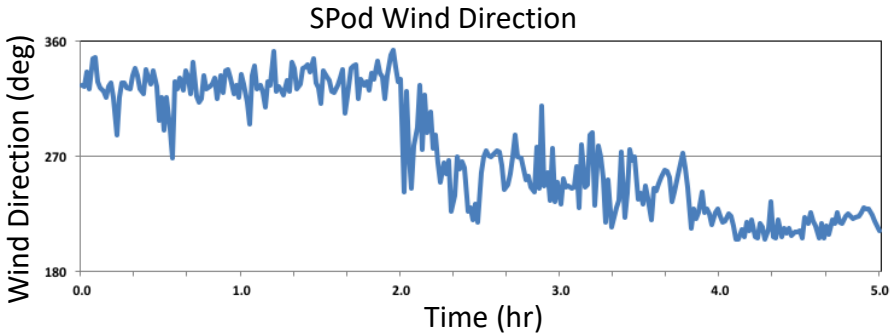
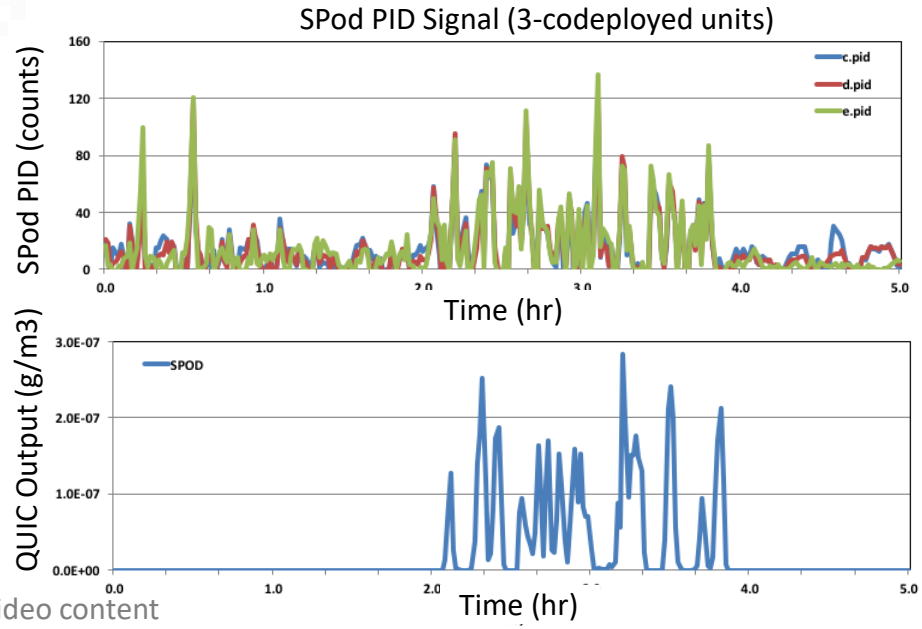


Combining Sensor Data and Wind Flow Models

Helps understand concentration fields and source locations

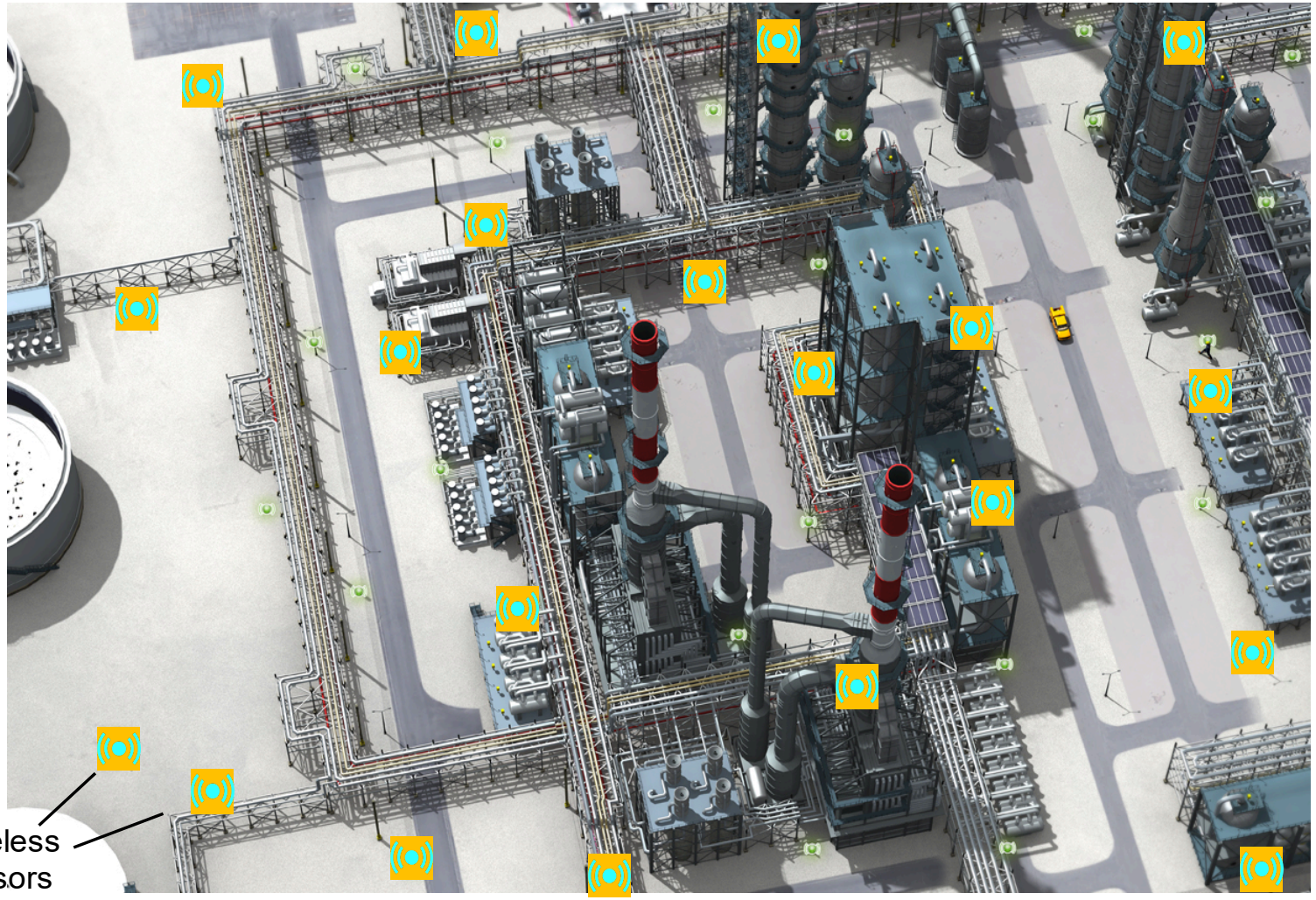




Los Alamos Quick Urban & Industrial Complex (QUIC) Dispersion Model
http://www.lanl.gov/projects/quic/
Easy to setup, runs on a laptop!

This slide contains video content

FHR-Molex-EPA ORD Leak Detection Sensor Network Collaboration

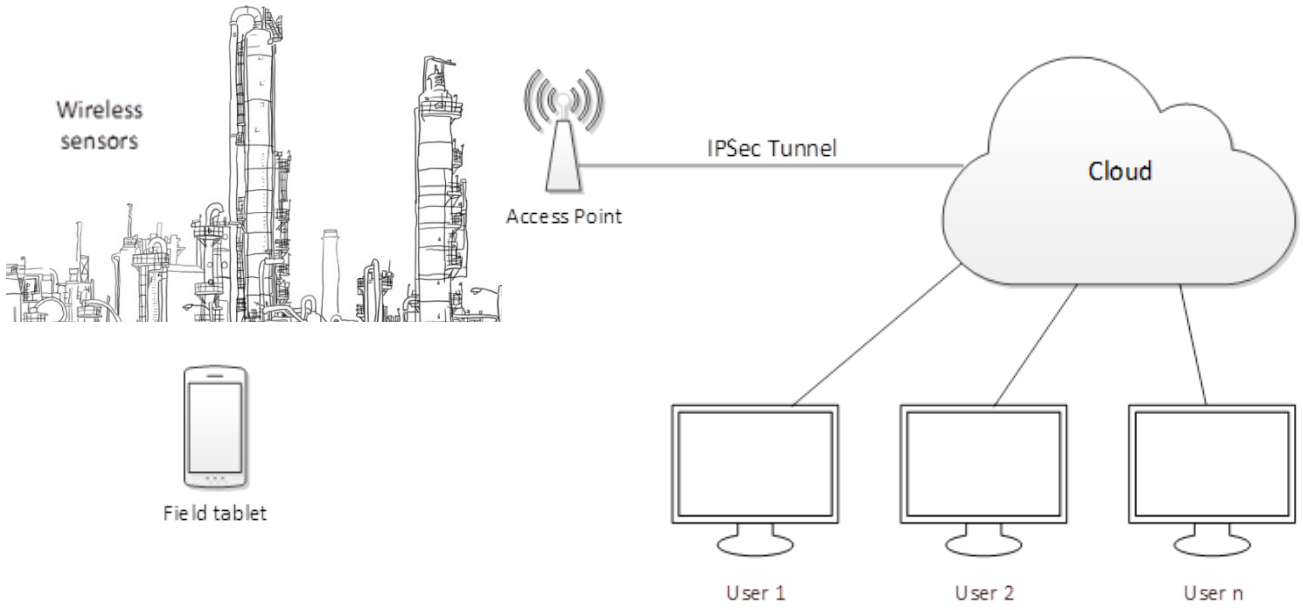


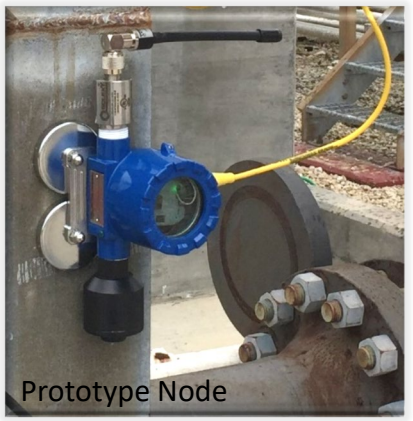
FLINT HILLS resources®

EPA

molex®

FHR-Molex-EPA ORD Leak Detection Sensor Network Collaboration





- A multimode network system approach: sensors, software, and procedures
- Automated leak detection and alerts
- In full-scale testing in multiple process units
- Potential alternative to manual Method 21

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A Few Take-away Points

- Important to establish application data quality objectives (DQOs)
  Must clearly define what it is you are trying to understand
- Application specifics determine sensor / model performance needs
- There are a lot of emerging lower-cost sensors (buyer beware)
- Collocated and gradient measurement configurations are very useful
- Don't underestimate the effects of flow field obstructions
- Diurnal signal characterization is important
- Models like EnviroSuite must have high quality met data (critical)
- Informatics turn sensor/model results and metadata into usable information
  This is critical because the amount of data generated is very large