

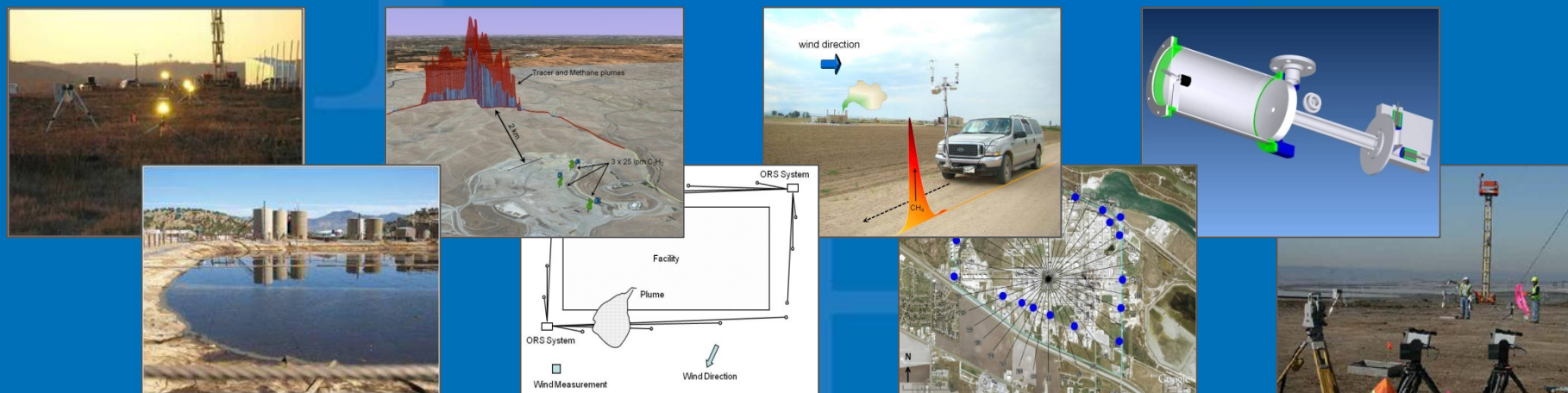


# Air Pollutant Source Investigation using Next Generation Emission Measurements and Models; Early Case Studies of 1,3-Butadiene Emissions in Louisville, KY *NEIC 2018 Tech Summit, Denver CO, August 21, 2018*

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**Office of Research and Development**

National Risk Management Research Laboratory, Air and Energy Management Division

*Interim draft data (subject to change), presented at the 2018 EPA NEIC  
Technical Information Exchange, 8/21/18, for scientific discussion purposes*

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

# Presentation Topics

- Rubbertown NGEM Demonstration Study (background)
- Instruments, sensors, and lab samples
  - Louisville APCD GC, Tricorntech field GC,
  - SPods, canisters, and passive samplers
- 1,3-butadiene measurement events
  - February 24-26, and May 7 (source close by, to the northeast)
  - June 19 (source far away, to the south, southwest)
- Combining measurements and models to locate the source
  - SPod concentration rose
  - Enhanced EnviroSuite modeling
  - Temporally combined trajectory analysis
  - Los Alamos QUIC model
- Summary and next steps

NGEM = next  
generation emissions  
measurements



# Rubbertown NGEM Demonstration Project

## *Brief Background*

- *What is the project focus?*
  - Prototype NGEM system near Rubbertown facilities
  - Select gas-phase air pollutants
  - Started September 2017 and will continue as funding allows
- *What do we want to do?*
  - Work together to try new NGEM approaches and learn about air pollution sources in Louisville (research)
- *Who is involved in this project?*
  - EPA Office of Research and Development (ORD), EPA Region 4, Louisville Air Pollution Control District (APCD), and Jacobs Technology (EPA contractor), technology providers

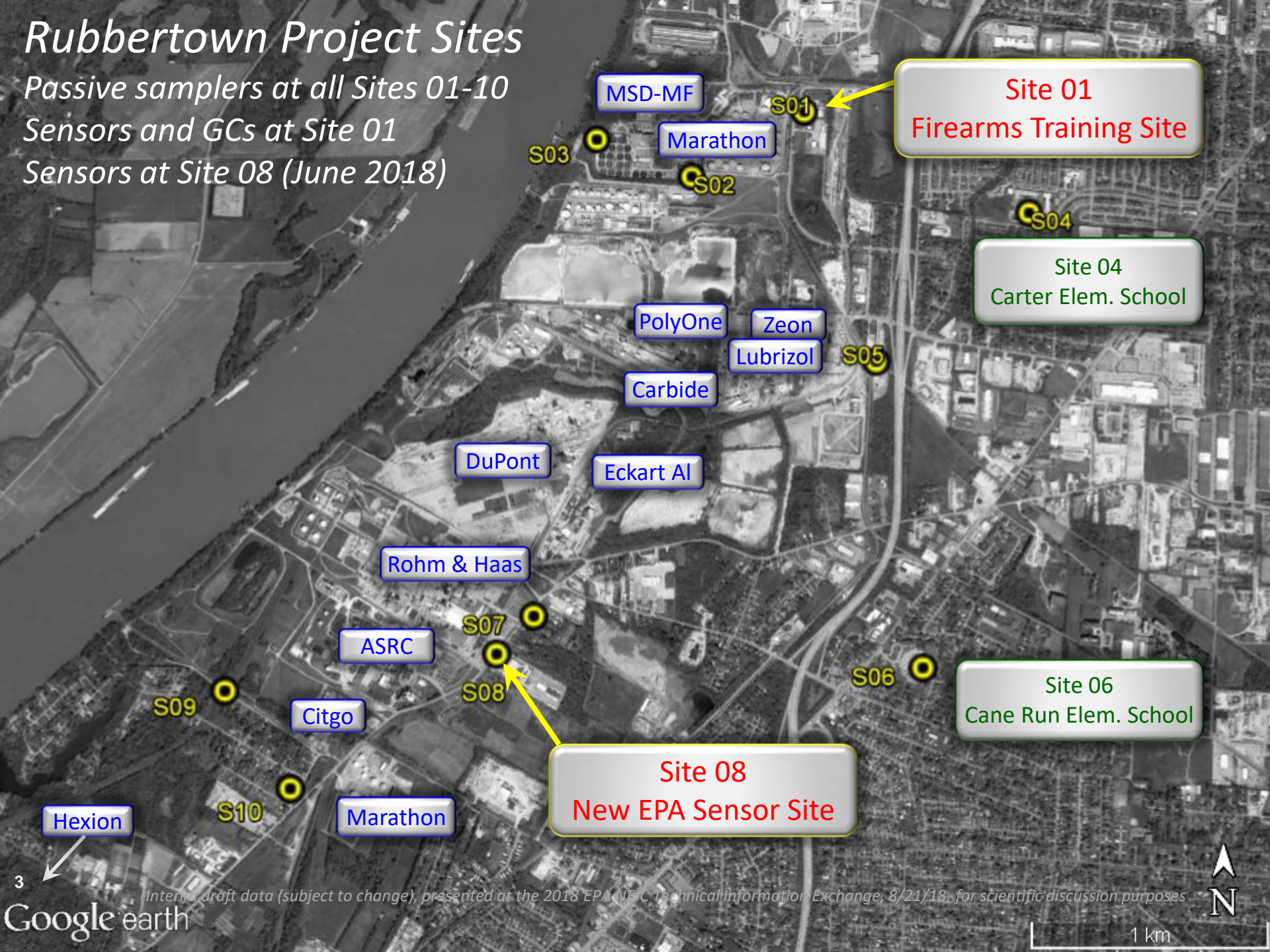


# Rubbertown Project Sites

Passive samplers at all Sites 01-10

Sensors and GCs at Site 01

Sensors at Site 08 (June 2018)



Site 01  
Firearms Training Site

Site 04  
Carter Elem. School

Site 06  
Cane Run Elem. School

Site 08  
New EPA Sensor Site

Internal draft data (subject to change), presented at the 2018 EPA NEIC Technical Information Exchange, 8/21/18, for scientific discussion purposes



SPod 1

SPod 2

NGEM Comparisons  
Louisville Study Site 01  
Started Fall 2017

Site 01  
(North)

Passive  
Sampler

ENMET eGC  
(benzene)

Tricortech  
MiTAP P310  
Field GC

APCD Auto GC  
Inside Shelter

Louisville Air Pollution  
Control District (APCD)  
(Installed Fall 2017)



Site 08  
(South)

SPod 1

SPod 2

Passive  
Sampler

Commercial  
SPod and  
VOC Sensor  
Prototypes\*

Tricorntech MiTAP  
P310 Field GC  
Moved from Site 01 - 7/19/18

ENMET eGC\*  
(1,3-butadiene)

Site 08 active measurements started mid-June 2018 (passive samplers Sept. 2017); \*denotes experimental sensors for development comparisons only (not official data until QA approval)

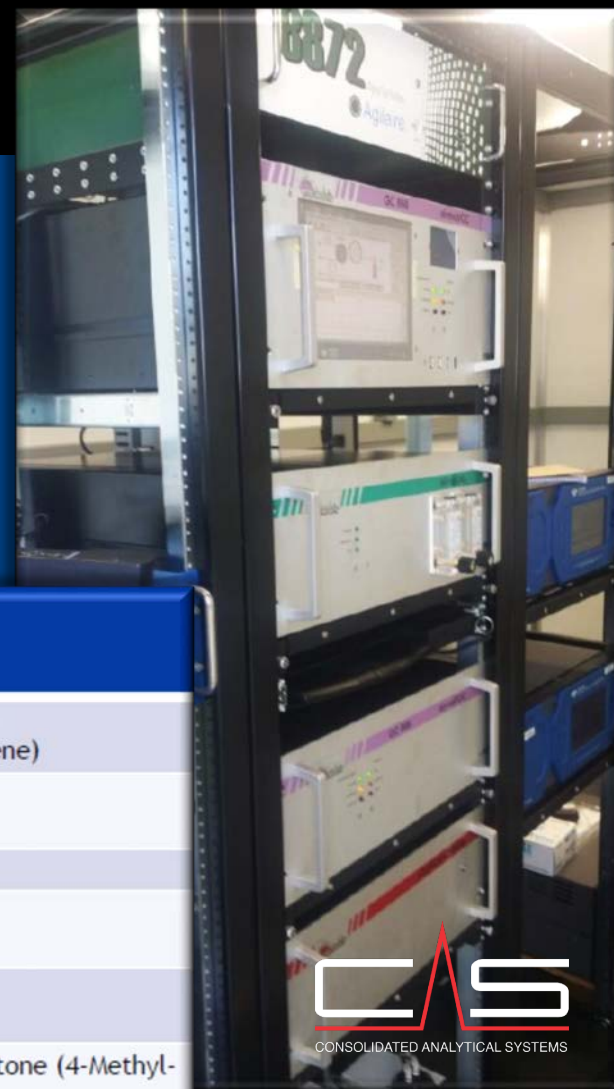


# Louisville APCD Auto-GC - Site 01

<u>CAS No.</u>	<u>Compound</u>
107-13-1	Acrylonitrile
71-43-2	Benzene
75-25-2	Bromoform
106-99-0	1,3-Butadiene
56-23-5	Carbon tetrachloride
67-66-3	Chloroform
106-46-7	1,4-Dichlorobenzene
75-09-2	Methylene chloride (Dichloromethane)

<u>CAS No.</u>	<u>Compound</u>
127-18-4	Perchloroethylene (Tetrachloroethylene)
79-01-6	Trichloroethylene
75-01-4	Vinyl Chloride
108-88-3	Toluene
100-41-4	Ethylbenzene
108-10-1	Methyl isobutyl ketone (4-Methyl- 2-pentanone)
100-42-5	Styrene
80-62-6	Methyl methacrylate
140-88-5	Ethyl Acylate

30 min cycle time (22 min air sample)  
Dual GC (FID), 30 m columns  
System is being developed/validated  
Near real-time data target, late 2018



**CAS**  
CONSOLIDATED ANALYTICAL SYSTEMS





# Tricorntech MiTAP P310 - Site 01

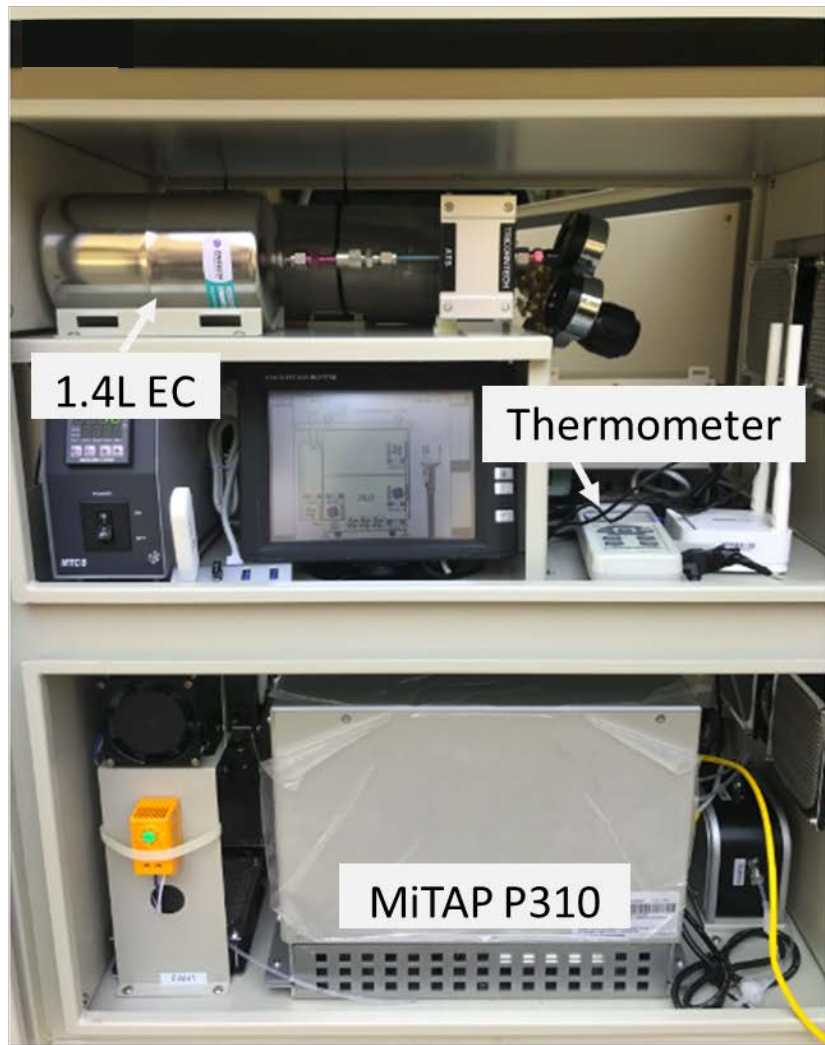
*(moved to Site 08 in July 2018)*

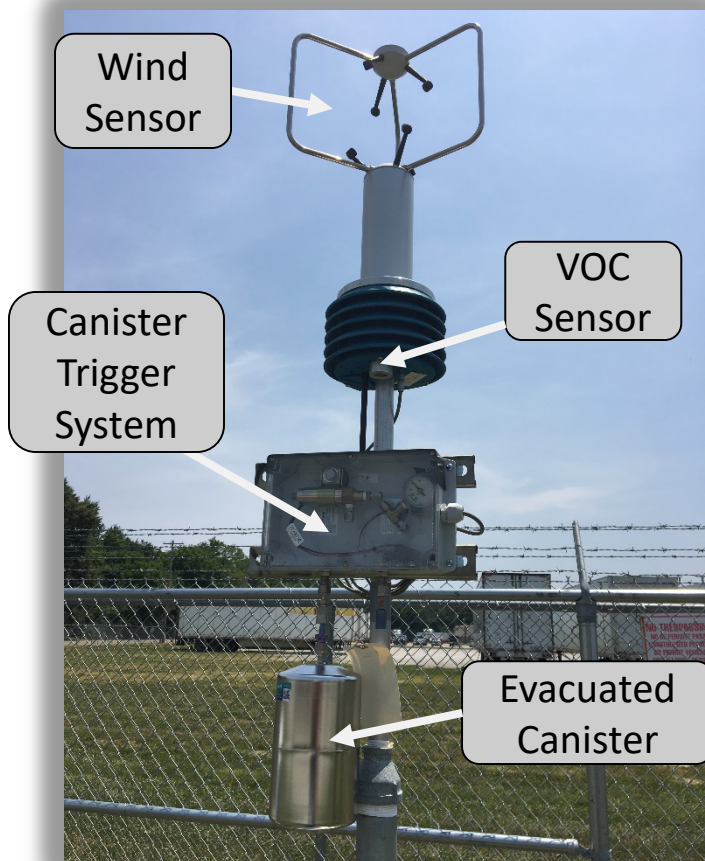


- Mid-cost field auto GC (no trailer required)
- 1 hr cycle time (15 min air sample)
- Fan-cooled enclosure, heated inlet
- Proprietary sorbent and sensor array
- On-board calibration cylinder
- Triggered canister grab sample
- Integrated meteorological measurements
- Method detection limits in the 0.1 to 0.3 ppbv range (compound dependent)
- Target list of 12 compounds for Rubbertown Study (customizable)
- 1,3-butadiene, BTEX, vinyl chloride, others

# Tricorntech MiTAP P310 - Site 01

(moved to Site 08 in July 2018)





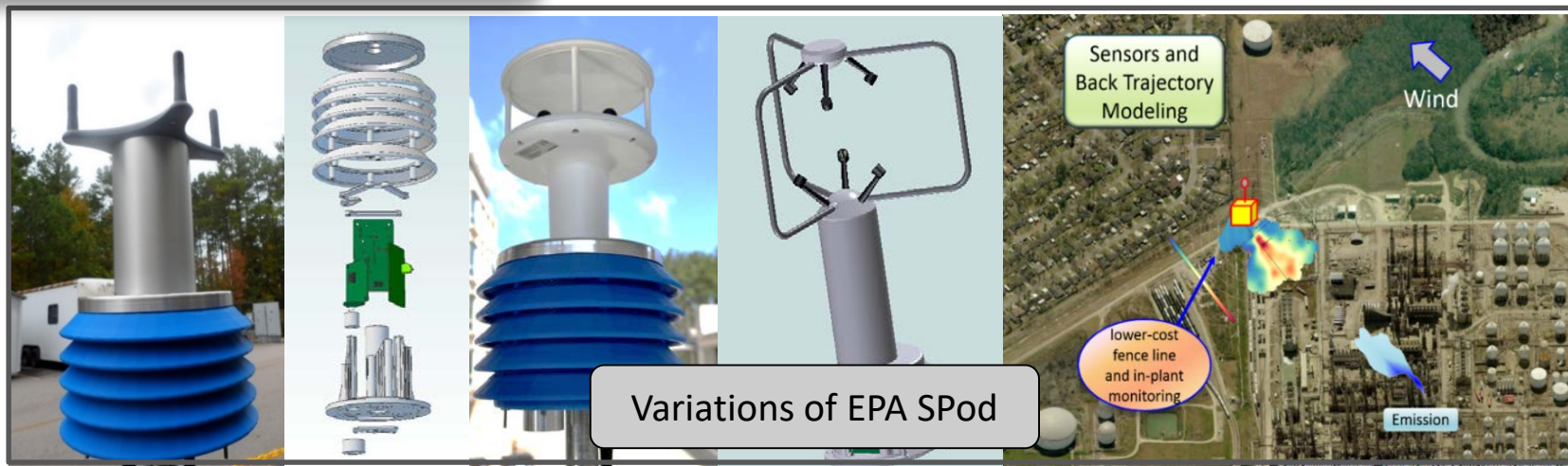
## SPod-type Fenceline Sensors

- Non-speciated VOC emission sensor
- Synchronized wind field measurement
- 1Hz time resolution
- Data ready for inverse models
- Can be solar-powered
- Auto canister grab sample for lab speciation
- EPA open-source design

More Info

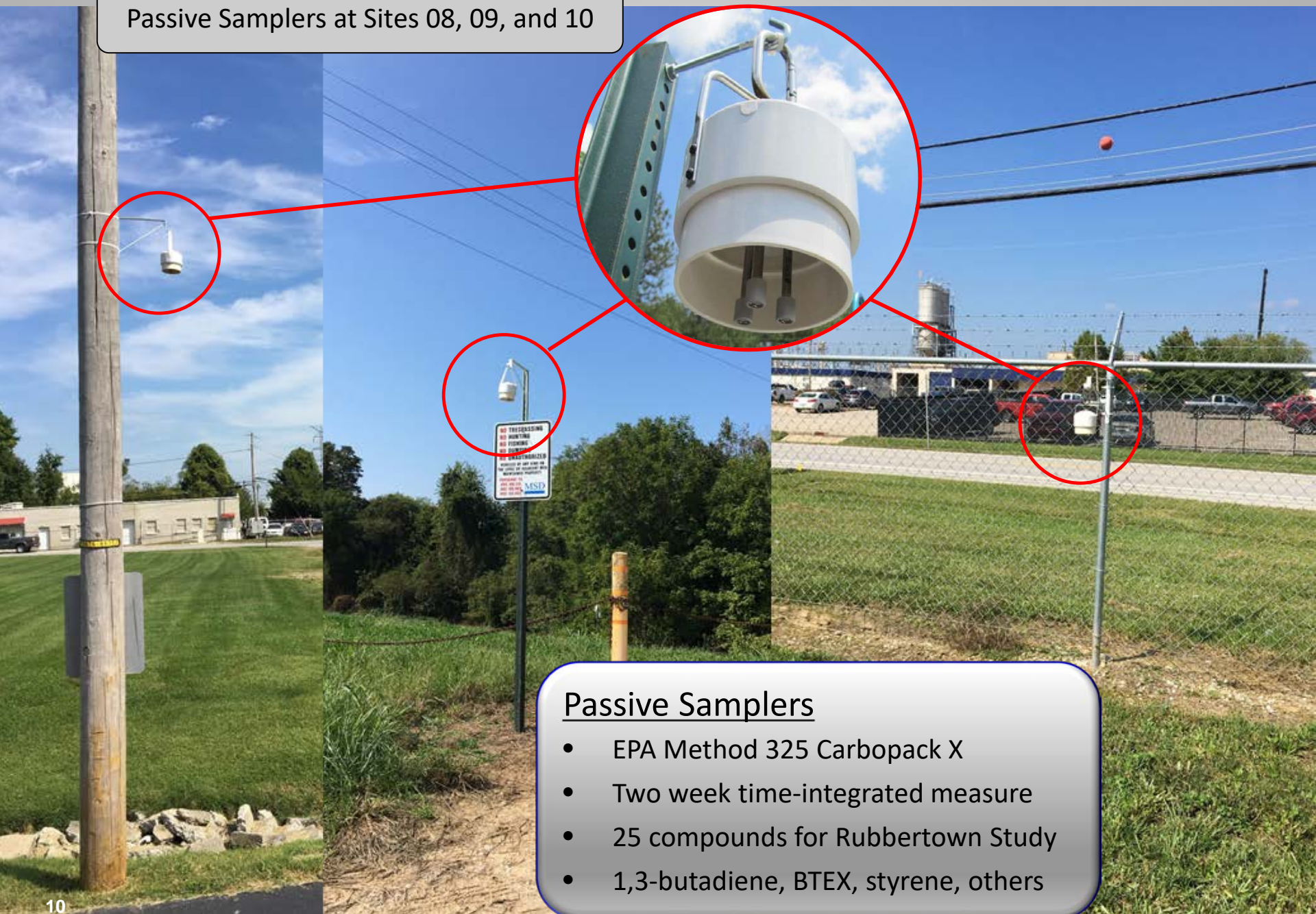


[https://www.epa.gov/sites/production/files/2016-04/documents/spod\\_fact\\_sheet.pdf](https://www.epa.gov/sites/production/files/2016-04/documents/spod_fact_sheet.pdf)





## Passive Samplers at Sites 08, 09, and 10



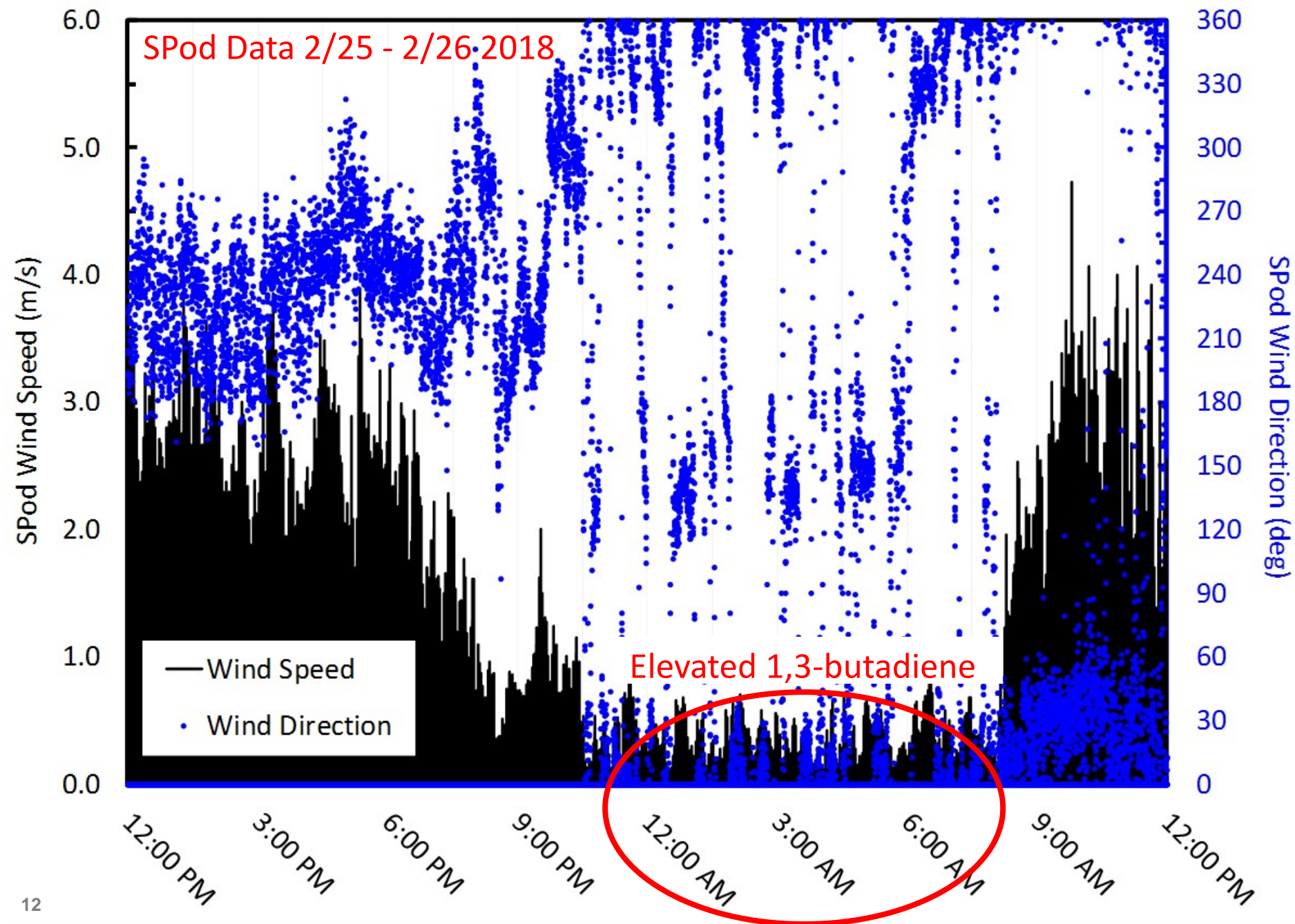
### Passive Samplers

- EPA Method 325 Carbopack X
- Two week time-integrated measure
- 25 compounds for Rubbertown Study
- 1,3-butadiene, BTEX, styrene, others

# 1,3-Butadiene February 24-26 and May 7, 2018 Events

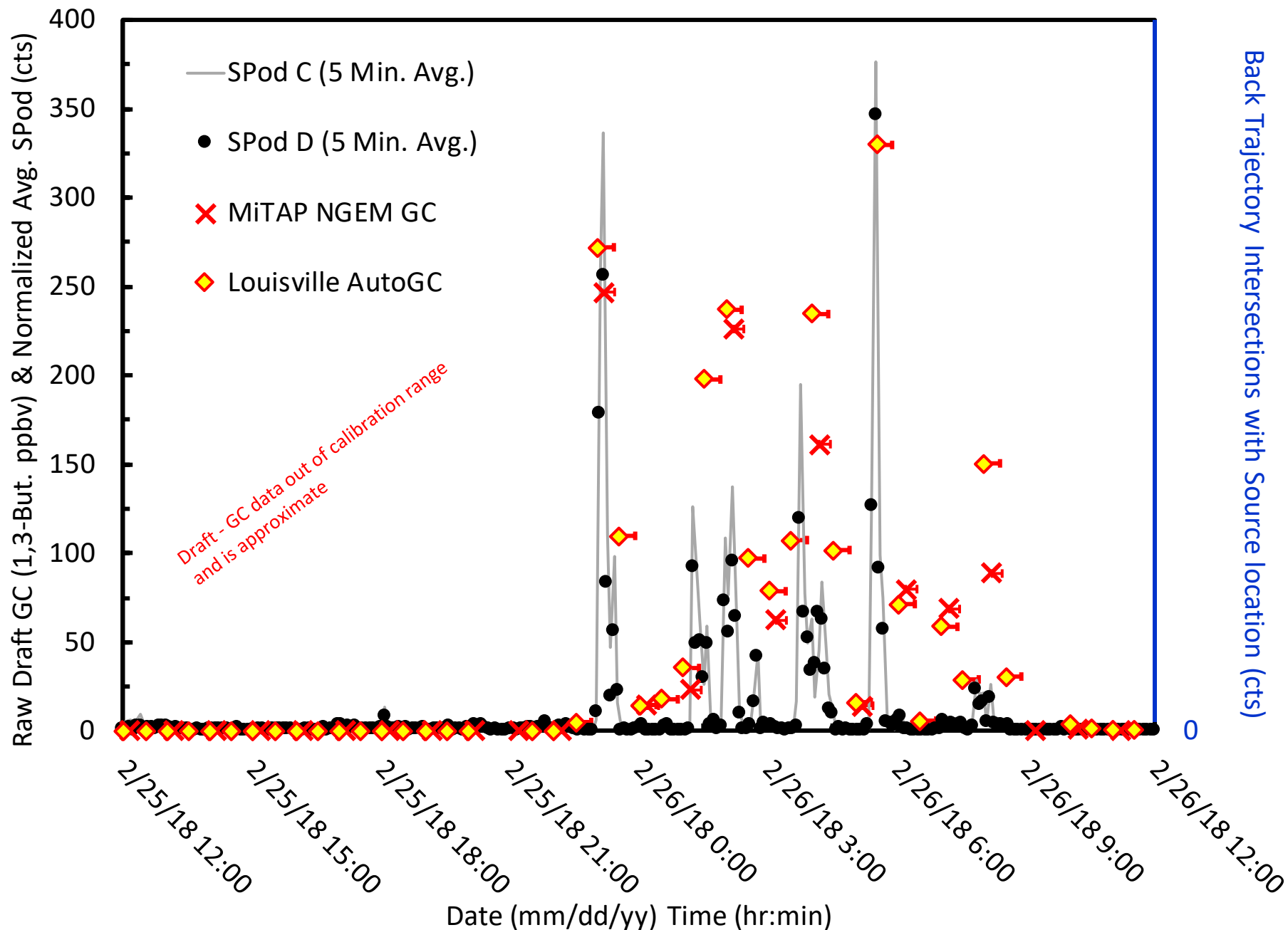
- February 24-26, 2018 (*focus on the late 2/25 to morning 2/26*)
  - More significant events (*compared to 5/7/18*)
  - Observed by multiple NGEM systems
  - Source is close by and to the northeast (not from facilities)
  - Occurred after multiple days of heavy rain (area flooding)
  - Low wind speed conditions yielded high concentrations
- May 7, 2018
  - Less significant event (brief)
  - Observed by multiple NGEM systems
  - Very similar source location as February events
  - Occurred after heavy rain



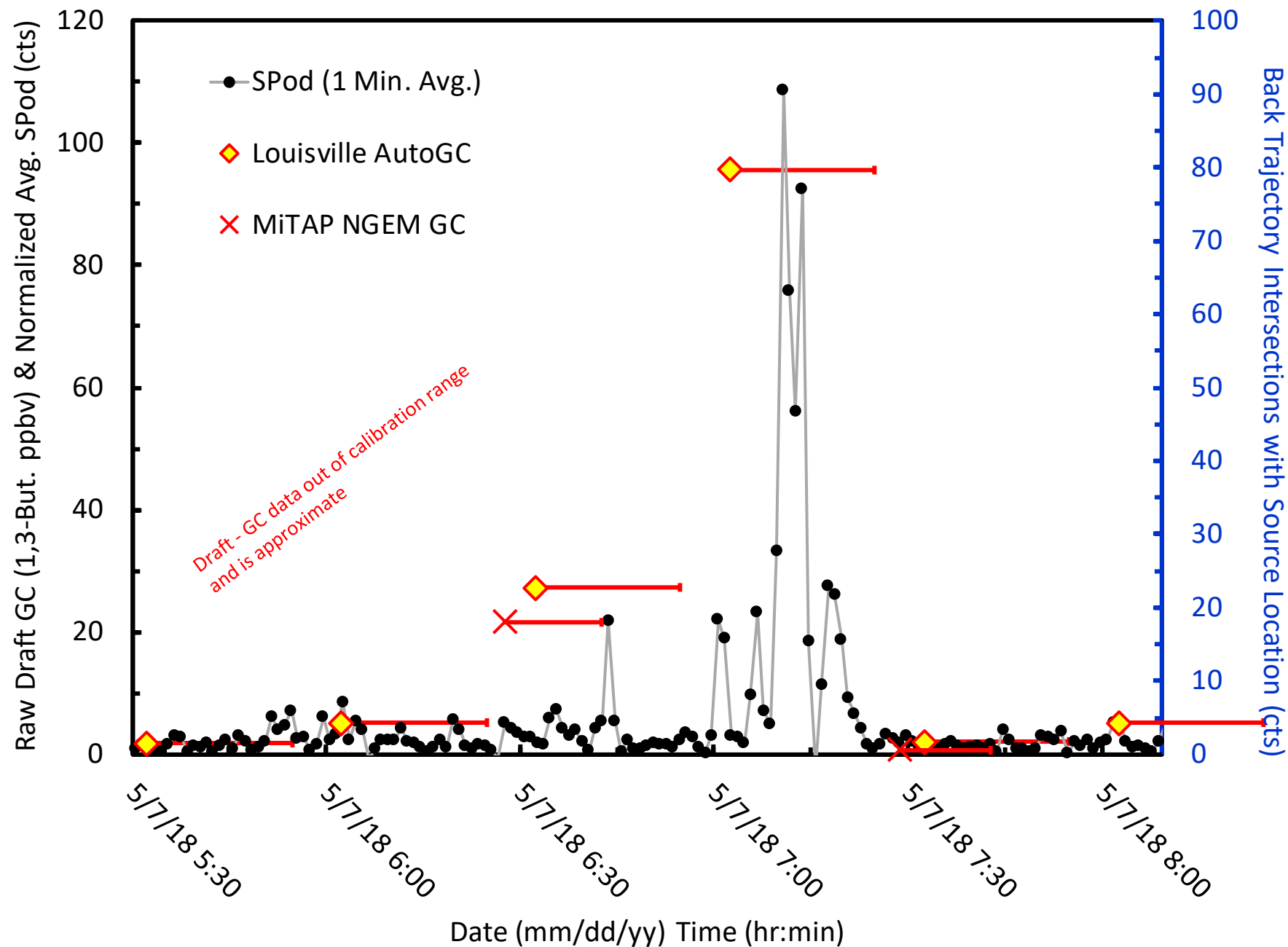




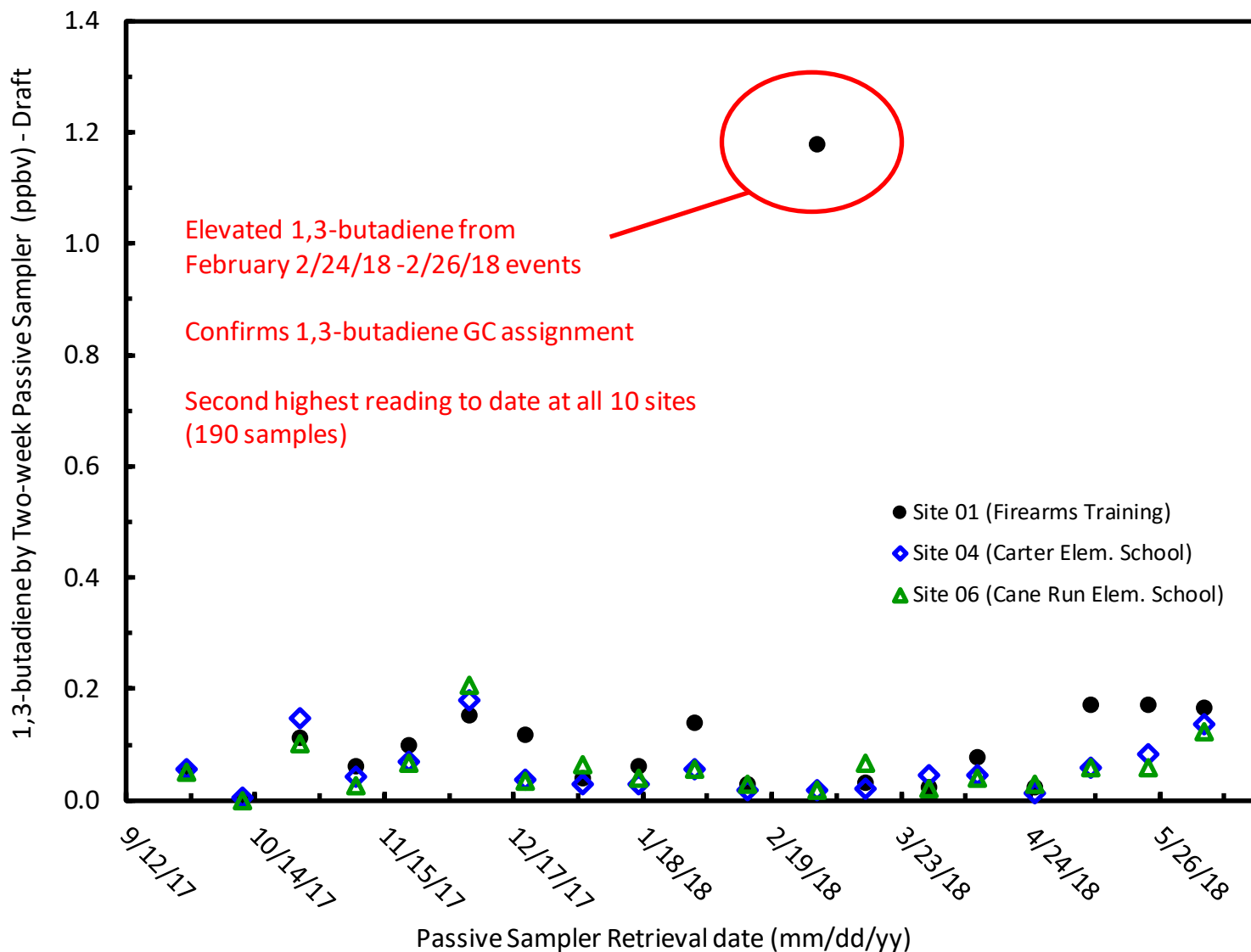
## Elevated 1,3-Butadiene 2/25/18 and 2/26/18 (Source to the NE)



## Elevated 1,3-Butadiene 5/7/18 (Source to the NE)



## Preliminary 1,3-Butadiene Passive Sampler Data for Sites 01, 04, and 06 - 19 Two-week Sampling Periods

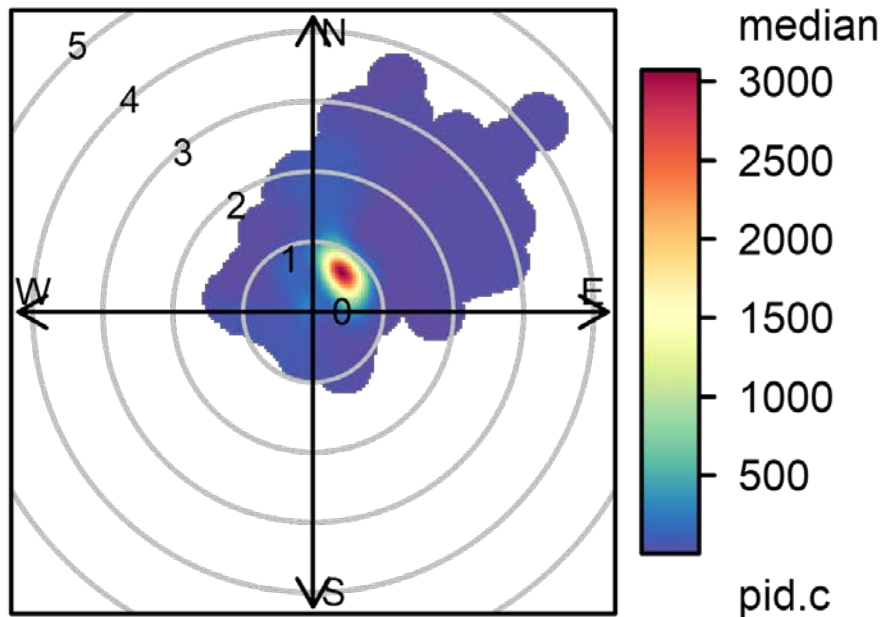


Draft data as of 7/10/18, minor correction factors pending

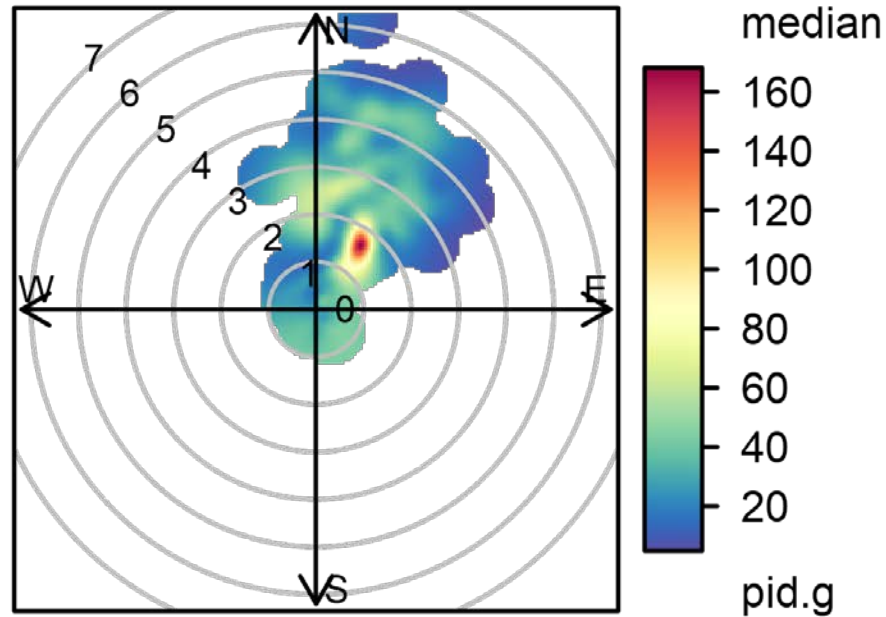


## Site 01 - SPod Concentration Roses for 2/25/18 - 2/26/18 and 5/7/18 Elevated 1,3-Butadiene Events

10 PM 2/25 to 11 AM 2/26



12 AM to 12 PM on 5/7



Elevated 1,3-Butadiene (source to the northeast)

# Elevated 1,3-Butadiene Feb 24-26 and May 7

© 2018 Microsoft

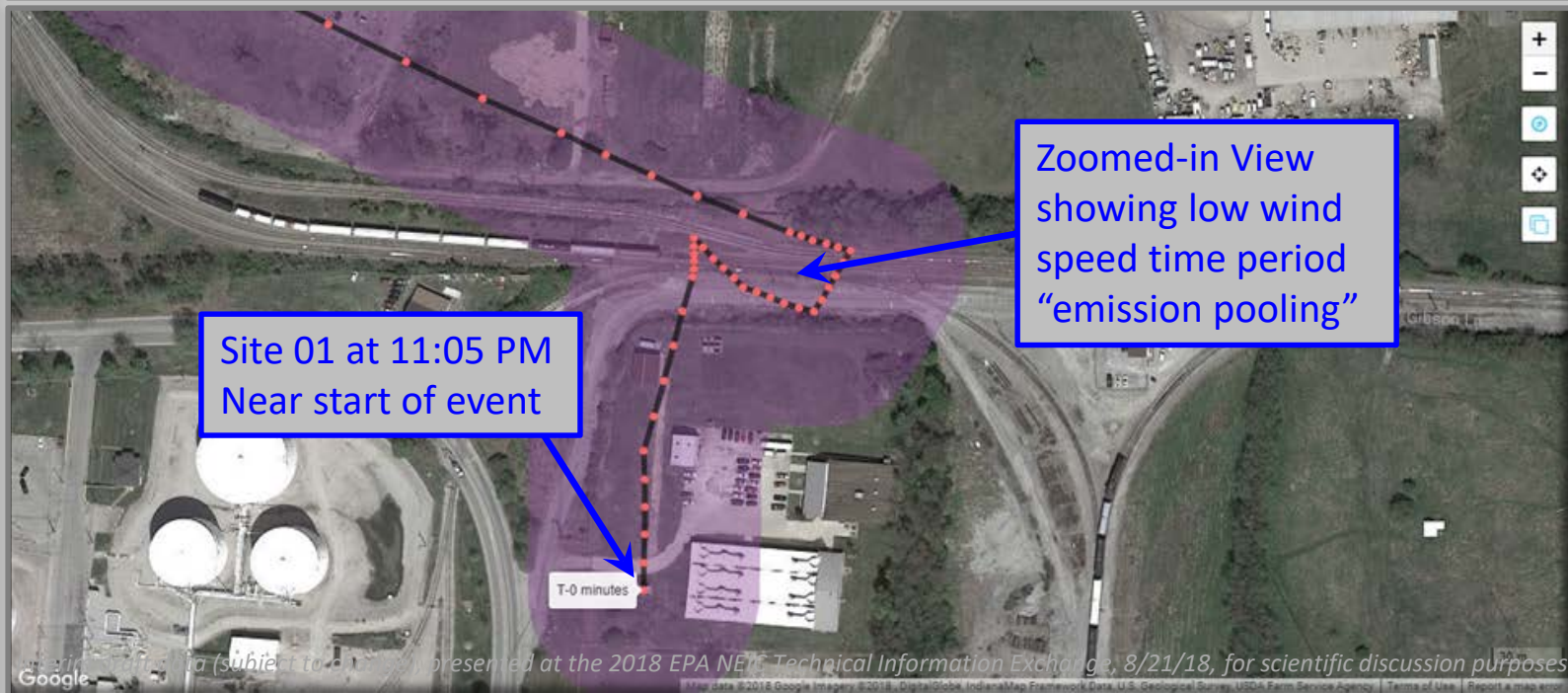
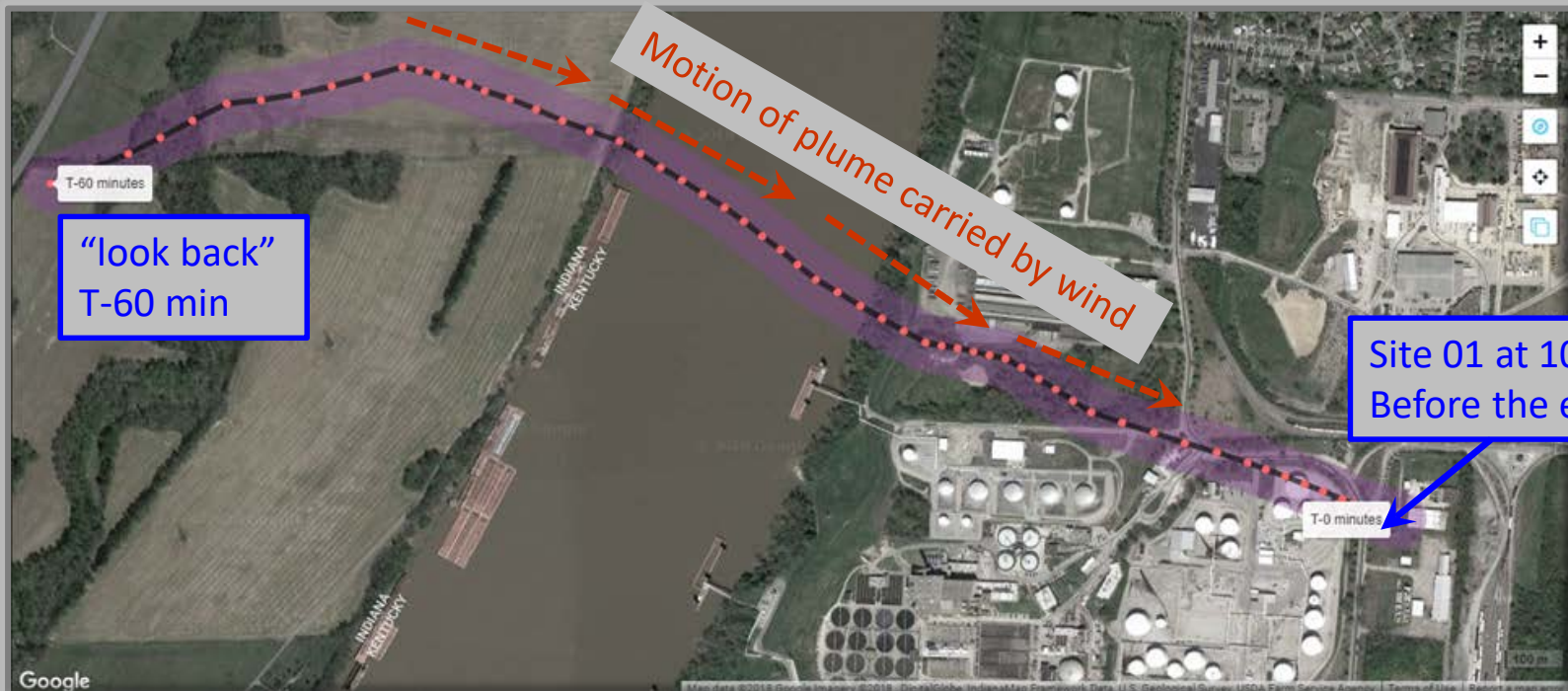
United States, KY,  
Louisville

Signal is from  
this direction  
(NE)

Facilities that use  
1,3-butadiene are  
> 1 km to SSW

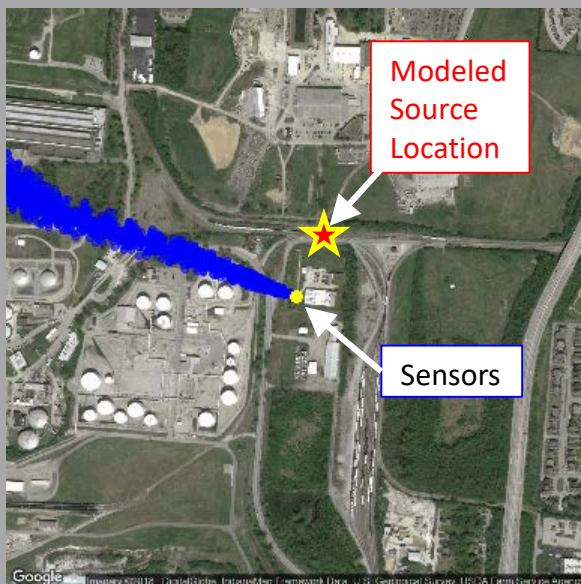
Monitoring Site 01



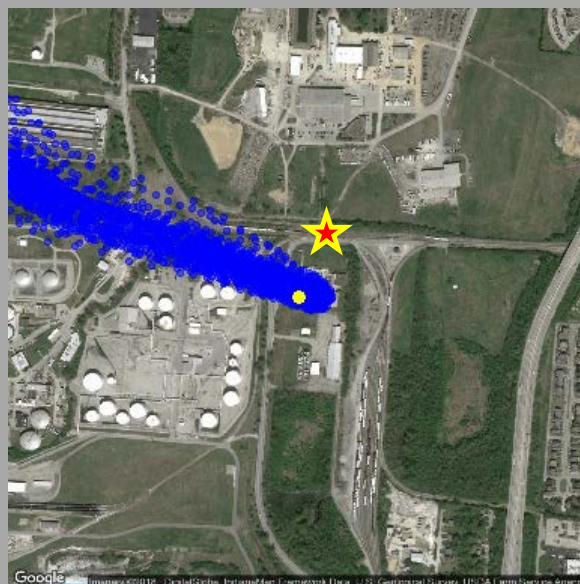




10:30 PM before event



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



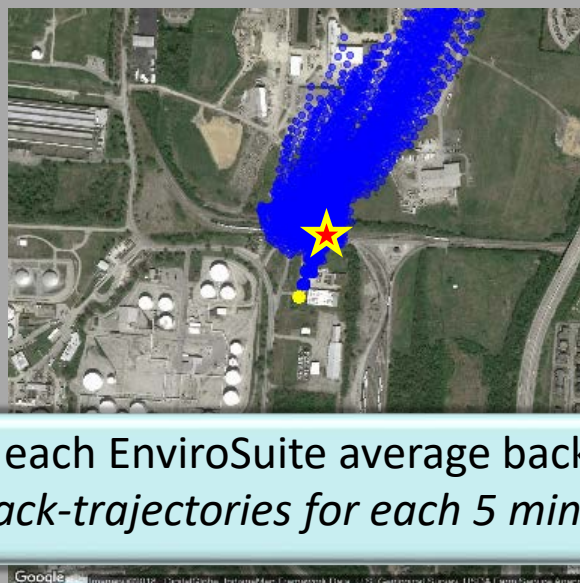
11:05 PM event start  
(stagnant at source)



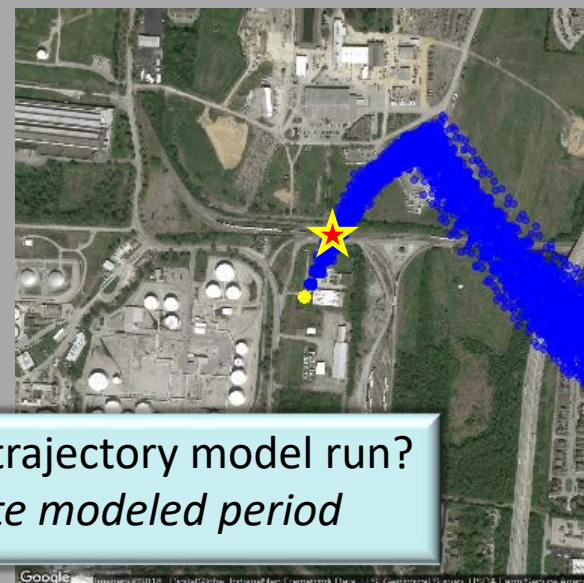
11:55 PM (no signal)



2:05 AM high reading



5:25 AM high reading

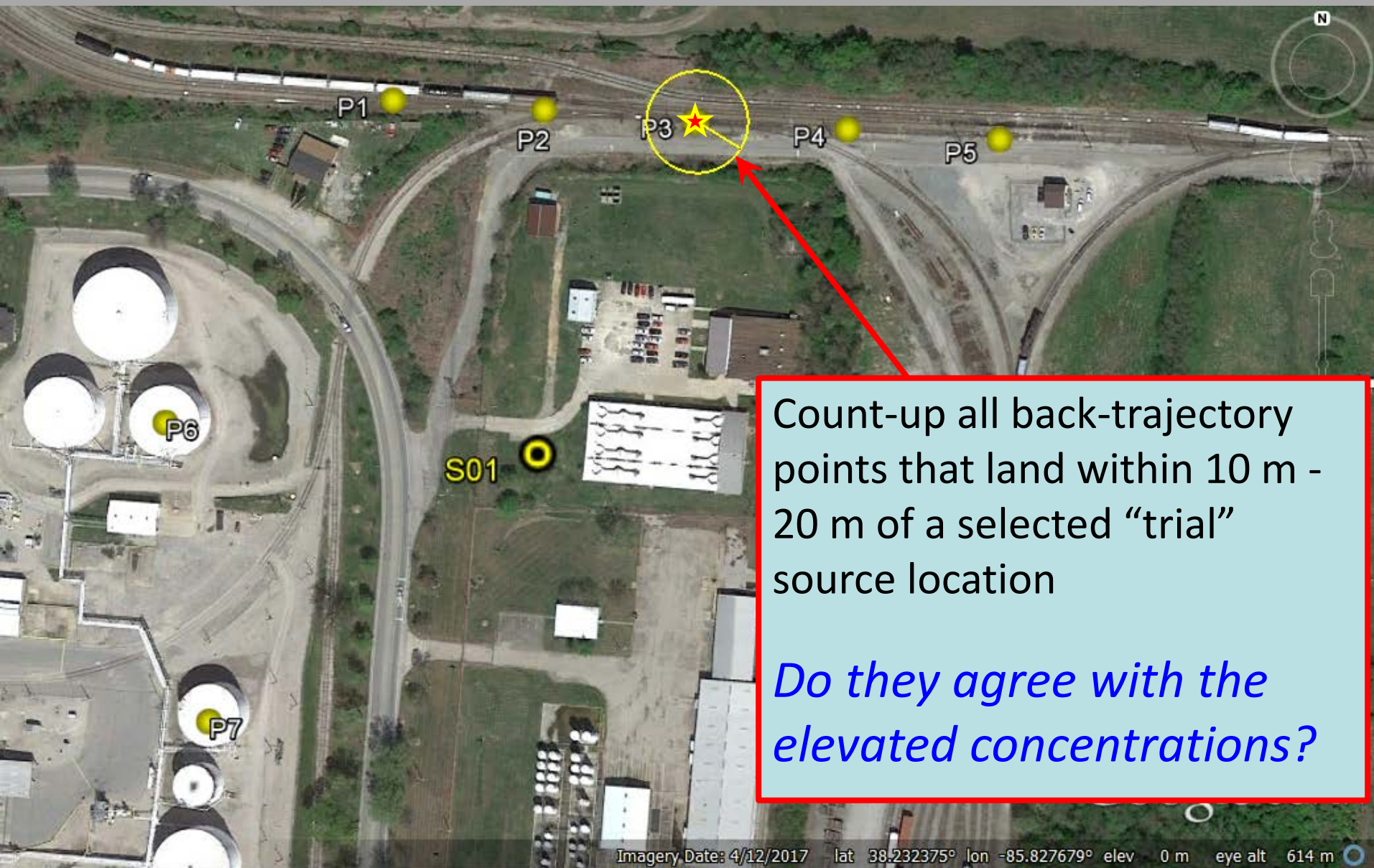


What is “underneath” each EnviroSuite average back-trajectory model run?  
*N= 99 stochastic back-trajectories for each 5 minute modeled period*



# Temporally Combined Trajectory Analysis (TCTA)

*Mathematically combine all 5-minute model runs from 2.5 days*



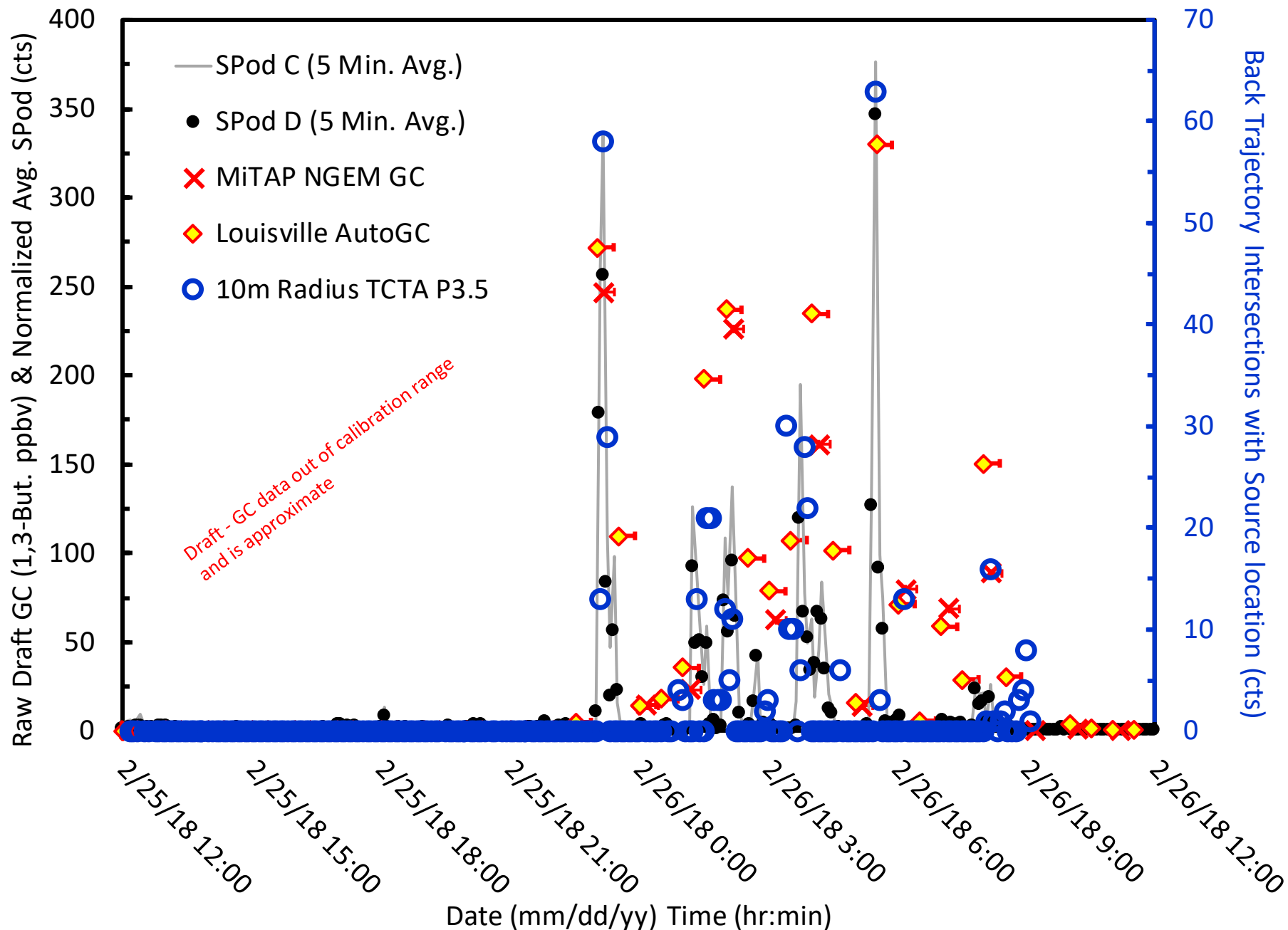
Count-up all back-trajectory points that land within 10 m - 20 m of a selected "trial" source location

*Do they agree with the elevated concentrations?*

Imagery Date: 4/12/2017 lat 38.232375° lon -85.827679° elev 0 m eye alt 614 m

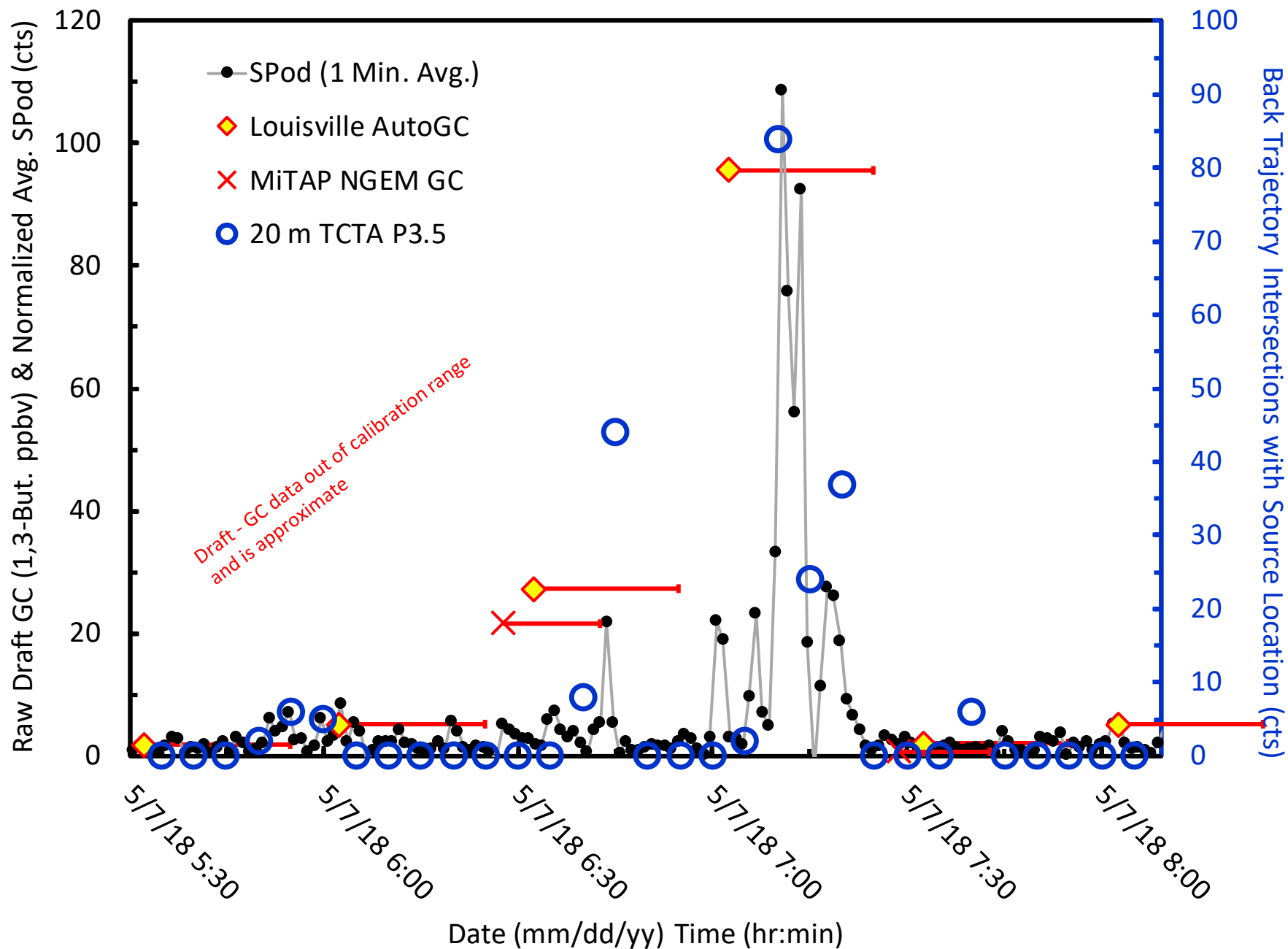


## Elevated 1,3-Butadiene 2/25/18 and 2/26/18 (Source to the NE)





## Elevated 1,3-Butadiene 5/7/18 (Source to the NE)





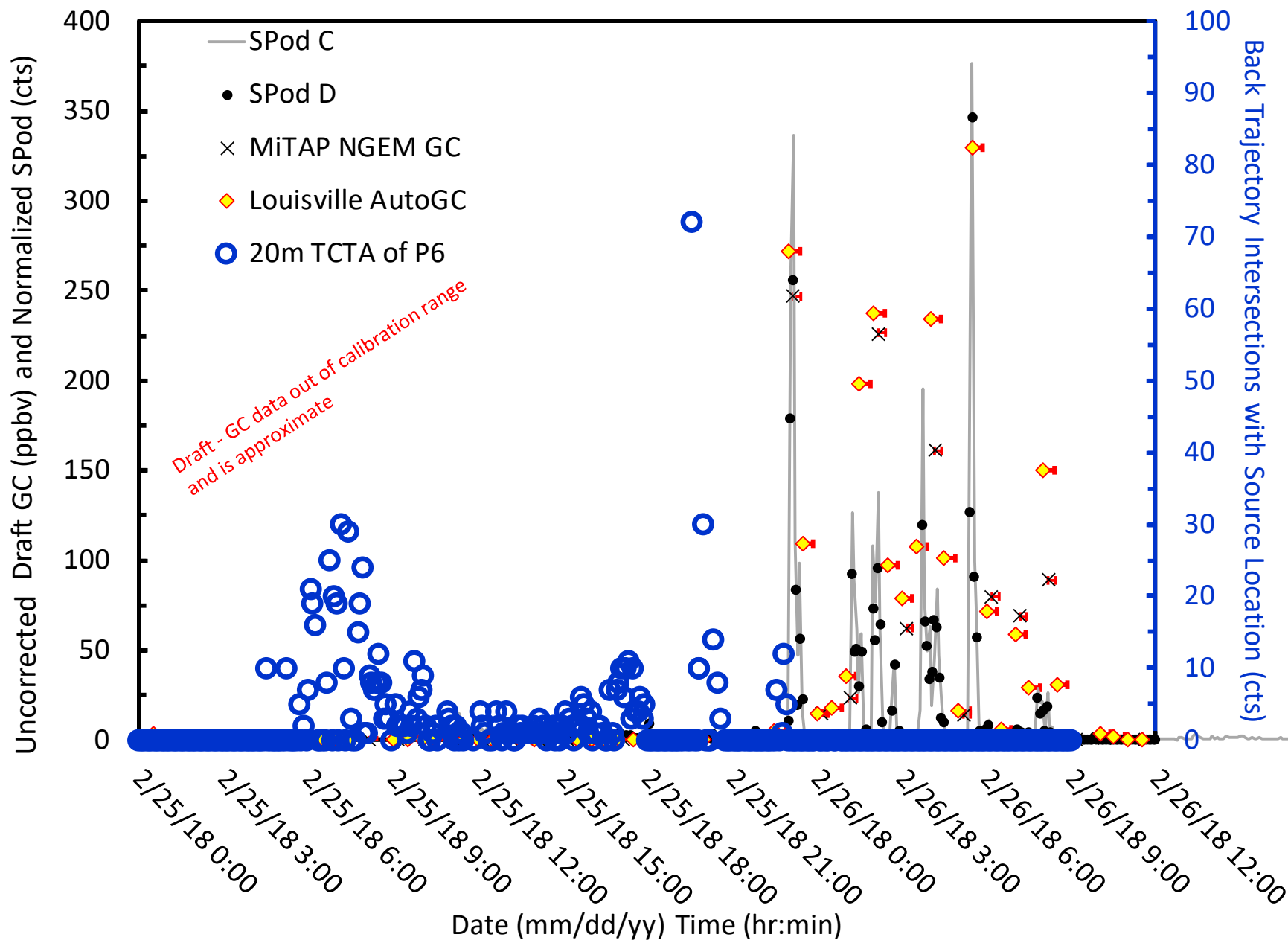


# Temporally Combined Trajectory Analysis (TCTA)

*Can also show that a potential source is not emitting*



## TCTA Screen of Potential Tank Source (Only SPod is Relevant)





# The Current TCTA Idea Has Several Issues

(Areas for future investigation)

Current point clouds are discrete (each minute) causing analysis issues at higher wind speeds

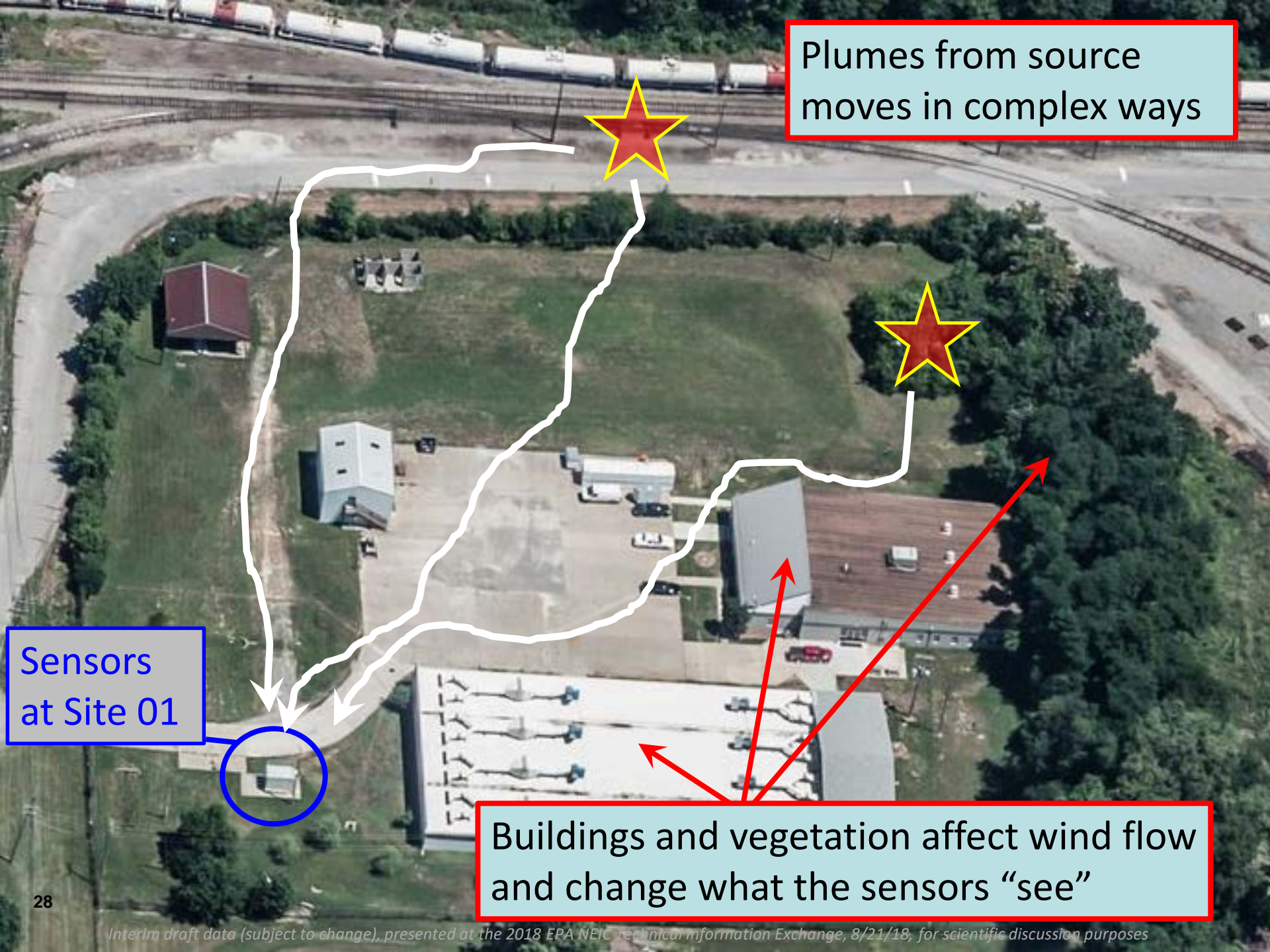
Less certainty in source location along the transport direction

Sensors

Model is very sensitive to meteorological factors

Buildings and vegetation affect wind flow and change what the sensors “see”.  
Need a different model  
To account for this





Plumes from source  
moves in complex ways

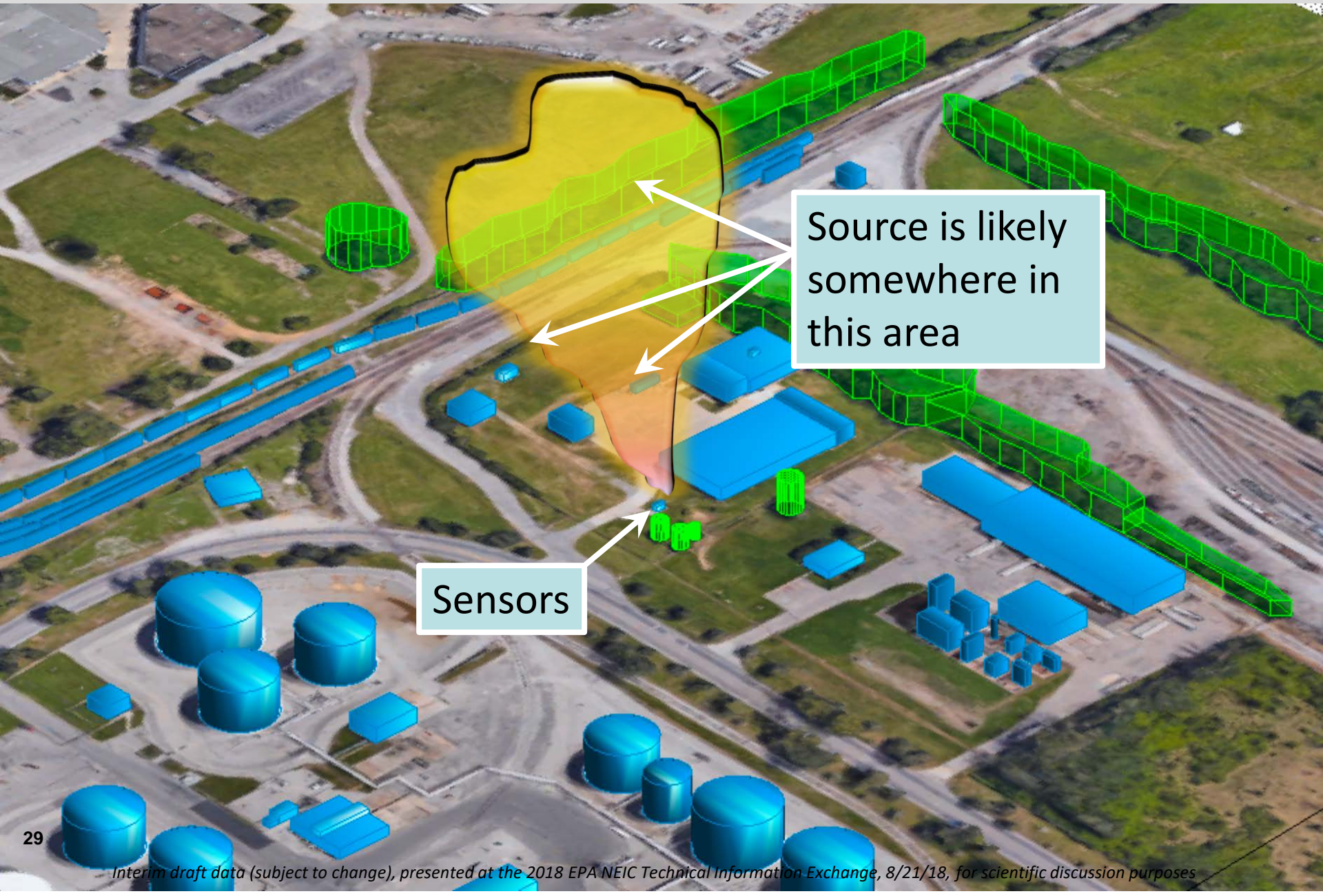
Sensors  
at Site 01

Buildings and vegetation affect wind flow  
and change what the sensors “see”



# 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 on 2/25/18*

Potential source locations  
on railroad track

Potential ground  
source (well)

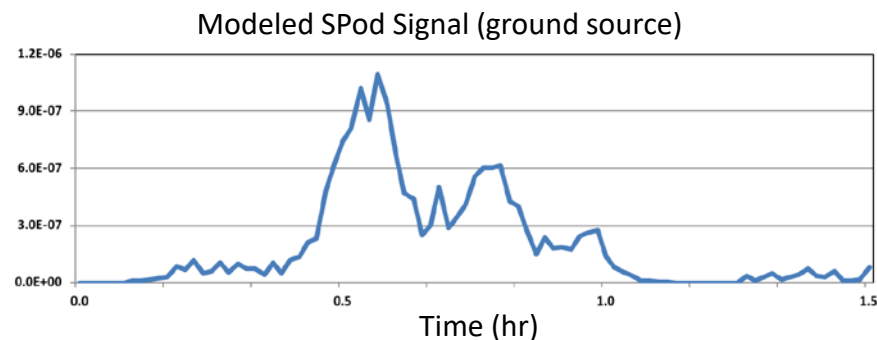
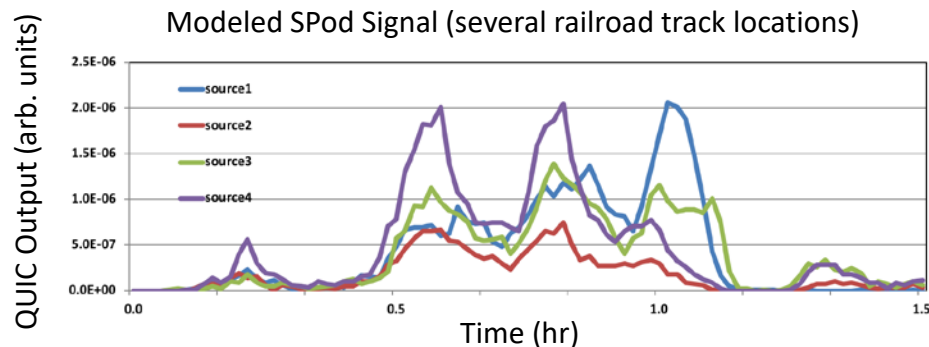
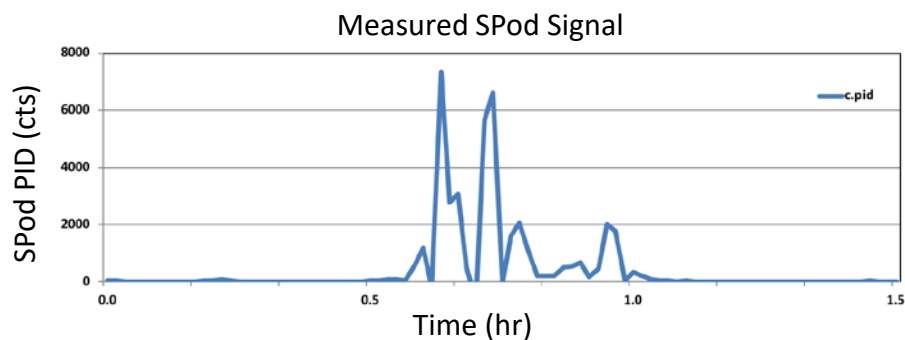
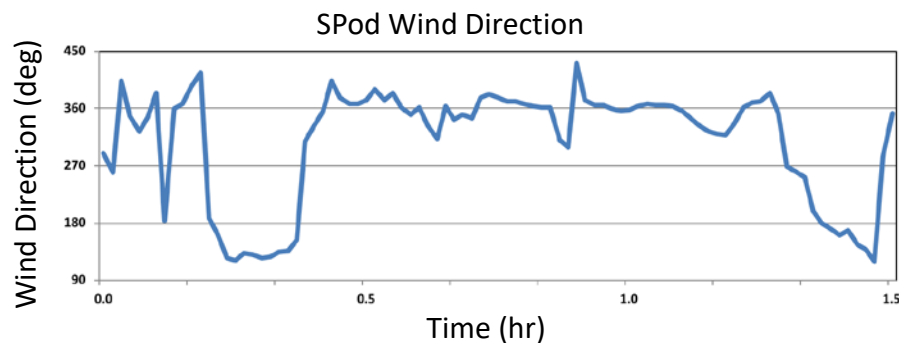
Sensors

Sensors

# QUIC model of two different locations to the NE

## 1.5 hours of event on 2/25/18

Working on improving site topographical accuracy

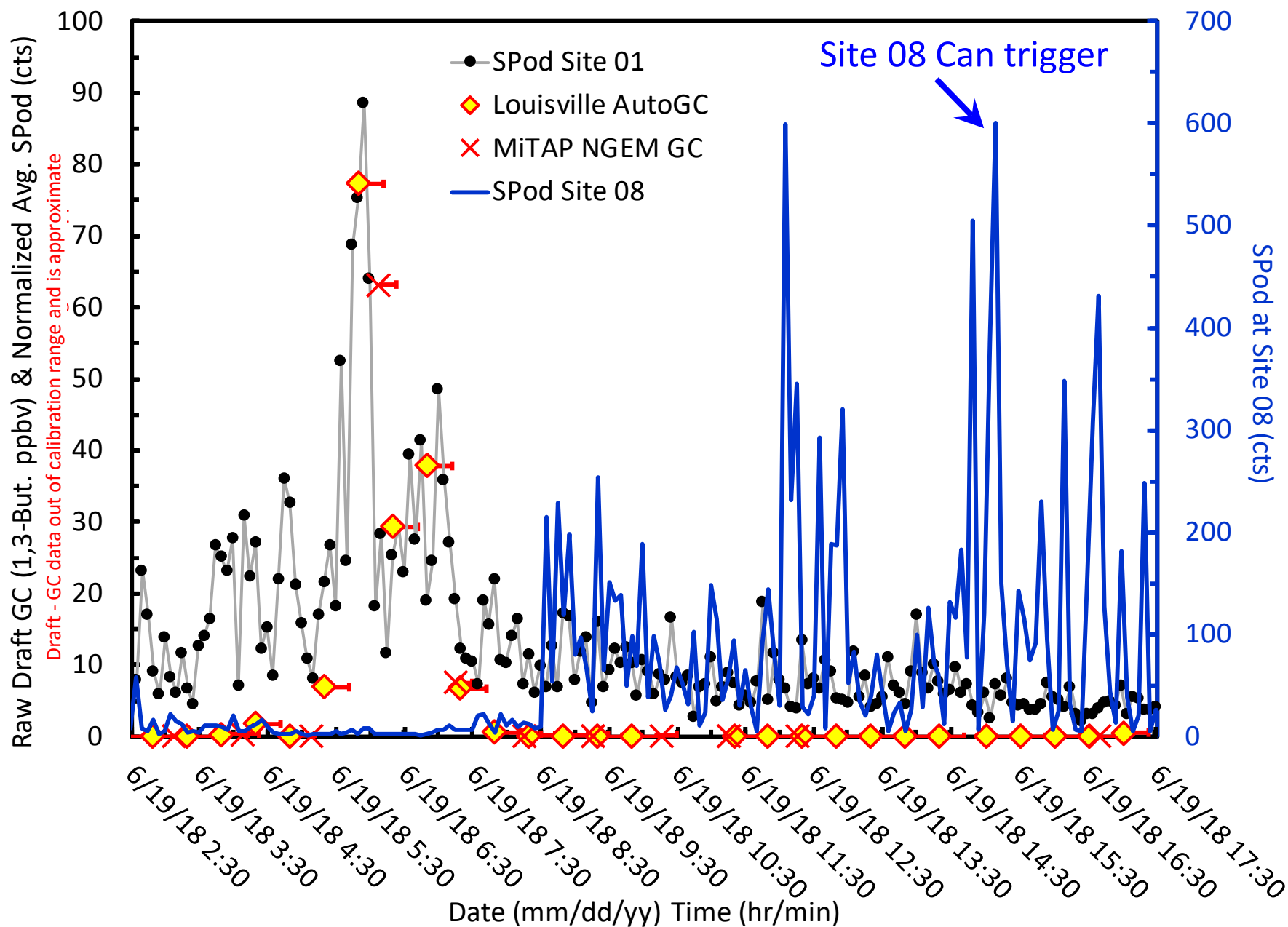


## 1,3-Butadiene June 19, 2018

- Observed from Site 01 in early morning
  - Measured by multiple NGEM systems
  - Source is to the south
  - 1,3-butadiene and cyclohexane observed simultaneously
- Observed at Site 08 later in morning
  - Observed by SPods (*only sensors installed at that time*)
  - Source is to the southwest
  - Auto canister indicates similar speciation to Site 01
  - Issues with back-trajectory modeling (*close to ground SPods*)

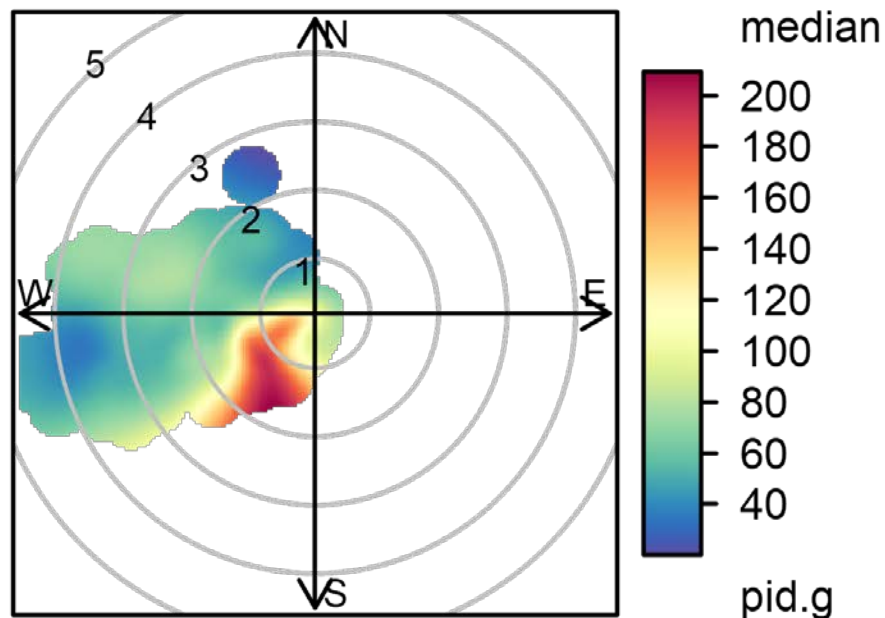


# 1,3-Butadiene June 19, 2018 - Sites 01 and 08

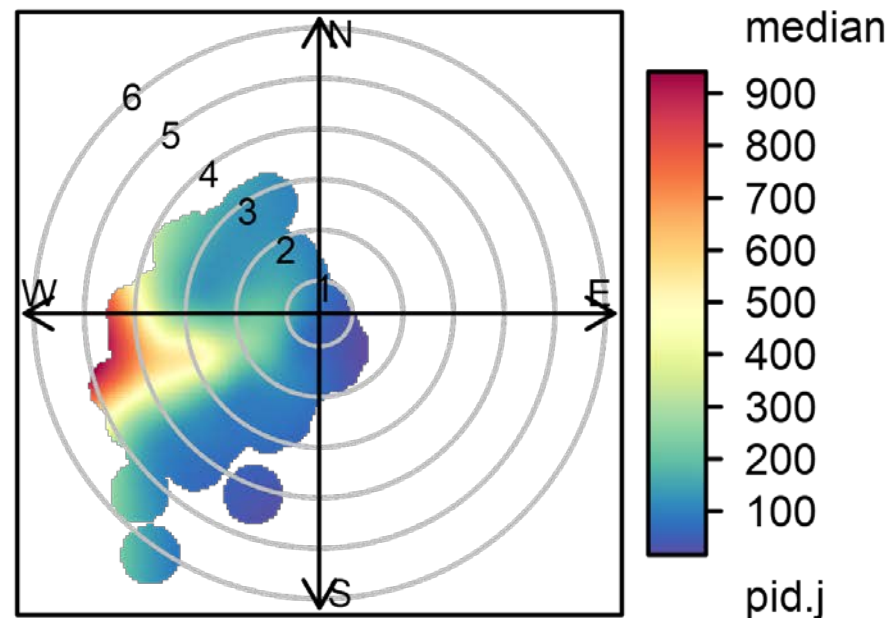


# SPod Concentration Roses for 6/19/18 from Site 01 and Site 08 - Elevated 1,3-Butadiene Event

Site 01 - 12 am to 12 pm

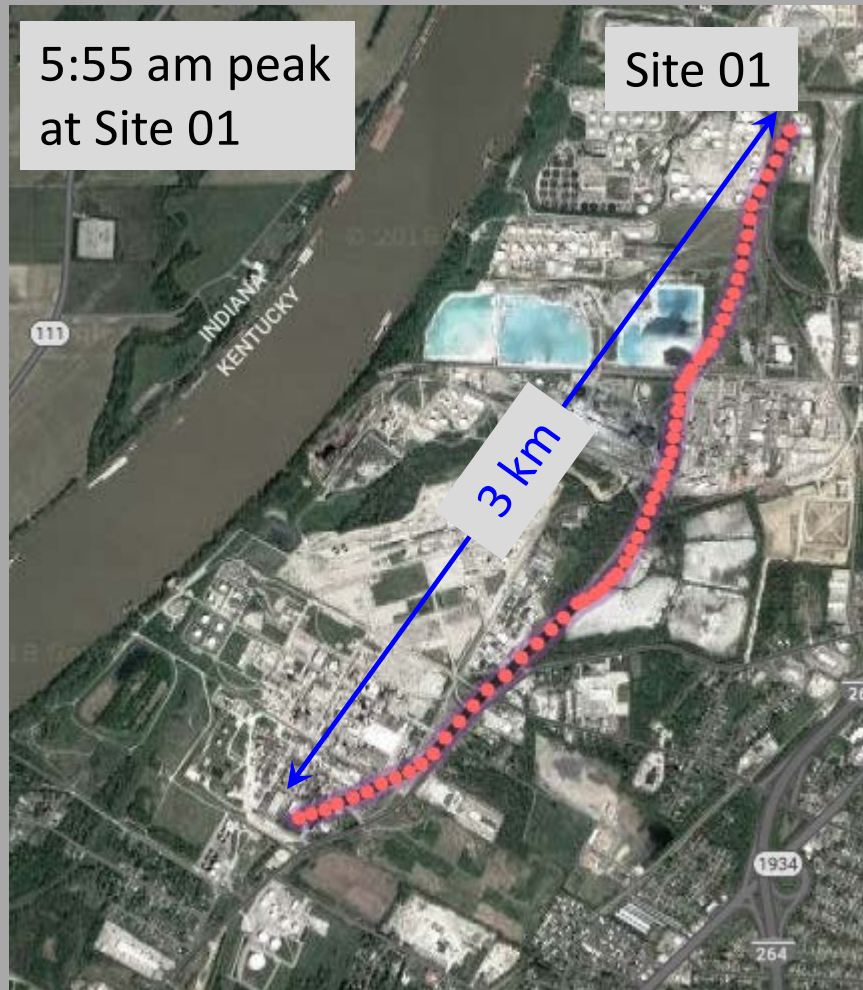


Site 08 - 6 am to 6pm



*Due to misalignment to true north, the SPods at Site 08 were rotated by about 8 degrees (west to north) on July 17, 2018 (adjustment not reflected in this image)*

# EnviroSuite Back-trajectory for 6/19/18 from Site 01 Peak at 5:55 am, Site 08 at 12:05 pm



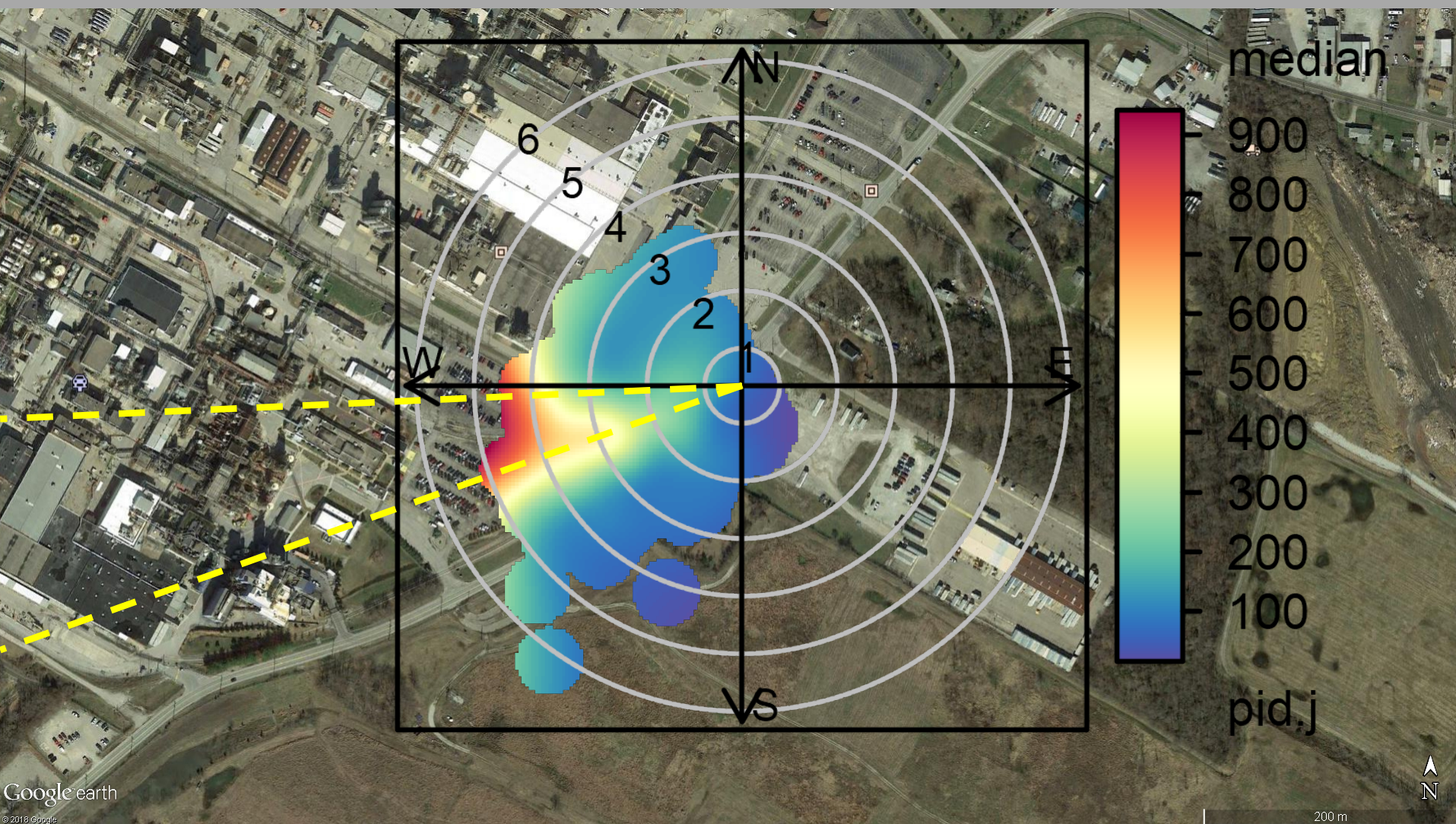
10 m met. tower at Site 01



2.5 m SPod met. at Site 08  
(higher uncertainty)



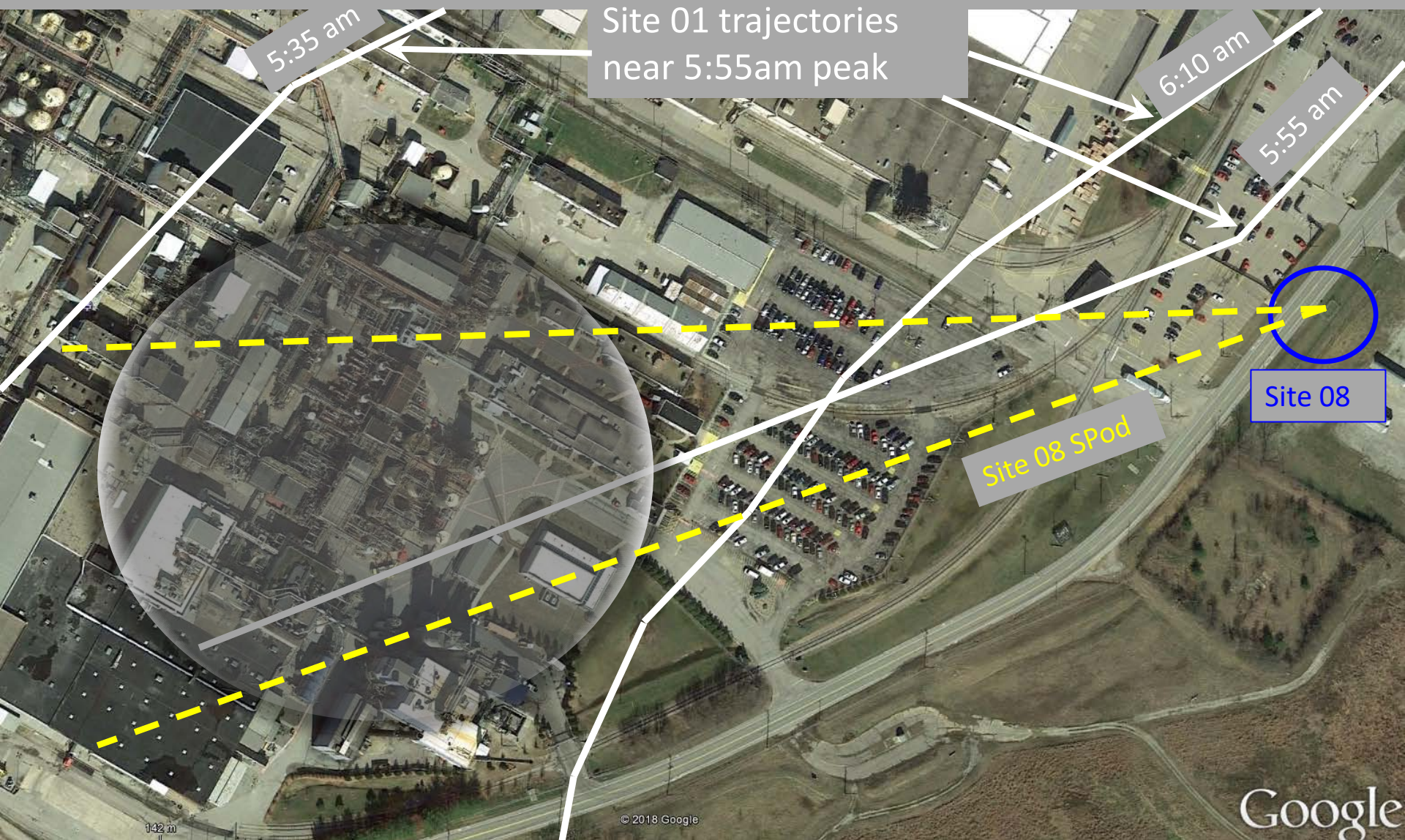
# Site 08 SPod Concentration Rose, 6 AM to 6 PM on 6/19/18



*The SPods at Site 08 were rotated by about 8 degrees west to north on July 17, 2018  
(adjustment not reflected in this image)*



# Site 01 Back-trajectories with Site 08 Concentration Rose - 6/19/18



## Summary and Next Steps

- Rubbertown Project is in process and is helping to advance NGEM equipment and inverse models (*much work remains*)
- Three high 1,3-butadiene events were described in draft form (*work continues to understand these events*)
- Investigation continues as to the possible identity of the source north of Site 01
- Work continues to improve real-time information and inverse model understanding (optimal meteorological requirements)
- Further integrate speciation data (GC at Site 08, canisters, passive samplers) on multiple temporal and spatial scales