USING INTELLIGENT EMISSIONS MONITORING TO EFFECTIVELY MANAGE EMISSIONS

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AIRDAR

THIS PRESENTATION WILL:

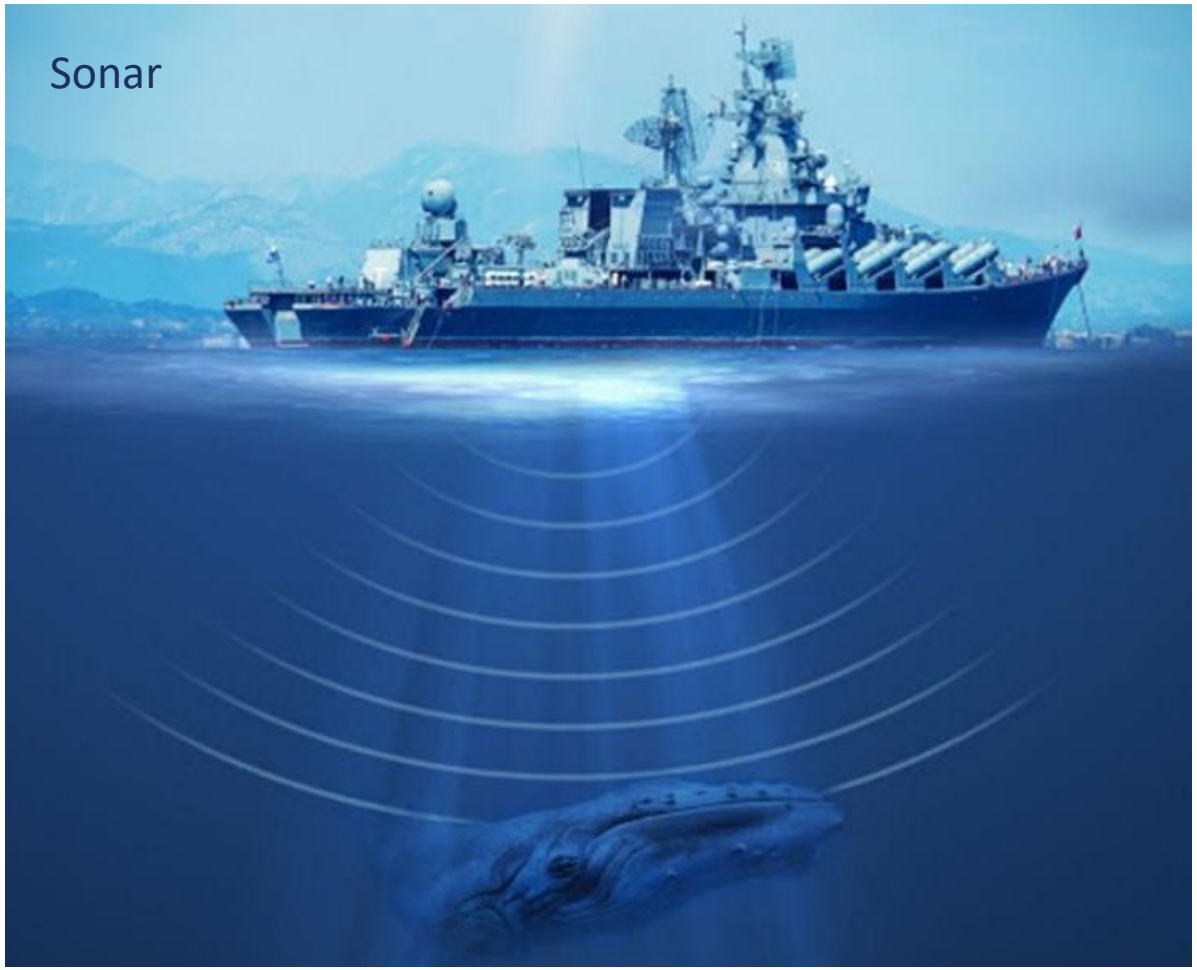
- Present the current challenges with measuring emissions
- Present an innovative technology for measuring air emissions
  - Demonstrate its application at 2 facilities with great success as well as preliminary work on some public data

NATURE OF EMISSIONS

The challenge	What is needed
Emissions can occur in unsuspected locations	Large spatial coverage
Emissions rates vary over time	Continuous monitoring
Confirmation bias	Undirected (unbiased) monitoring

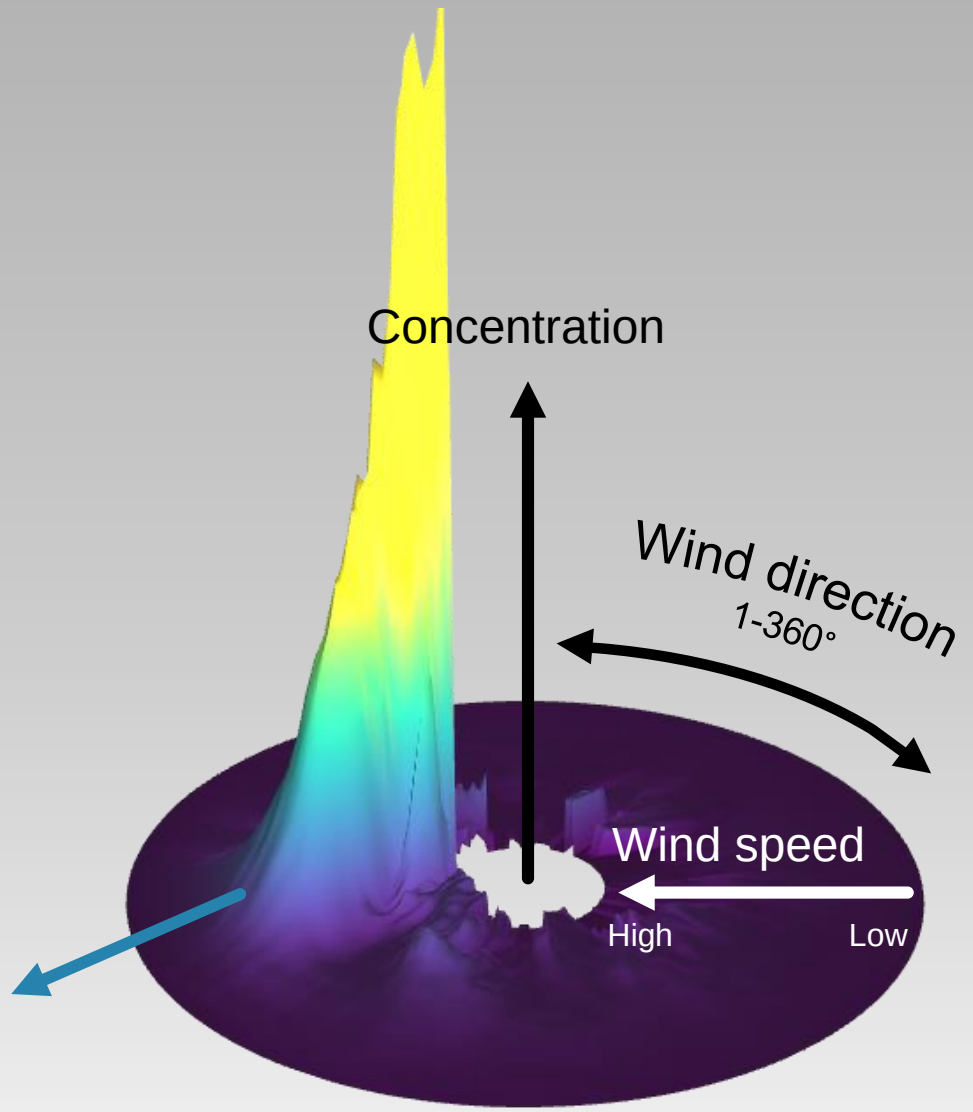
AIRDAR : AIR DETECTION AND RANGING

AIRDAR : AIR DETECTION AND RANGING



HOW IT WORKS

1. Visualizes a plume in data
2. Finds the direction to the source
3. Triangulates from multiple sampling points
4. Quantifies emissions once distance to source is known



HOW IT WORKS

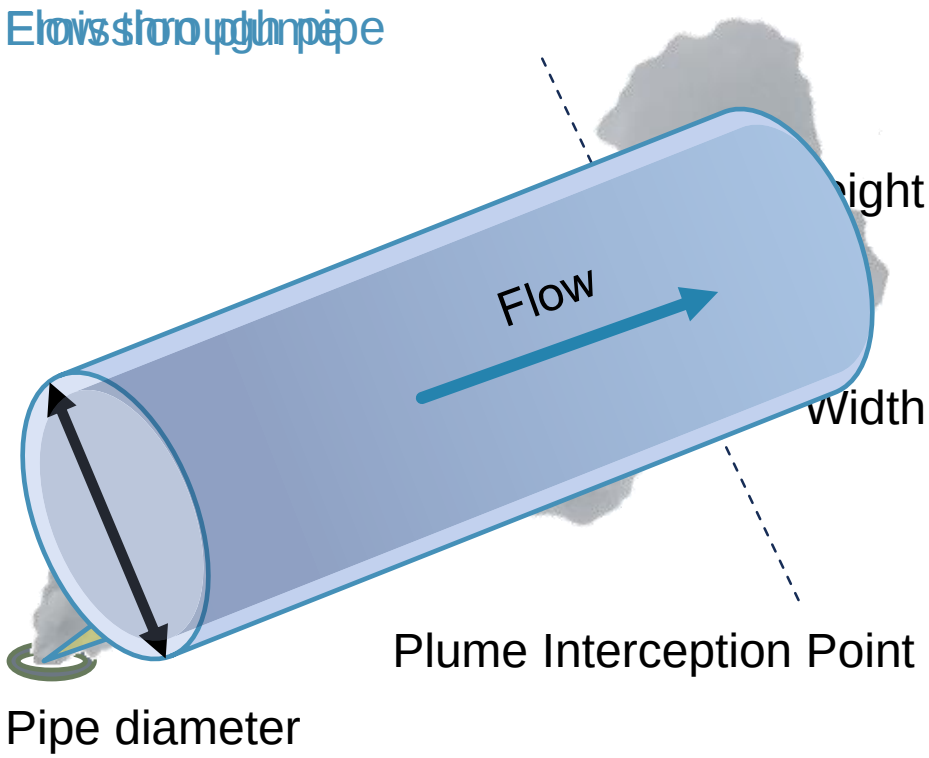
1. **Find cross-sectional area**

2. **Determine flux**

   Concentration x Fluid Velocity = Flux

3. **Get flow rate**

   Area x Flux = Flow (Emission) Rate



More details can be found in U.S. Patent 8,510,059

HOW IT WORKS

The nose: standard detectors

Measure concentrations

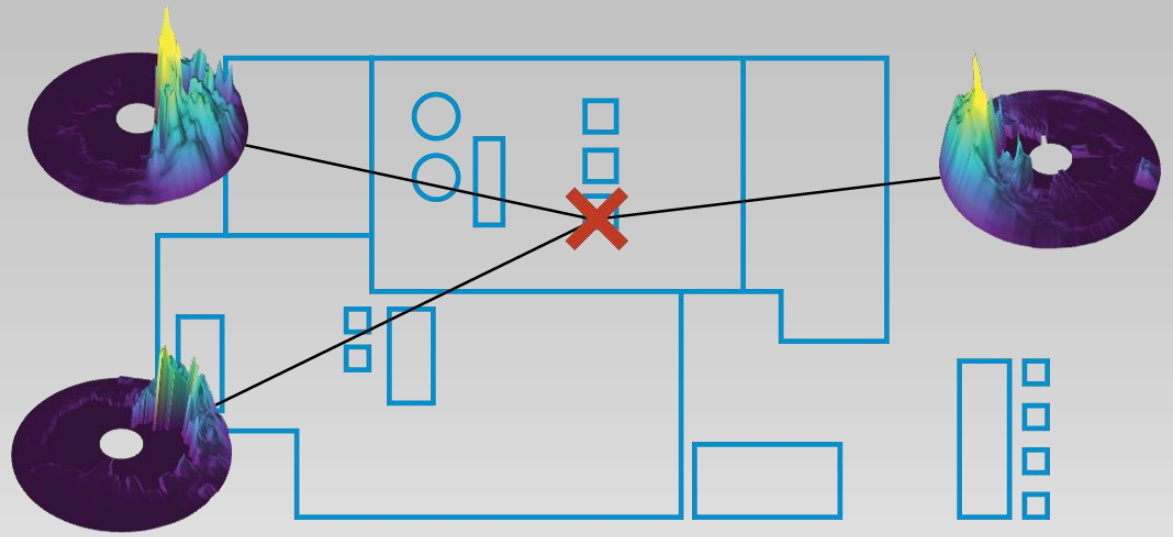
- Traditional monitors
- New sensors

The brain: data analytics

Tracks plumes back to their sources and quantify emissions

CAPABILITIES

- Continuous monitoring of all emission sources
- Unattended operations
- Any compound
- On-site and off-site coverage
- Enables cost savings



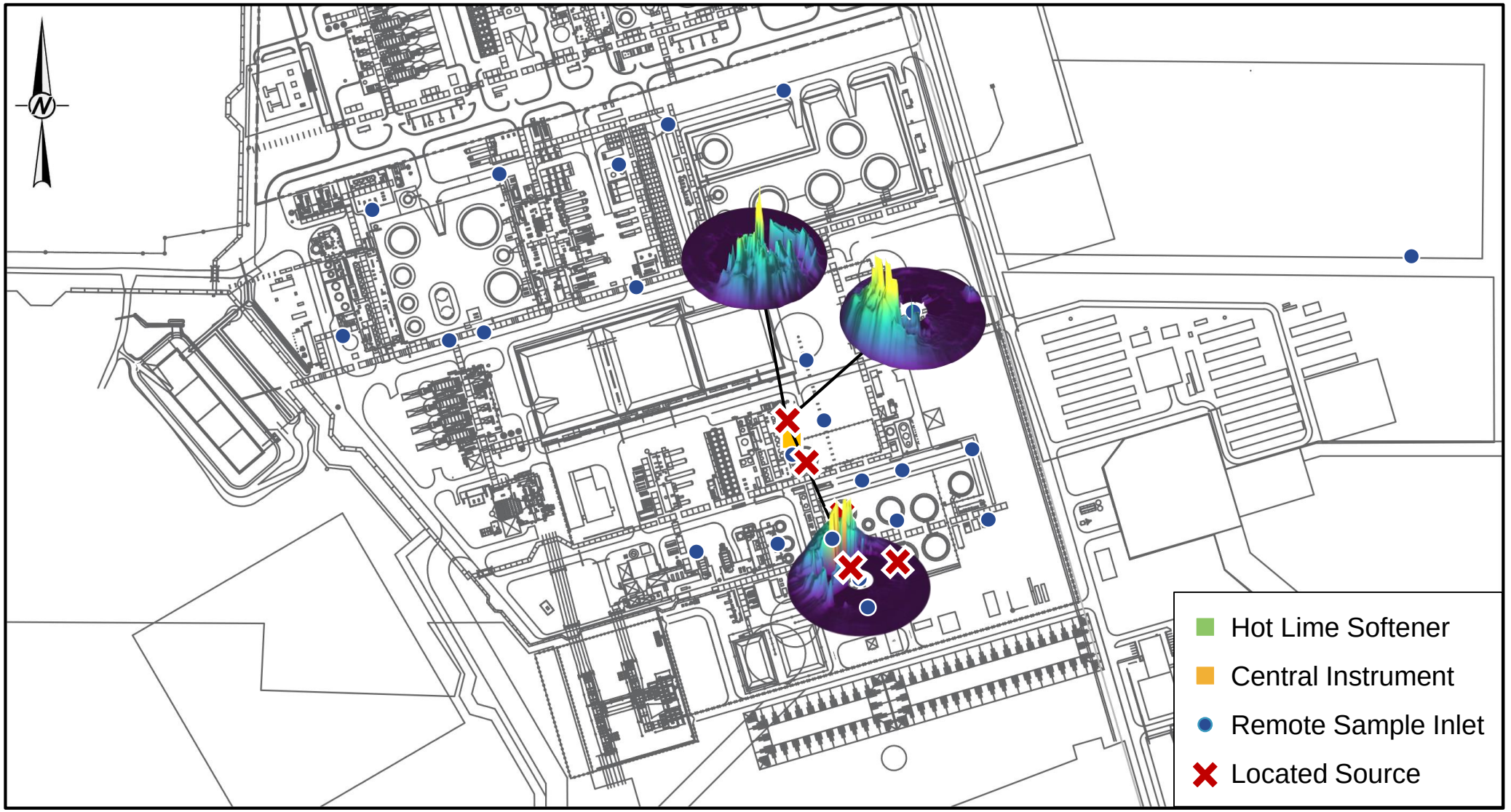
CASE STUDIES

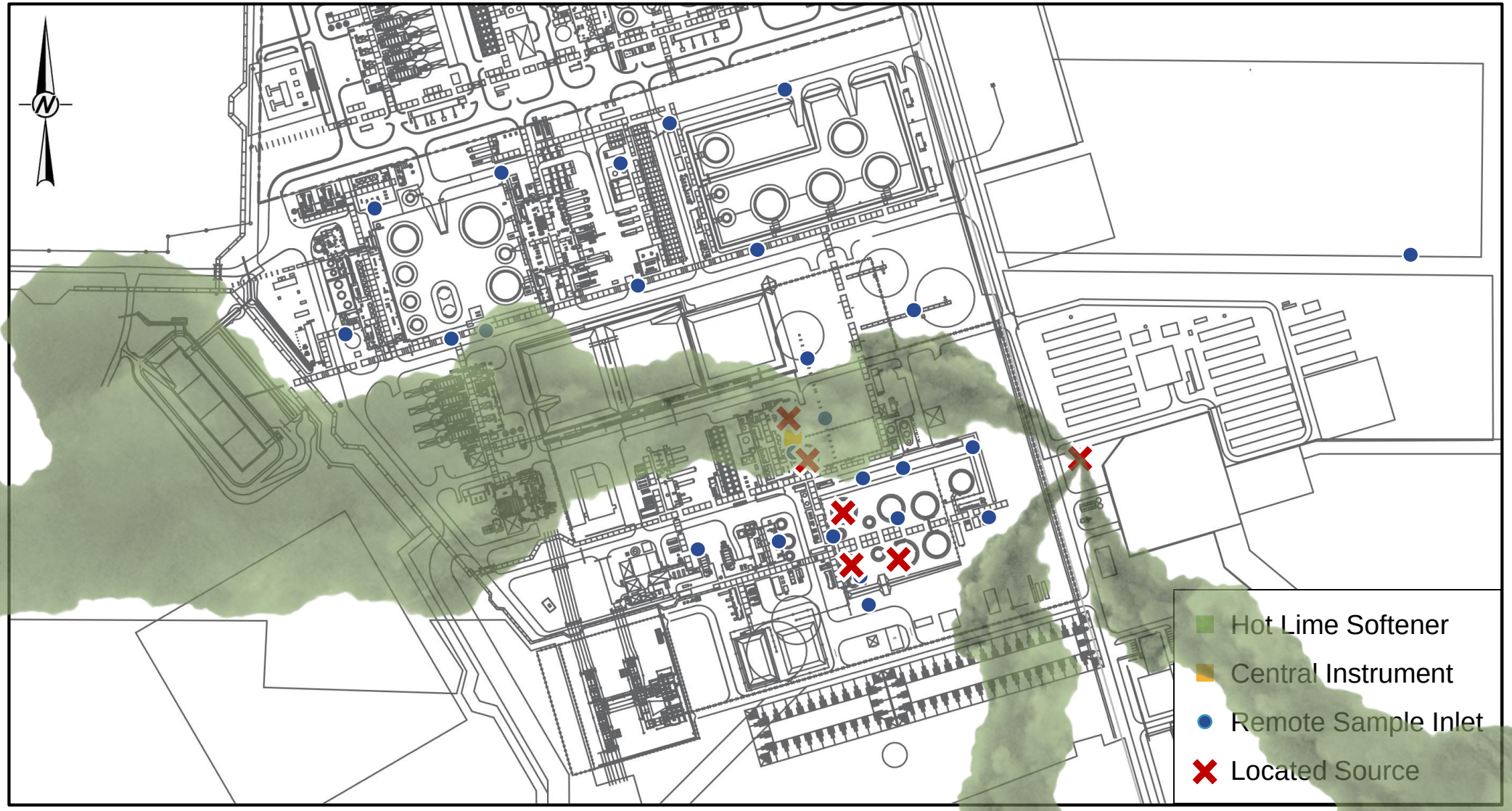
SAGD FACILITY

BACKGROUND

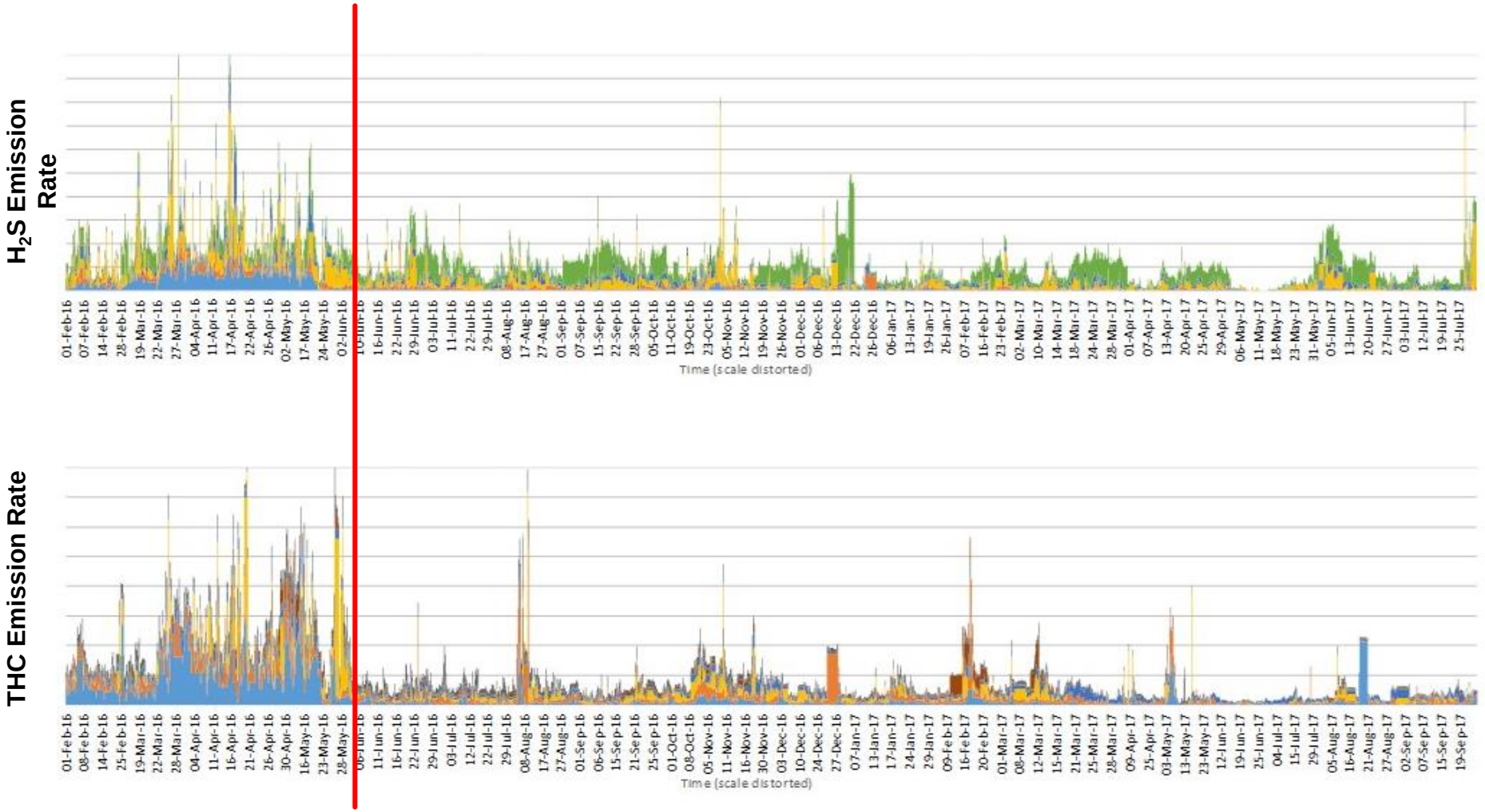
- Facility was experiencing high levels of H_2S
- Known emission sources present
  - Hot Lime Softener (HLS), tanks
  - Relative importance unknown
  - Costly to contain
- Continuous monitoring of H_2S and methane (THC) was implemented


HLS
Central Instrument
Hot Lime Softener
Central Instrument
Remote Sample Inlet
Located Source

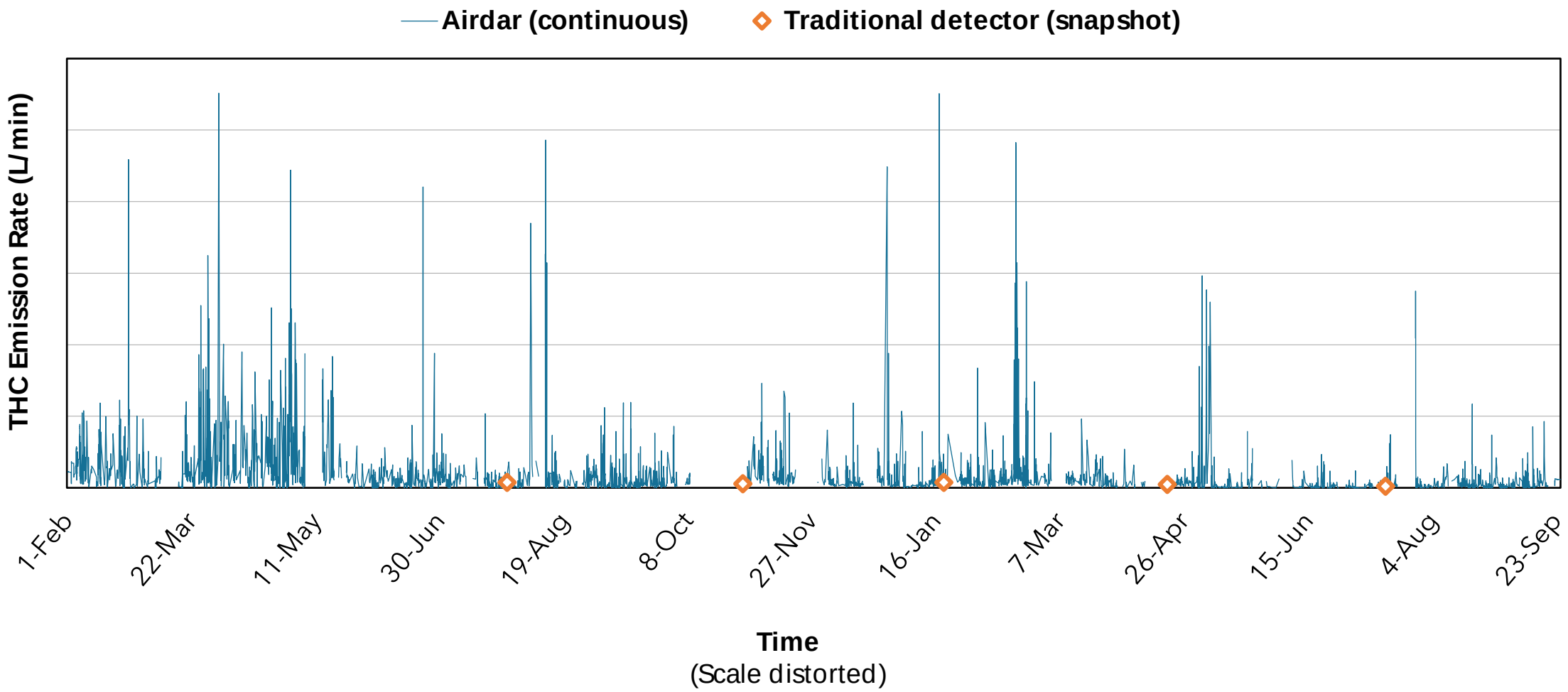

Hot Lime Softener
Central Instrument
Remote Sample Inlet
Located Source


Hot Lime Softener
Central Instrument
Remote Sample Inlet
Located Source

Site intervention - dramatic emission reductions



CONTINUOUS MONITORING

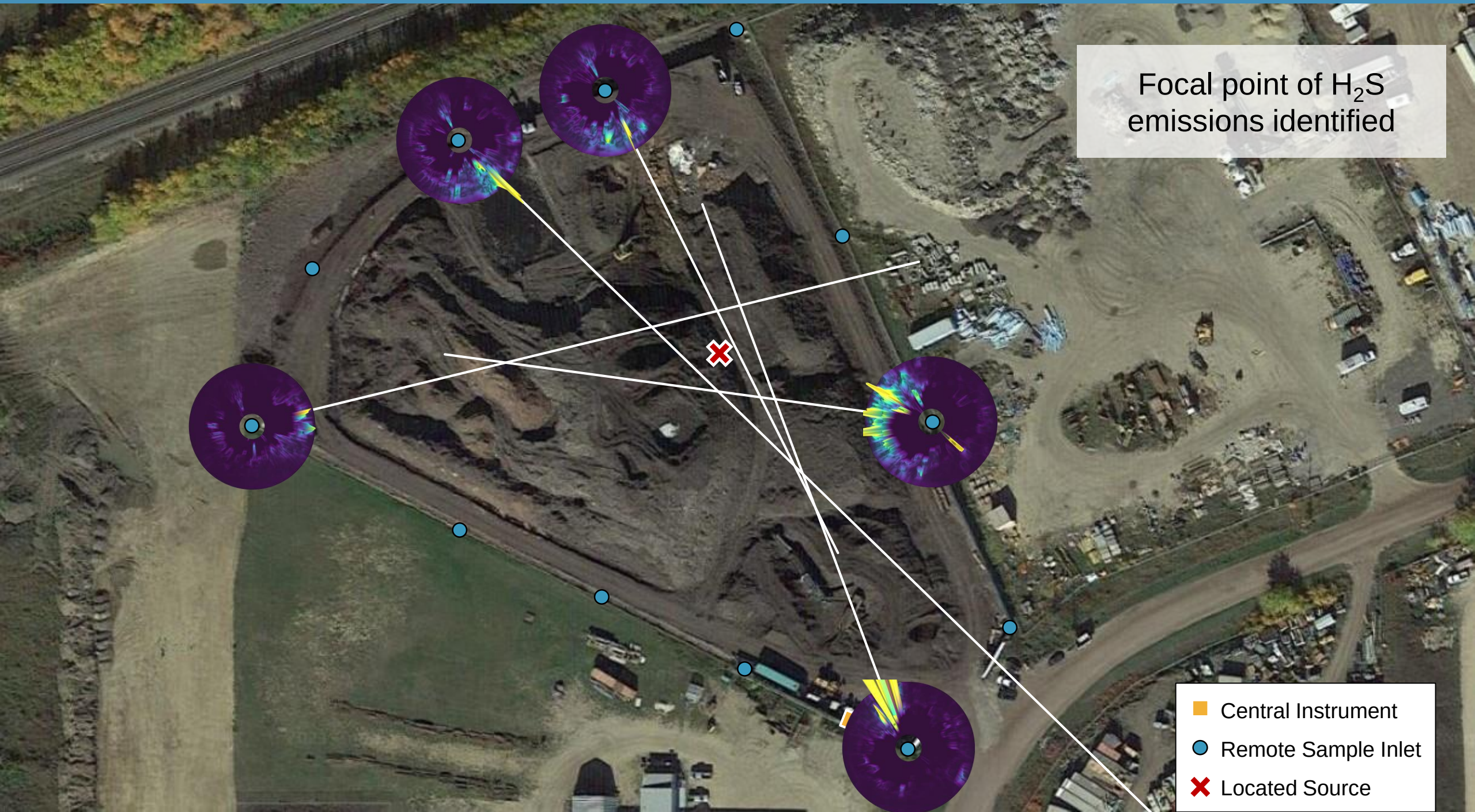


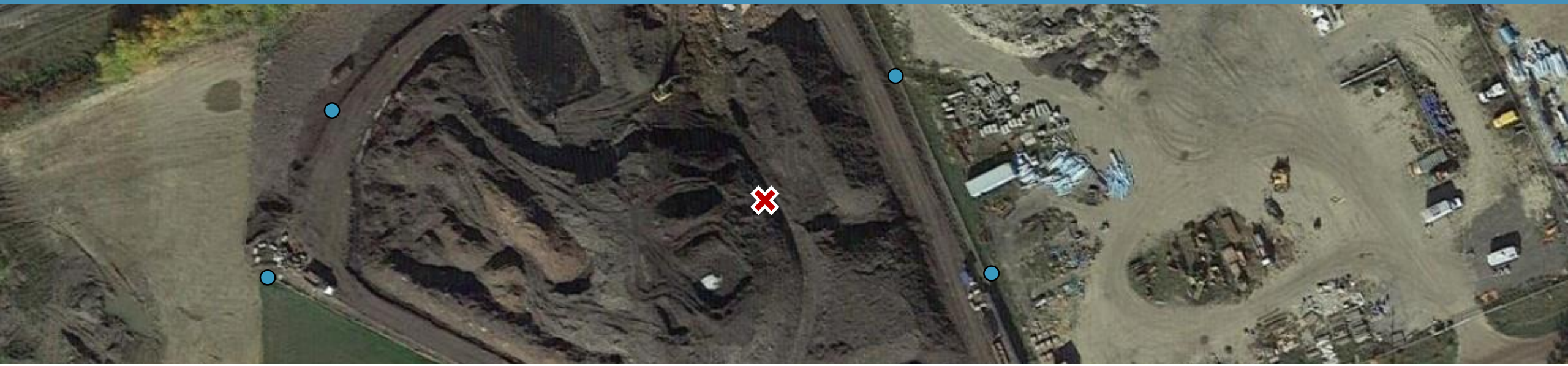
CLEANIT GREENIT COMPOST FACILITY

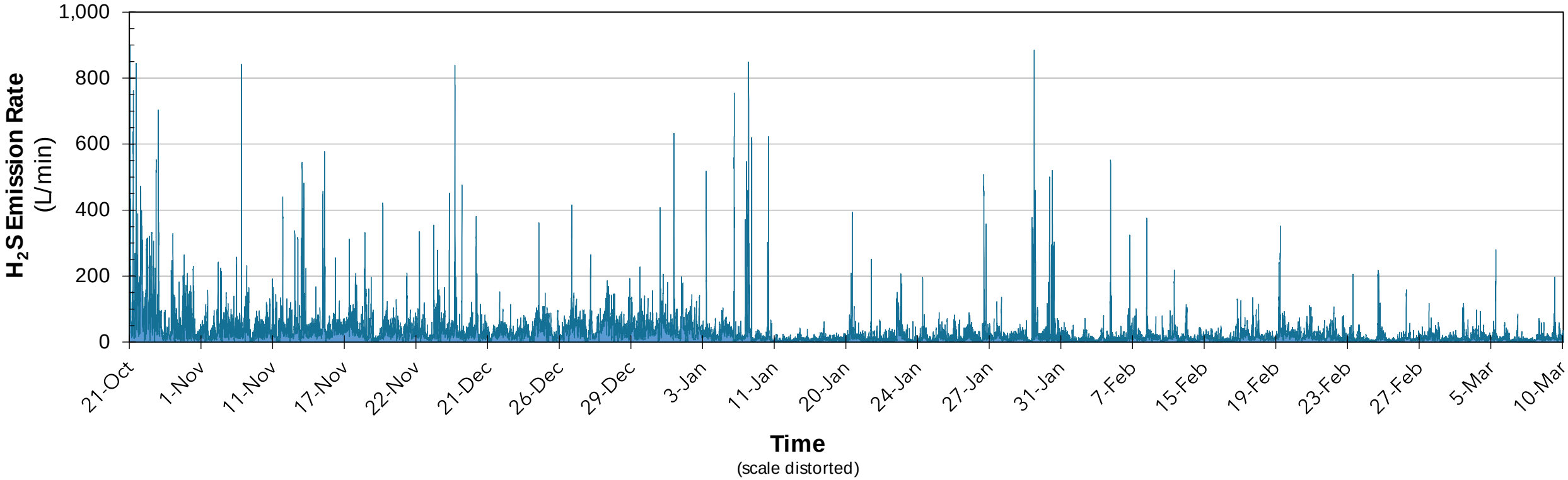
BACKGROUND

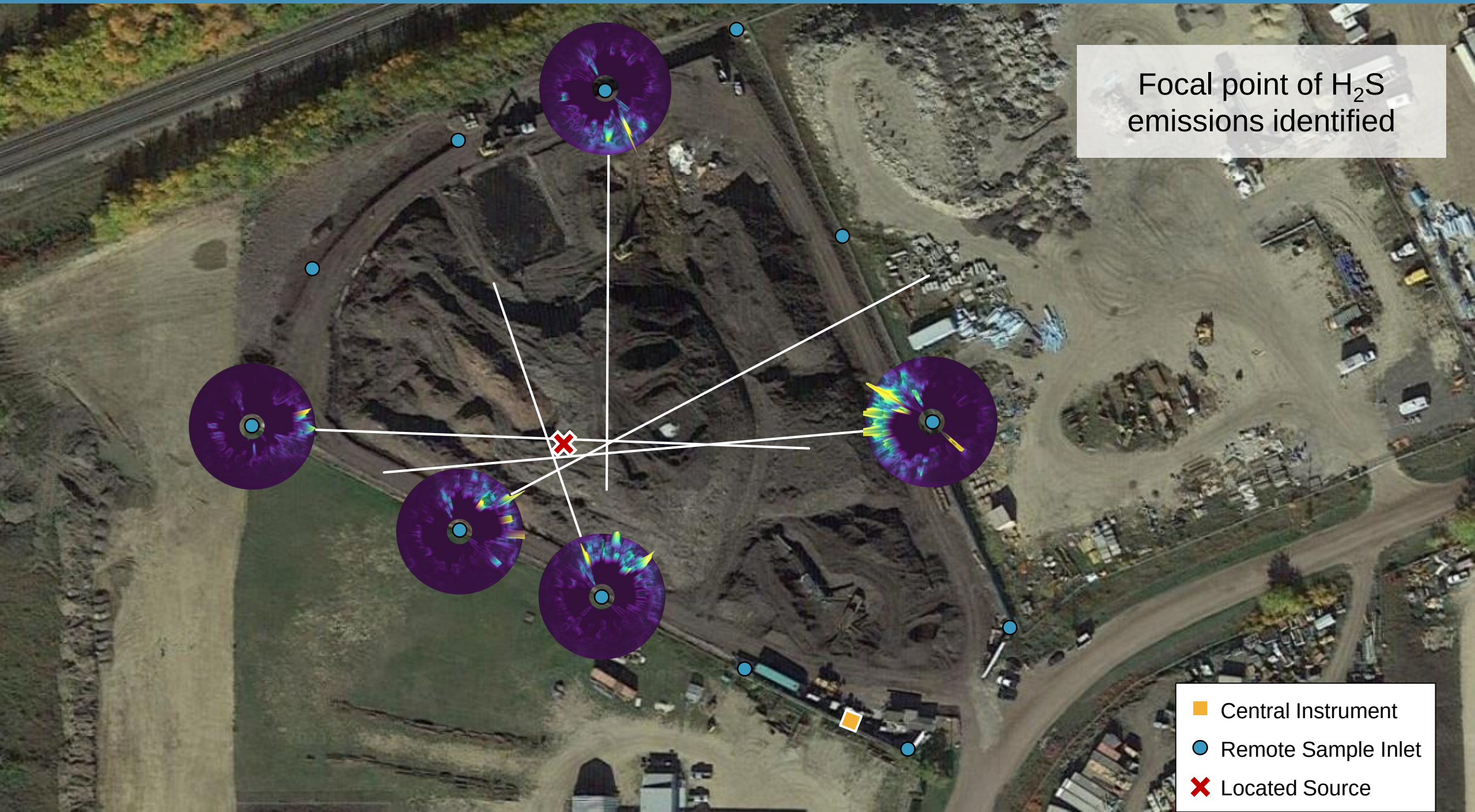
- Client was under pressure due to odour problems
- Situated in an area with other players
- Continuously monitored H_2S for 6 months starting in October 2019
  - Fence line measurements taken to understand maximum effect in all directions

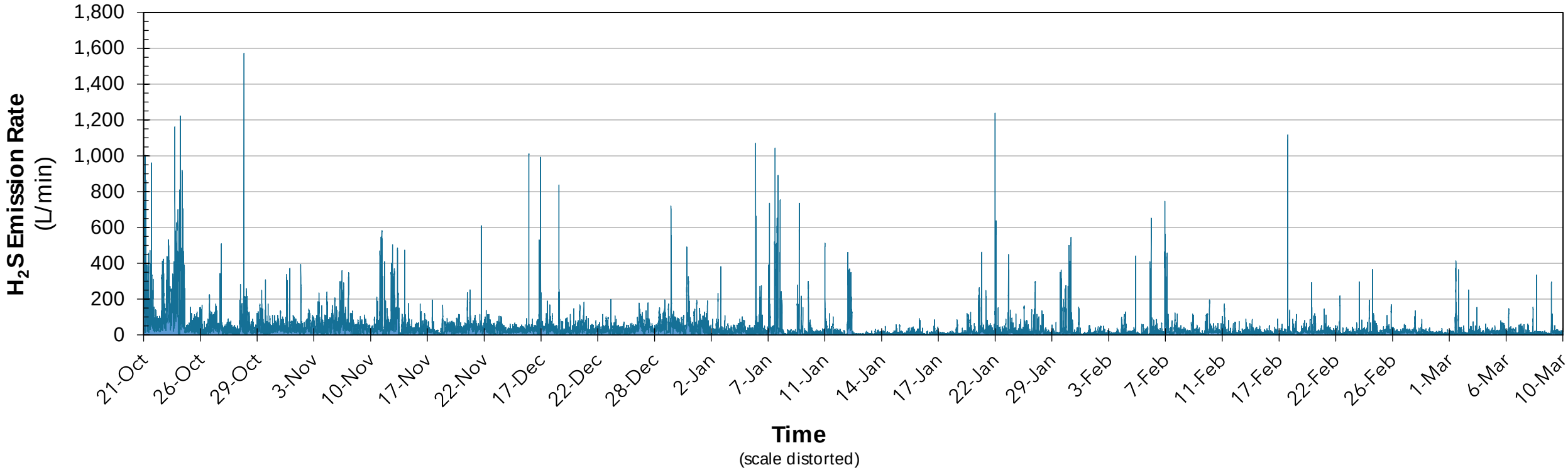

Sample inlets placed around the perimeter
Central Instrument
Remote Sample Inlet
Located Source


Focal point of H_2S emissions identified
Central Instrument
Remote Sample Inlet
Located Source




H_2S Emission Rate
(L/min)
1,000
800
600
400
200
0
21-Oct
1-Nov
11-Nov
17-Nov
22-Nov
21-Dec
26-Dec
29-Dec
3-Jan
11-Jan
20-Jan
24-Jan
27-Jan
31-Jan
7-Feb
15-Feb
19-Feb
23-Feb
27-Feb
5-Mar
10-Mar
Time
(scale distorted)


Focal point of H_2S emissions identified
Central Instrument
Remote Sample Inlet
Located Source


H_2S Emission Rate
(L/min)
1,800
1,600
1,400
1,200
1,000
800
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0
21-Oct
26-Oct
29-Oct
3-Nov
10-Nov
17-Nov
22-Nov
17-Dec
22-Dec
28-Dec
2-Jan
7-Jan
11-Jan
14-Jan
17-Jan
22-Jan
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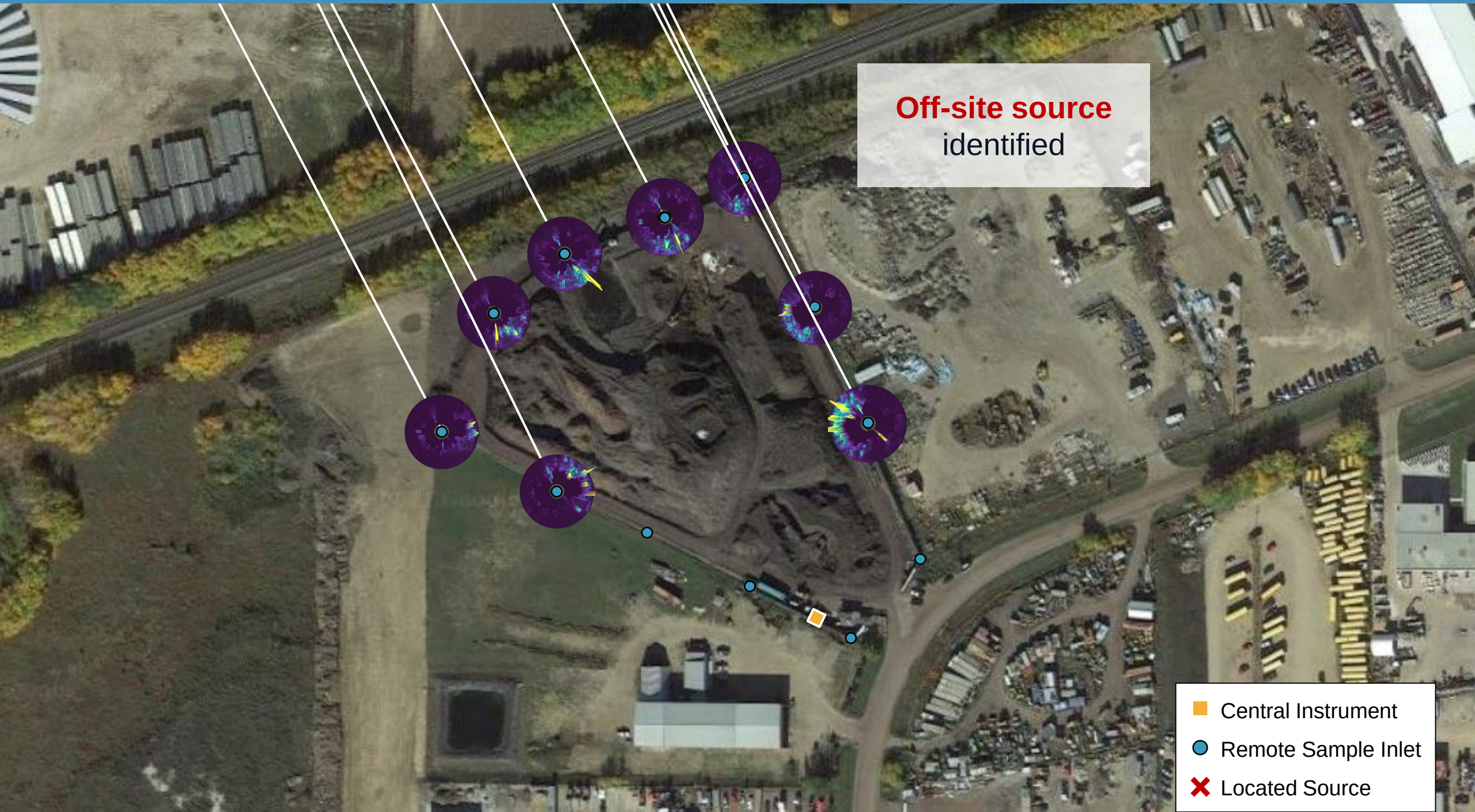
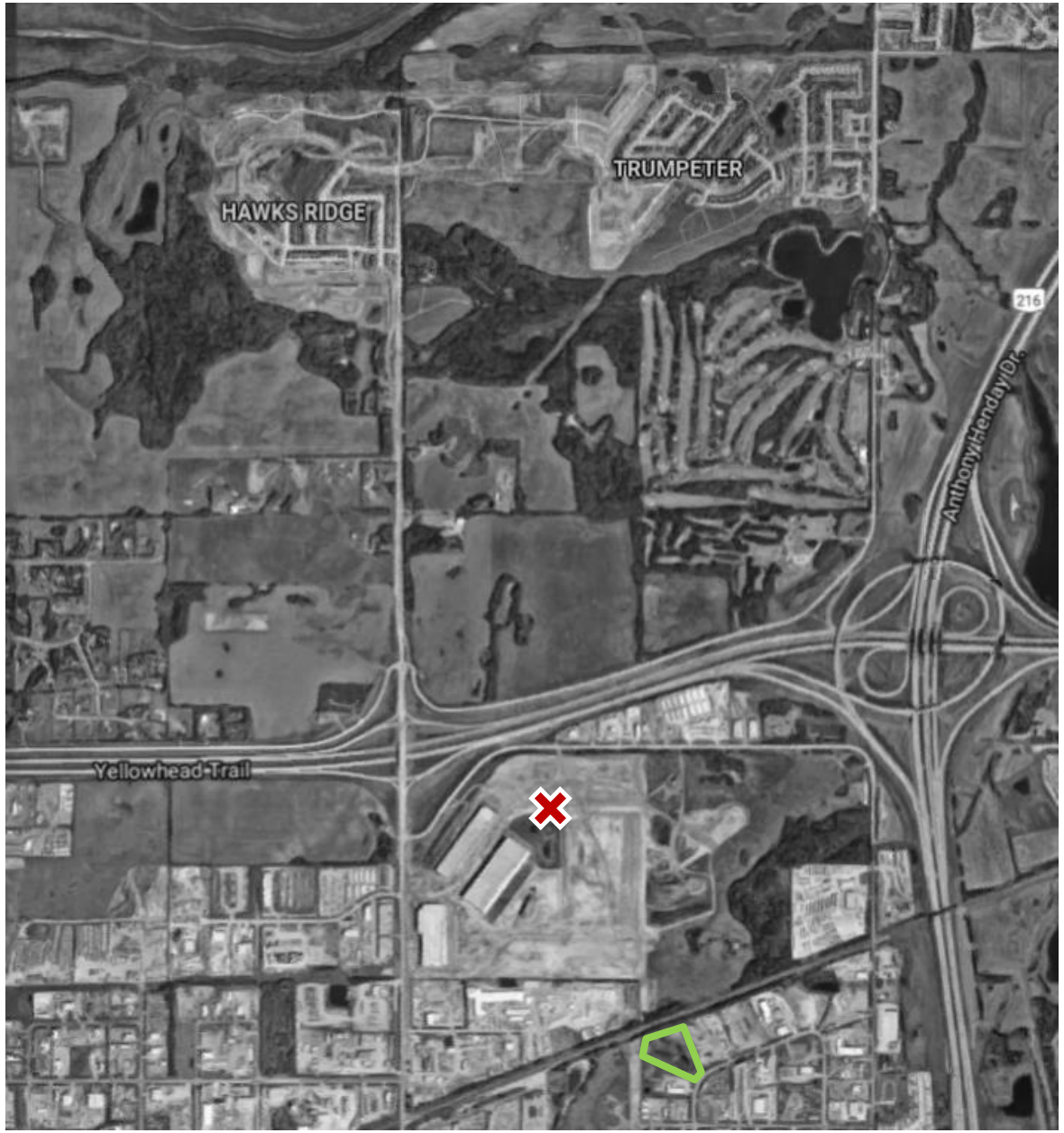
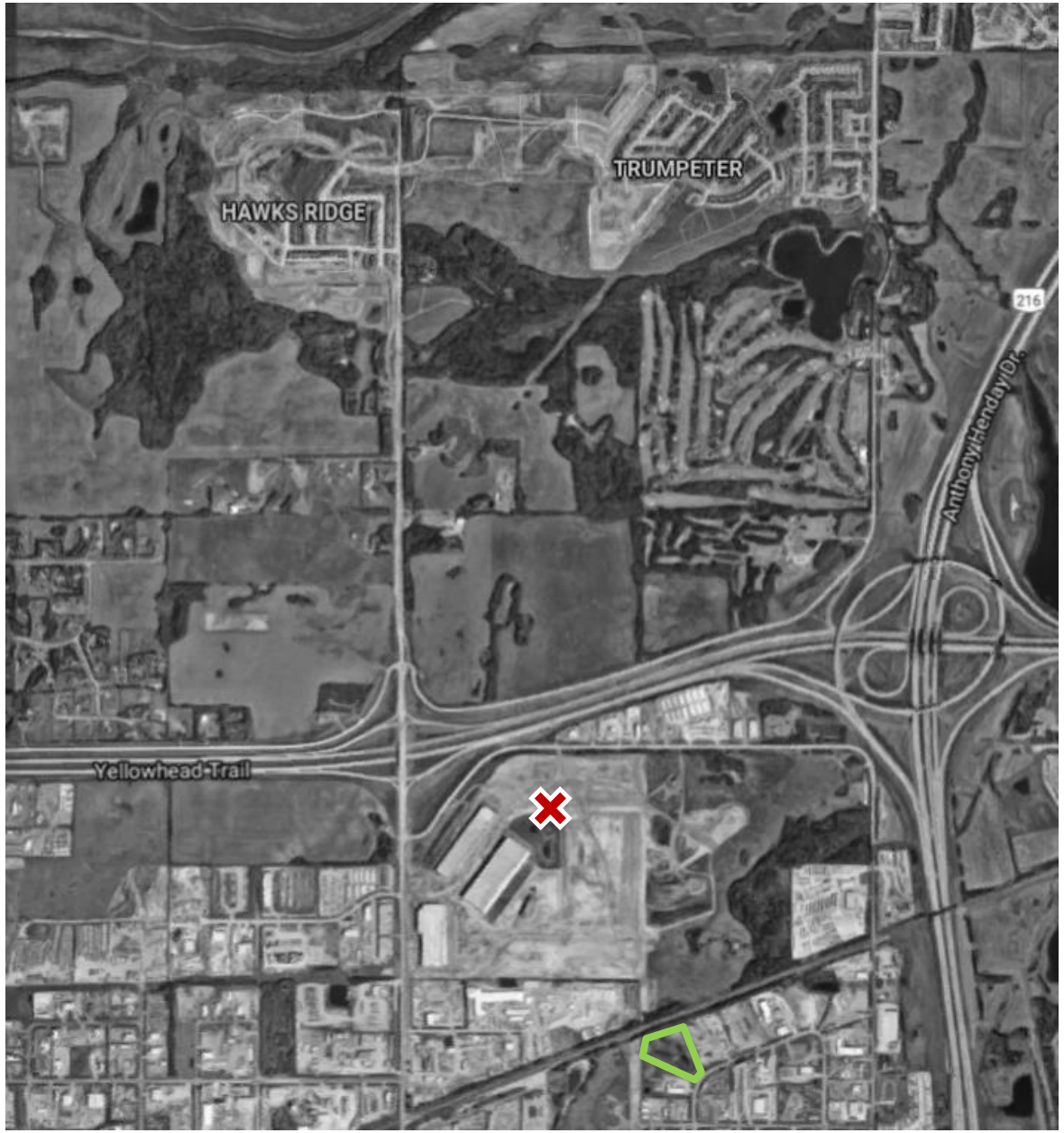
26-Feb
1-Mar
6-Mar
10-Mar
Time
(scale distorted)


Off-site source
identified
Central Instrument
Remote Sample Inlet
Located Source



Stagnant wastewater collection line located north of Cleanit Greenit



2 ppm (2000 ppb) H_2S detected

UPDATES IN NEAR REAL-TIME

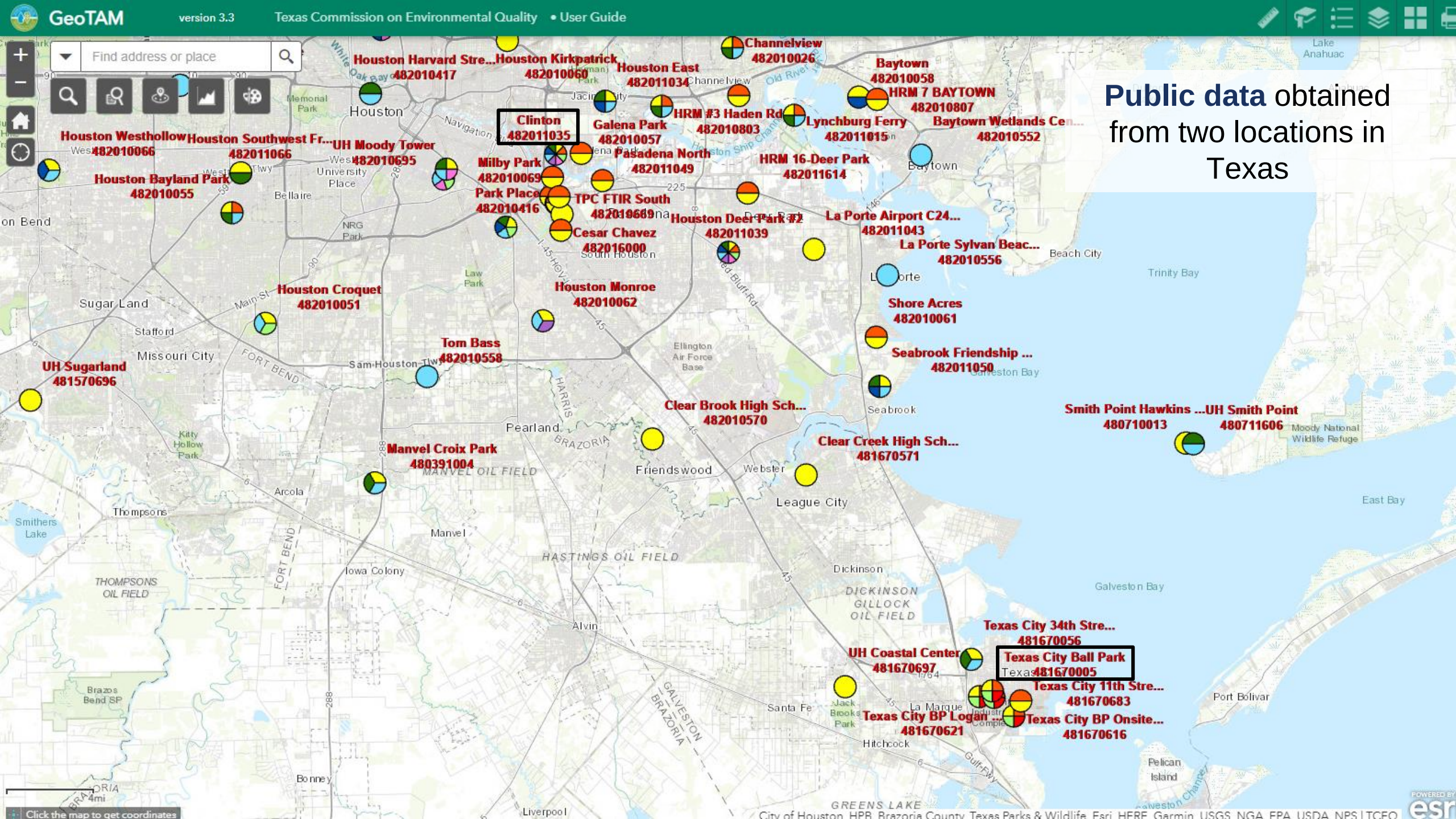
ADVANTAGES OF THIS SYSTEM

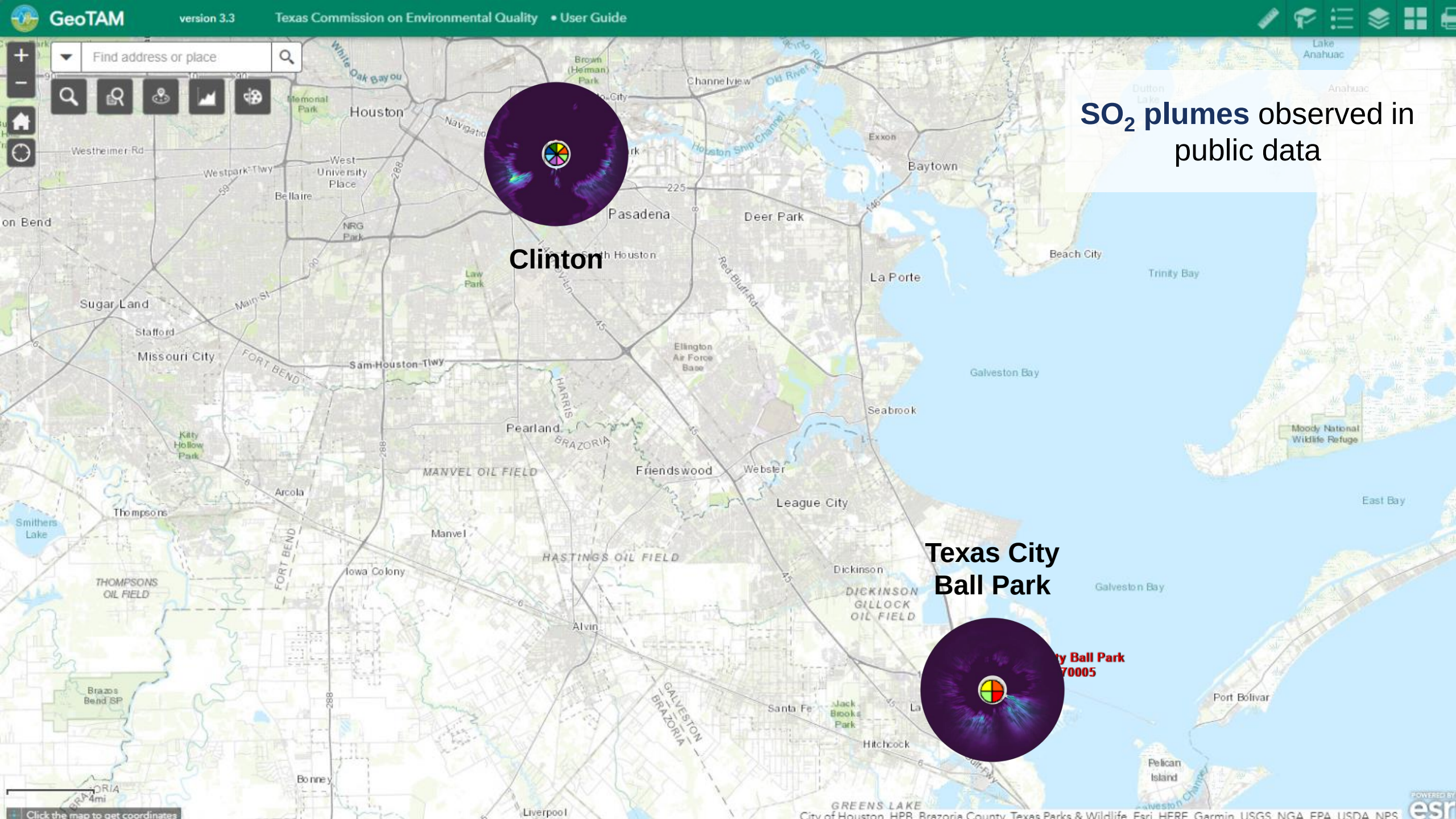
- Real-time notifications of high H_2S levels
- Emissions can be attributed to specific sources
- Improvements can be demonstrated

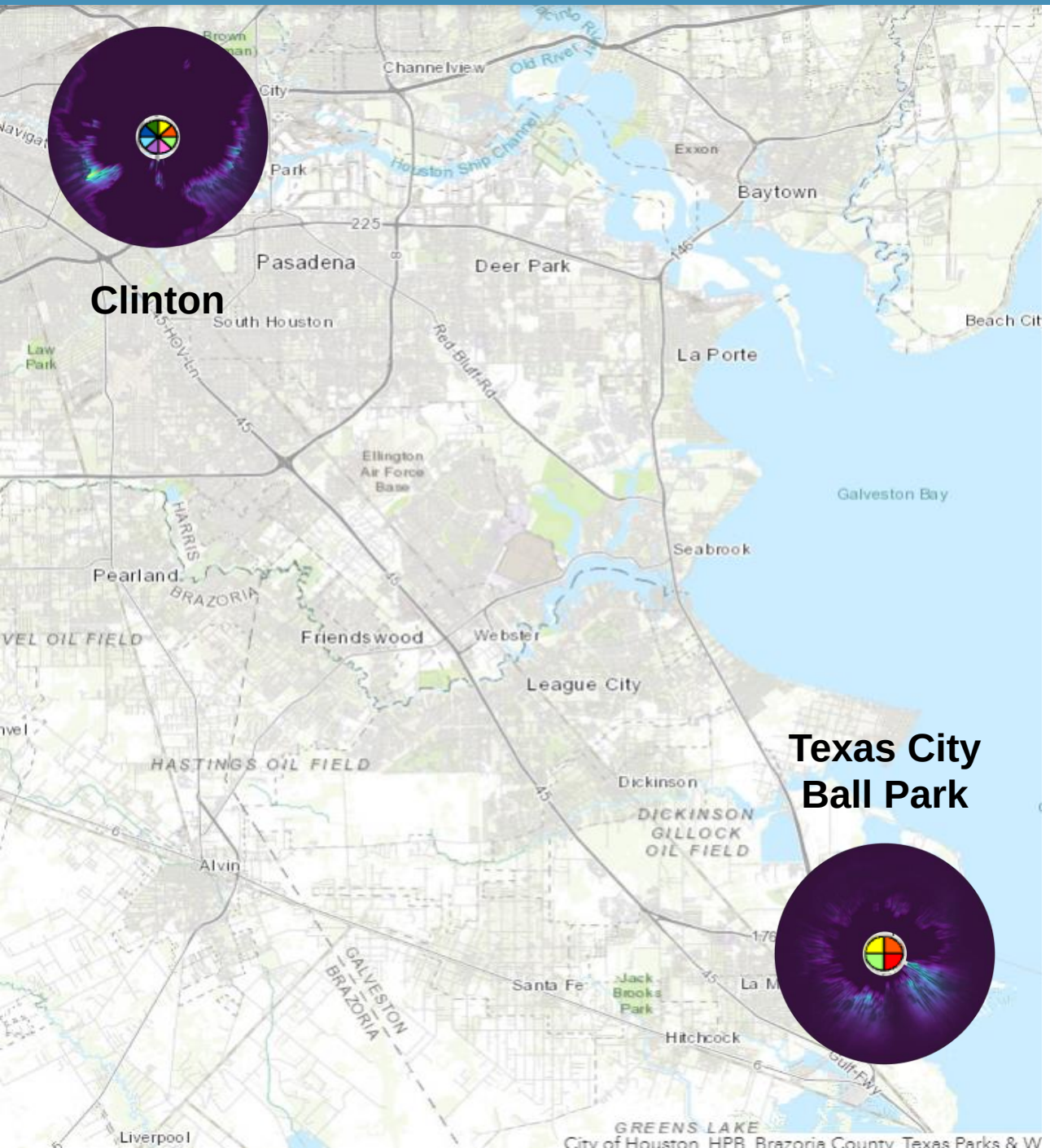
PUBLIC DATA

Disclaimer

Airdar Online Services Inc. ("**AOS**") analysis is a tool that works to, wherever possible, identify source plumes in concentration data and provide a measurement of source emission rates and source locations (the "**Tool**" or the "**Analysis**"). Although all reasonable care has been taken in preparing this Analysis, its accuracy, quality, completeness, effectiveness, or utility is dependent on several factors, including but not limited to (i) generally, the accuracy, quality, or completeness of the raw input data, and (ii) specifically, whether raw input data from more than one observation position was available. For these reasons, neither AOS nor any of its affiliates or representatives makes any representations or warranties, express or implied, as to the accuracy, completeness, or reliability of the Analysis provided here or its quality, merchantability or fitness for a particular purpose. Similarly, AOS relies on the provider of the raw input data to ensure that all data has been properly and legally obtained. AOS does not have the capacity or expertise to evaluate or perform due diligence on the raw data sources and assumes the provider of the data has obtained all required and applicable permissions for use. This Tool may contain occasional typographical or other human errors, and reasonable efforts will be made to correct these when such errors are identified. Please contact AOS at any point [support@airdar.com] if you have further questions on any of the above.


GeoTAM
version 3.3
Texas Commission on Environmental Quality • User Guide
Find address or place
Public data obtained from two locations in Texas
Houston Harvard Stre... 482010417
Houston Kirkpatrick 482010060
Houston East 482011034
Channelview 482010026
Baytown 482010058
HRM 7 BAYTOWN 482010807
Clinton 482011035
Galena Park 482010057
HRM #3 Haden Rd 482010803
Lynchburg Ferry 482011015
Baytown Wetlands Ce... 482010552
Houston Westhollow 482010066
Houston Southwest Fr... 482011066
UH Moody Tower 482010695
Milby Park 482010069
Pasadena North 482011049
HRM 16-Deer Park 482011614
Houston Bayland Park 482010055
Park Place 482010416
TPC FTIR South 482010689
Houston Deer Park #2 482011039
La Porte Airport C24... 482011043
Cesar Chavez 482016000
La Porte Sylvan Beac... 482010556
Houston Croquet 482010051
Houston Monroe 482010062
Shore Acres 482010061
Tom Bass 482010558
Seabrook Friendship ... 482011050
UH Sugarland 481570696
Clear Brook High Sch... 482010570
Smith Point Hawkins ... 480710013
UH Smith Point 480711606
Clear Creek High Sch... 481670571
Manvel Croix Park 480391004
Texas City 34th Stre... 481670056
UH Coastal Center 481670697
Texas City Ball Park 481670005
Texas City 11th Stre... 481670683
Texas City BP Logan ... 481670621
Texas City BP Onsite... 481670616
Houston
Sugar Land
Missouri City
Stafford
Pearland
Friendswood
Webster
League City
Seabrook
Baytown
Channelview
Bellaire
West University Place
Galveston Bay
Trinity Bay
East Bay
Dickinson
Alvin
Manvel
Iowa Colony
Thompsons
Arcola
Santa Fe
Hitchcock
Port Bolivar
Pelican Island
Beach City
Lake Anahuac
Smithers Lake
Brazos Bend SP
Kitty Hollow Park
Jack Brooks Park
Moody National Wildlife Refuge
Ellington Air Force Base
MANVEL OIL FIELD
HASTINGS OIL FIELD
THOMPSONS OIL FIELD
DICKINSON GILLOCK OIL FIELD
GREENS LAKE
Click the map to get coordinates
City of Houston, HPB, Brazoria County, Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS | TCEQ


GeoTAM
version 3.3
Texas Commission on Environmental Quality • User Guide
Find address or place
SO_2 plumes observed in public data
Clinton
Texas City Ball Park
Houston
Pasadena
Baytown
Deer Park
La Porte
Pearland
Sugar Land
Missouri City
Stafford
Friendswood
Webster
Seabrook
League City
Dickinson
Alvin
Manvel
Iowa Colony
Arcola
Thompsons
Bonney
Liverpool
Santa Fe
Hitchcock
Port Bolivar
Pelican Island
Beach City
Galveston Bay
Trinity Bay
East Bay
Lake Anahuac
Channelview
Bellaire
West University Place
Westheimer Rd
Sam Houston Tlwy
Main St
Fort Bend
Harris
Brazoria
Galveston
MANVEL OIL FIELD
HASTINGS OIL FIELD
DICKINSON GILLOCK OIL FIELD
THOMPSONS OIL FIELD
GREENS LAKE
Ellington Air Force Base
Moody National Wildlife Refuge
Brazos Bend SP
Smithers Lake
Kitty Hollow Park
NRG Park
Memorial Park
Brown (Herman) Park
Law Park
Jack Brooks Park
Exxon
Houston Ship Channel
Red Bluff Rd
Old River
White Oak Bayou
Click the map to get coordinates
4mi
City of Houston, HPB, Brazoria County, Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS
esri



SO_2 plumes observed

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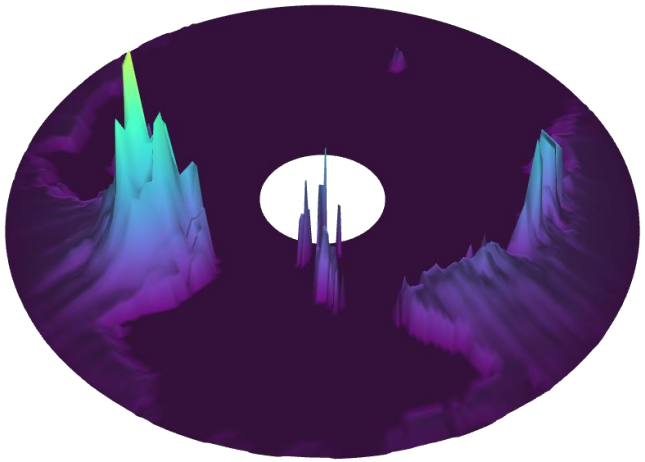
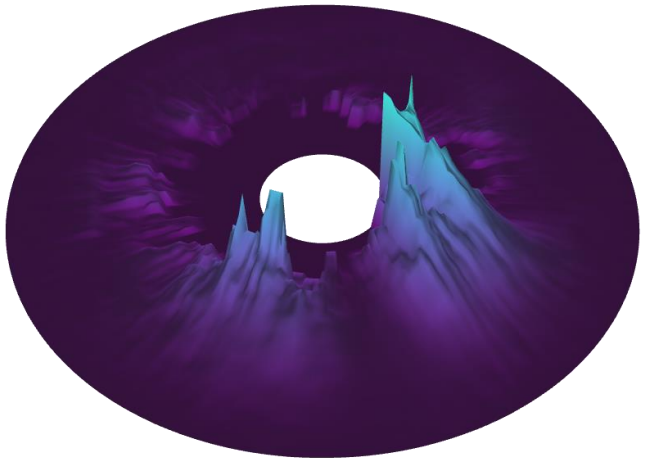
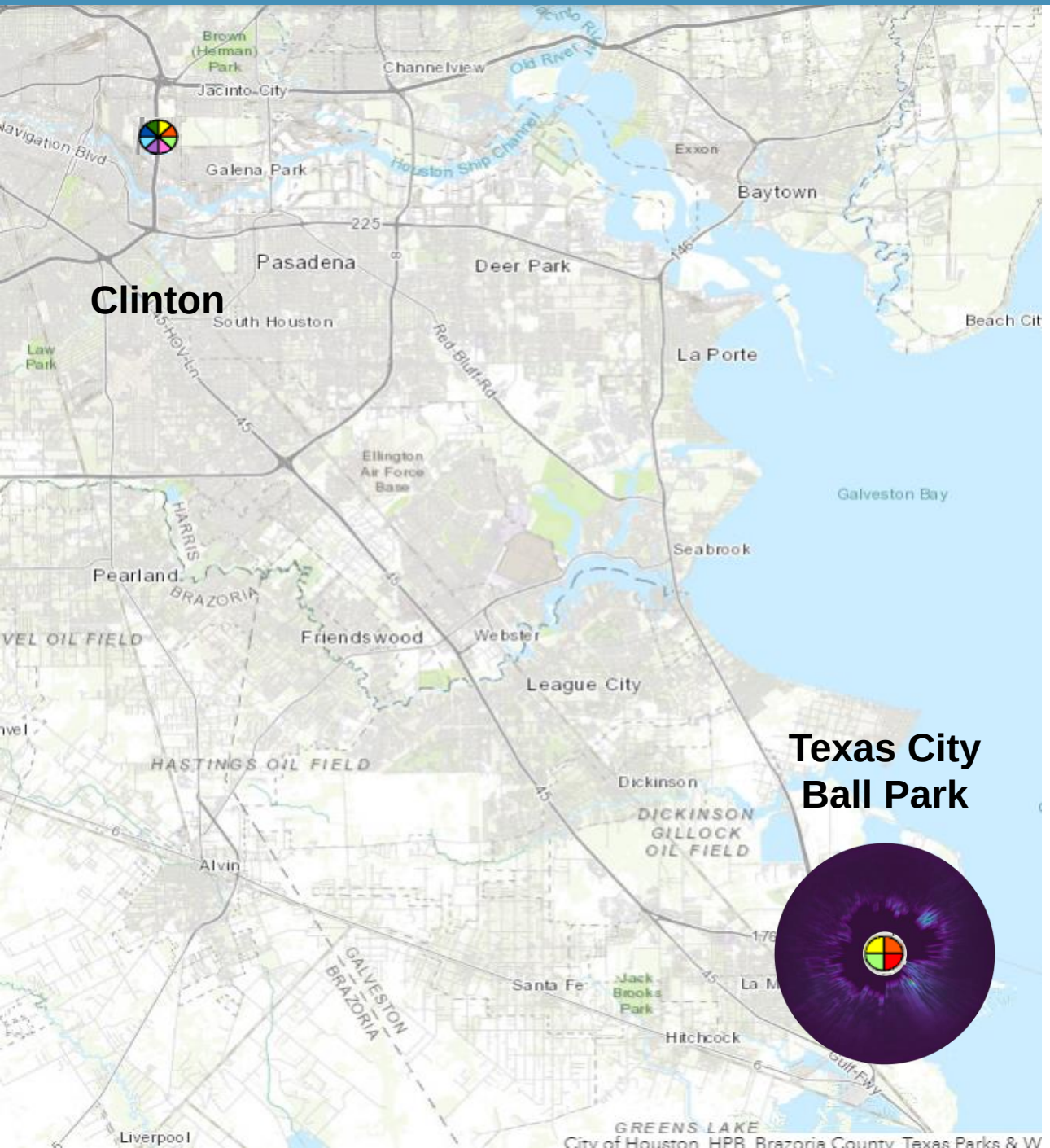
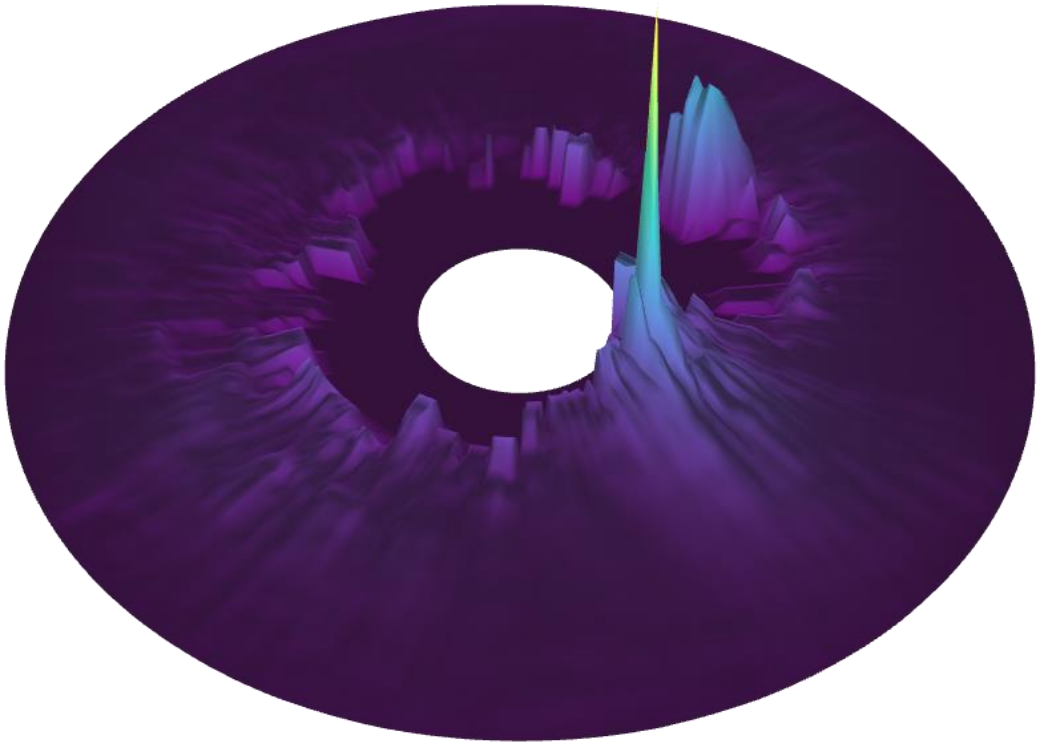


Texas City Ball Park

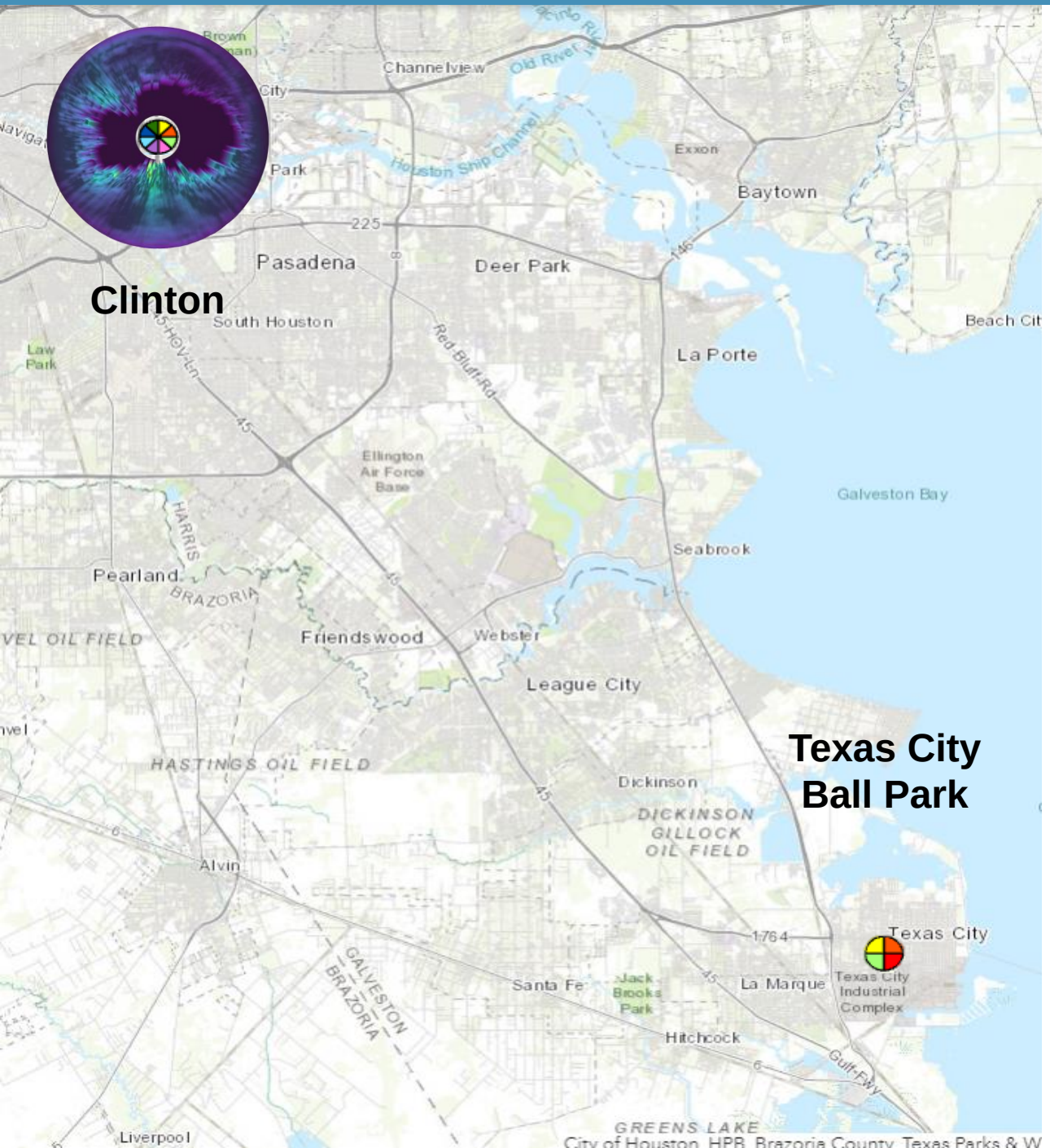




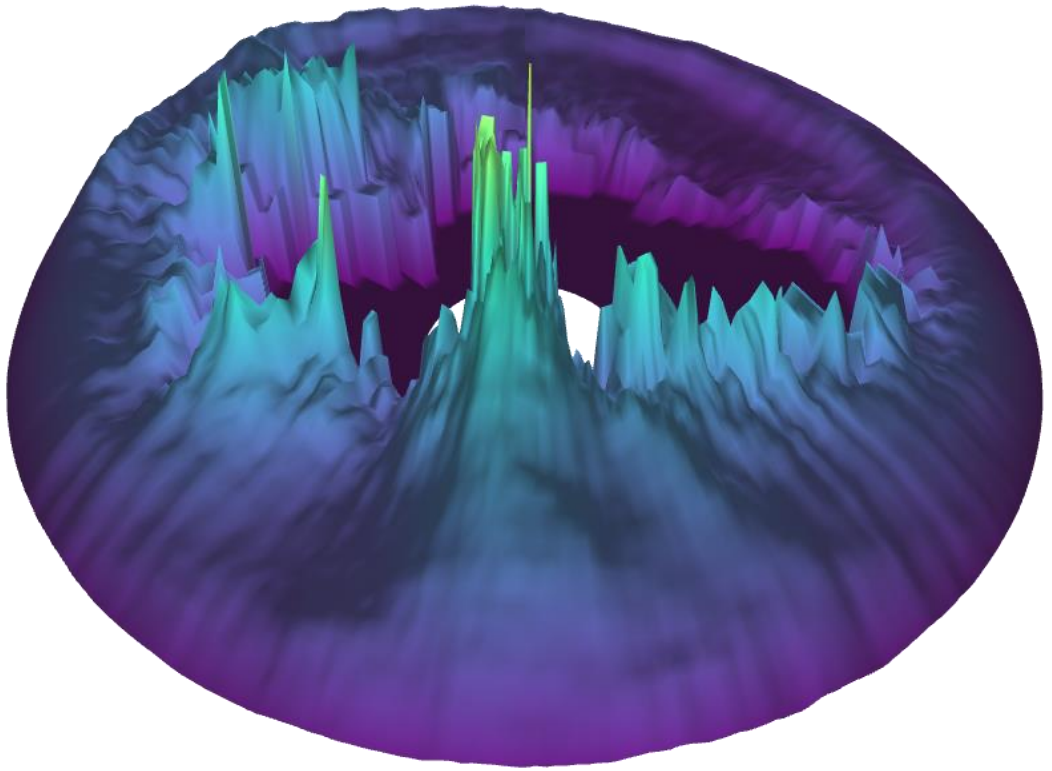
H_2S plumes observed



Texas City Ball Park



NO_x plumes observed



Clinton

SUMMARY

- Continuous monitoring methods overcome many challenges with measuring emissions
- Emissions can be directly measured, which was impossible in the past
- Concentration measurements can be used to locate and quantify emission sources

QUESTIONS?

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Thank you for listening

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