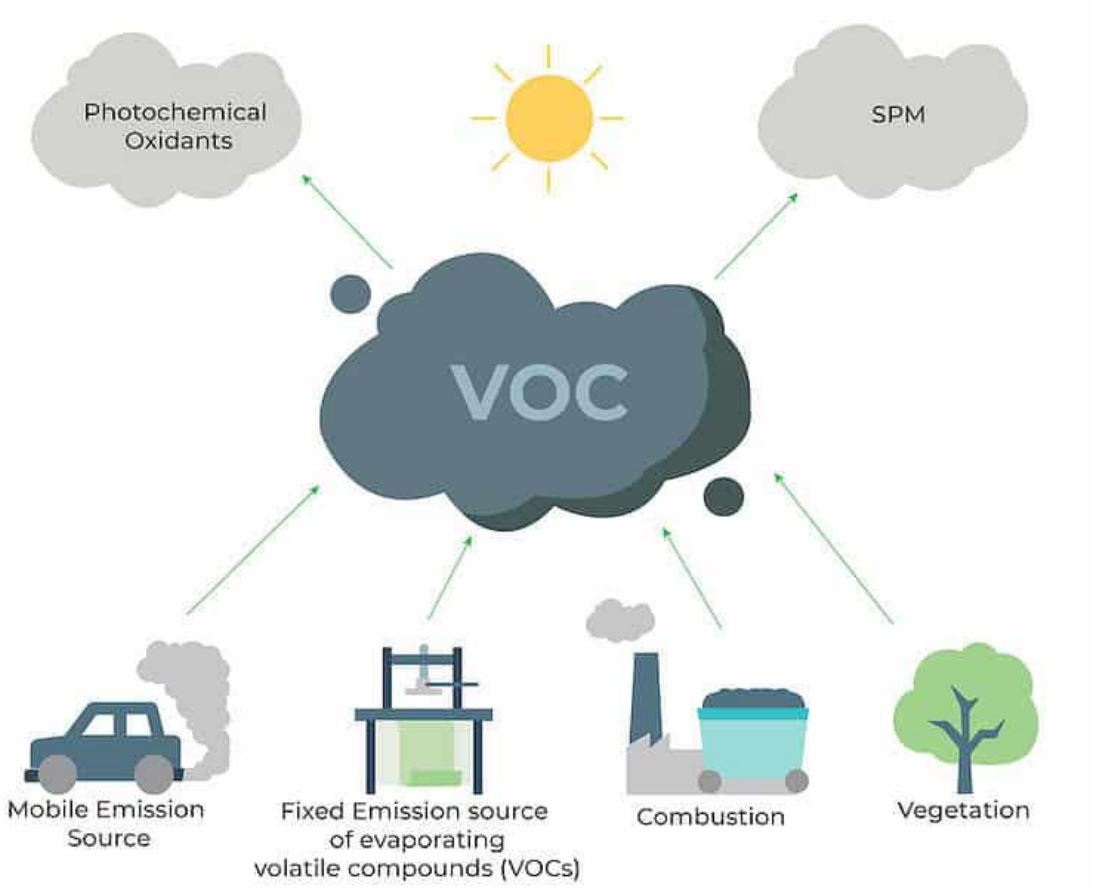
The Application of Non-Targeted Mobile Air Monitoring To Assess Volatile Organic Compounds in Non-Occupational Settings

Eva Vitucci, PhD

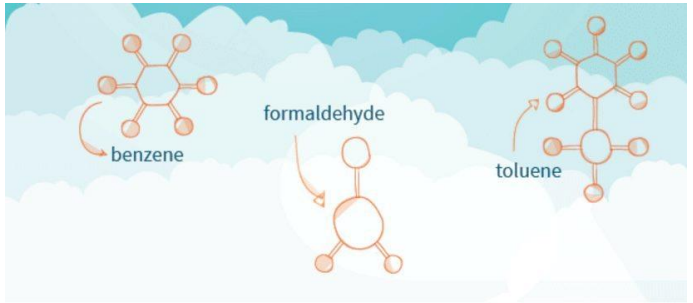
Texas A&M University

College Station, TX

Volatile Organic Compounds (VOCs)



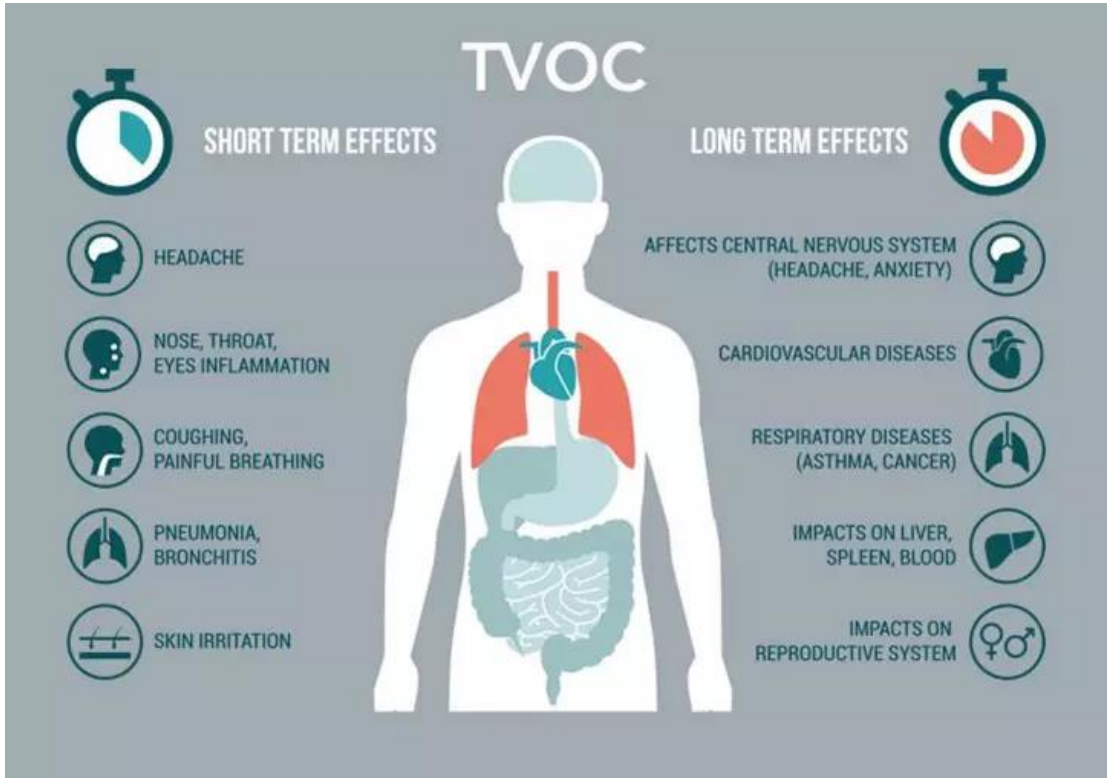
- Non-criteria air pollutant
  - *Hazardous air pollutants*
- Carbon-containing compounds with high vapor pressure



- Emitted from natural and anthropogenic sources
- Can pose serious health concerns

BTEX Compounds: Benzene, Toluene, Ethylbenzene, Xylene

- Common VOCs
  - Sources:
    - Vehicular exhaust
    - Solvents
    - Cooking emissions
    - Industrial operations
- Associated with serious health concerns
- Monitored in occupational settings
  - Refineries required to monitor for benzene (*fenceline monitoring program*)



EnviroCorp

Volatile Organic Compounds (VOCs) are Under Investigated in Residential Communities

A petroleum refinery adjacent to community residents and a residential park in Manchester, in east Houston. Texas Tribune

- Assessment of VOCs in fenceline communities has historically been under investigated
  - *Fenceline communities:* Communities bordering industrial operations
- Lack of monitoring prevents:
  - VOC emission characterization
  - Human health risk assessment
  - Development of exposure reduction strategies
- Fenceline communities may be at an increased risk for a variety of adverse health effects

Texas Communities of Concern

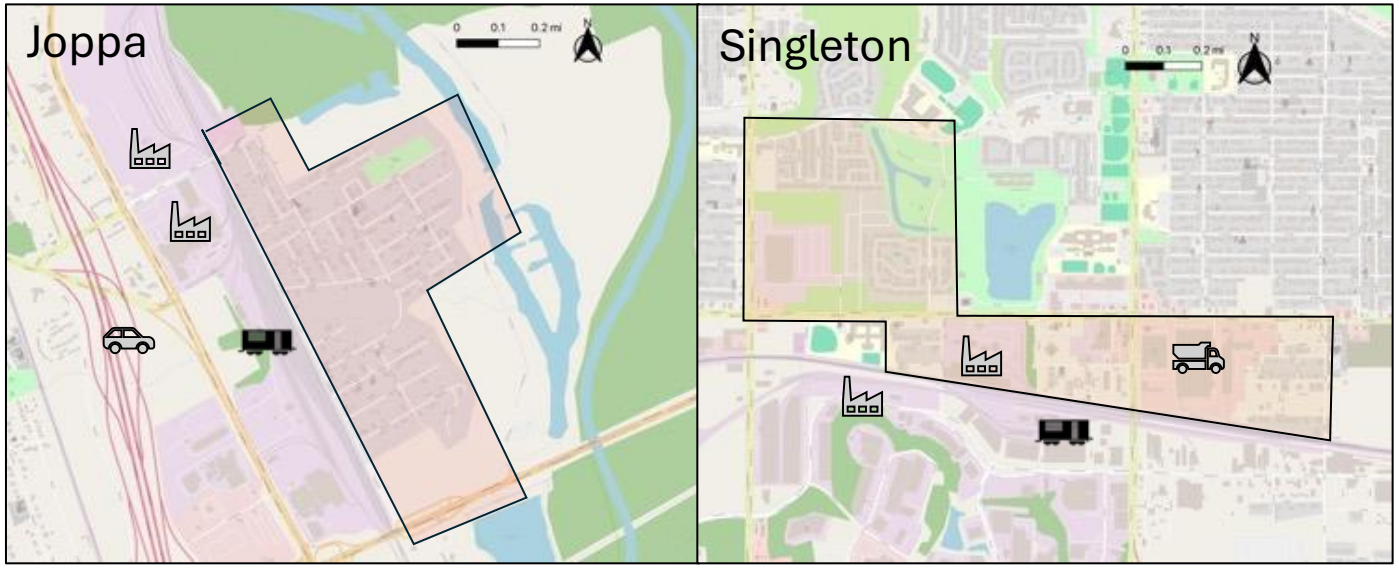
- Joppa and Singleton – Fenceline Communities
  - Two communities within Dallas County
  - Top 10% of the nations most toxic communities
  - Surrounded by large industrial air polluters
  - Elevated incidences of respiratory diseases

: Railroad switchyard

: Industrial factory

: Loading zone

: Highway



Texas Communities Express Concern Regarding Elevated VOC Burden

Joppa Environmental Health Project 2020-2023
West Dallas Environmental Health Project 2024

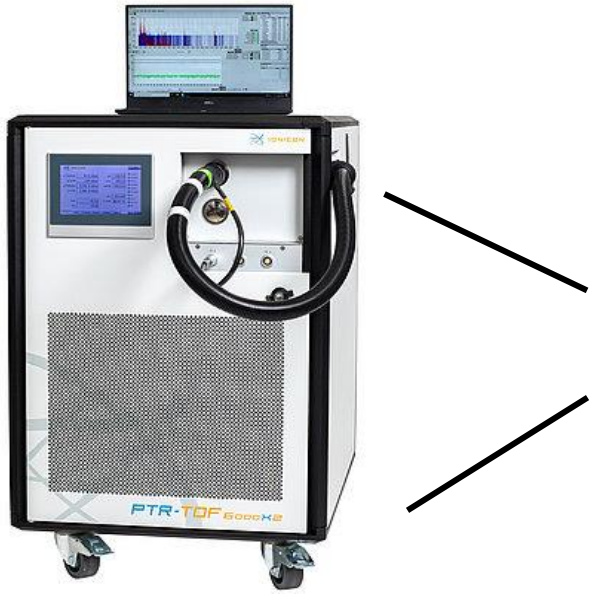
Results for Joppa and Singleton Corridor Health Surveys
and SharedAirDFW.com PM 2.5 monitoring
during the survey period.

Texas A&M, Downwinders at Risk, Justice for Joppa/Justicia para Joppa, Singleton United/Unidos

Joppa	Singleton Corridor
AIR MONITORING	AIR MONITORING
Hinton Street high : 26 ug/m3 SharedAir DFW high : 56-71 ug/m3	Hinton Street: Range from 1.7 - 19 ug/m3 SharedAir DFW: Range from 6.7 - 222 ug/m3
PM Levels were 2-3 times higher than Hinton Street	PM levels were 11 tmes higher than Hinton Street
EPA daily standard exceeded 24 times	EPA daily standard exceeded 35 times

- Develop VOC monitoring plan to:
  - Characterize community VOCs across sampling days and seasons
  - Compare VOCs in Joppa & Singleton to a local, non-fenceline background

mRAPID Sampling Van

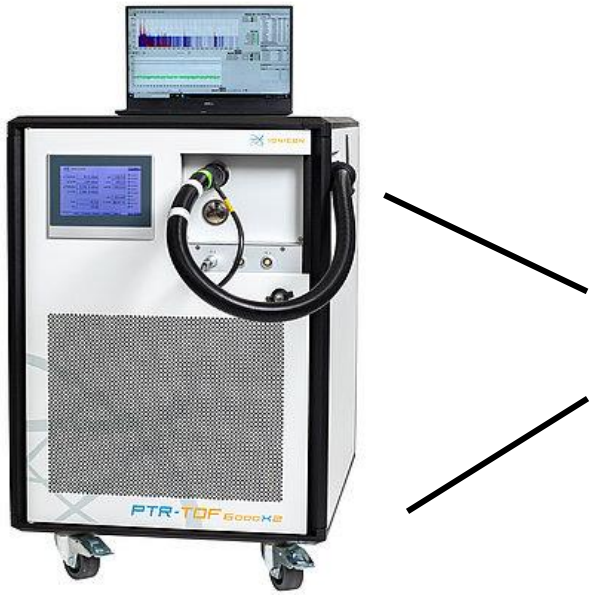


PTR-ToF-MS
- Measures 100s – 1000s of species
- 1 second resolution
- Highly sensitive

mRAPID Van

- Rapid and sensitive detection of a large array of VOCs
- Targeted approach:
  - Select VOCs of interest
- Non-targeted approach (NTA):
  - Non-biased assessment of VOCs

mRAPID Sampling Van



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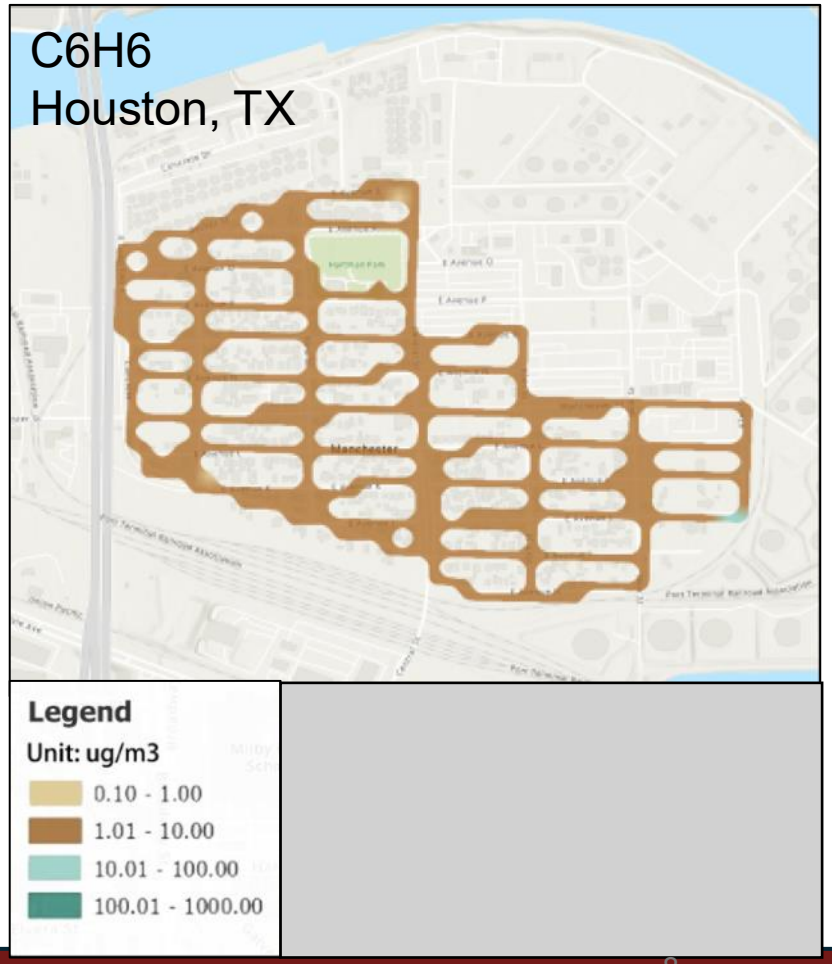
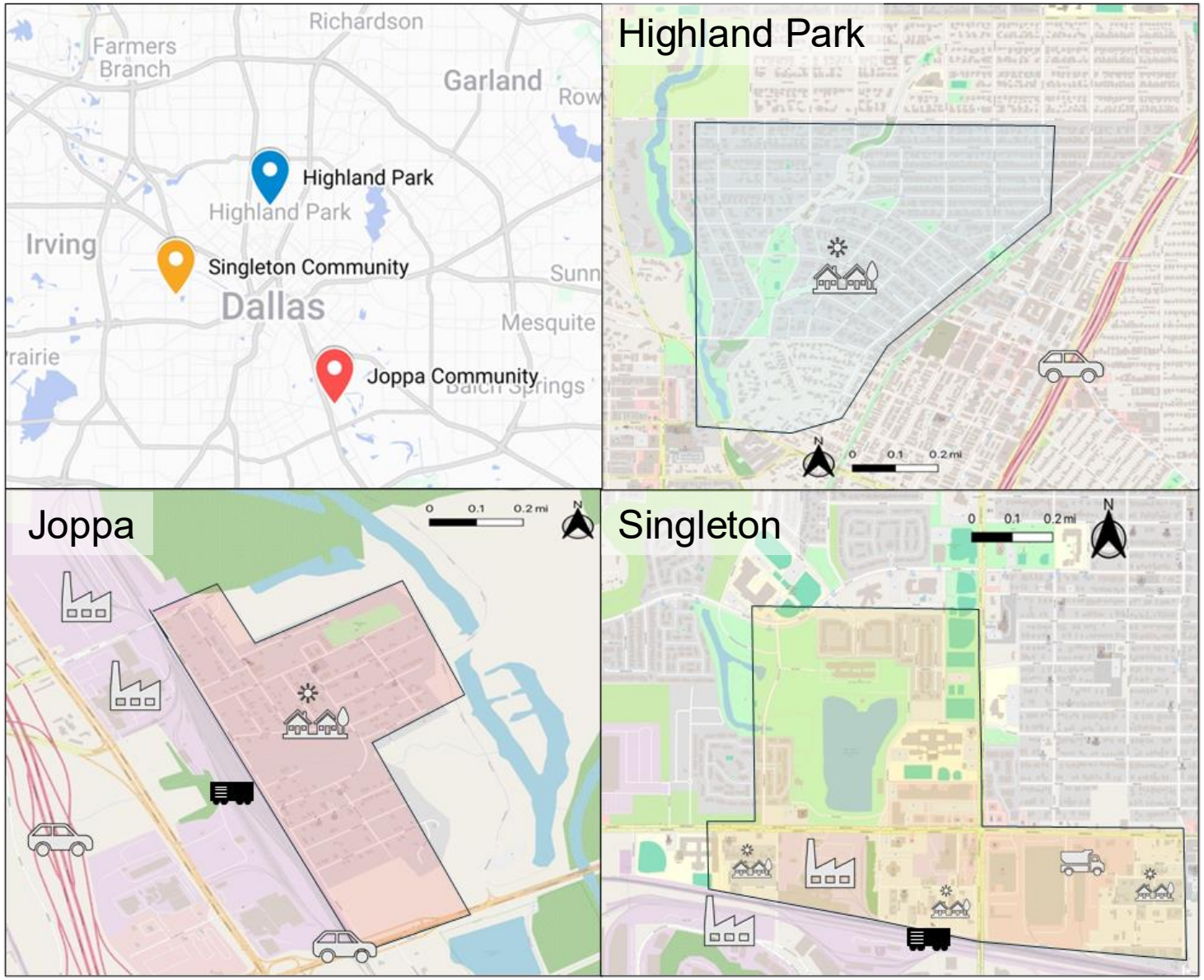
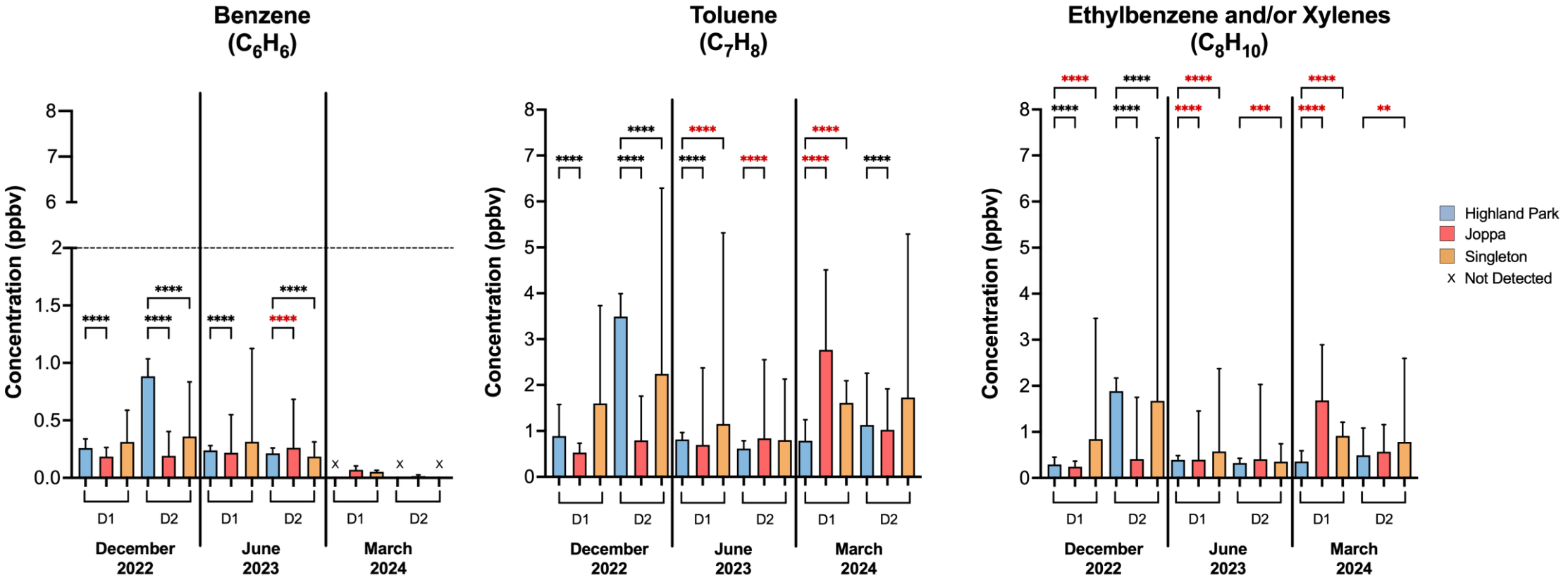




Sampling Strategy

- Sampled across 3 months
  - December 2022
  - June 2023
  - March 2024
- Sampled two days during each month
- Compared to local background, Highland Park
- Sampled all 3 locations on every sampling day

Targeted BTEX Monitoring Reveals Small Differences Between Communities

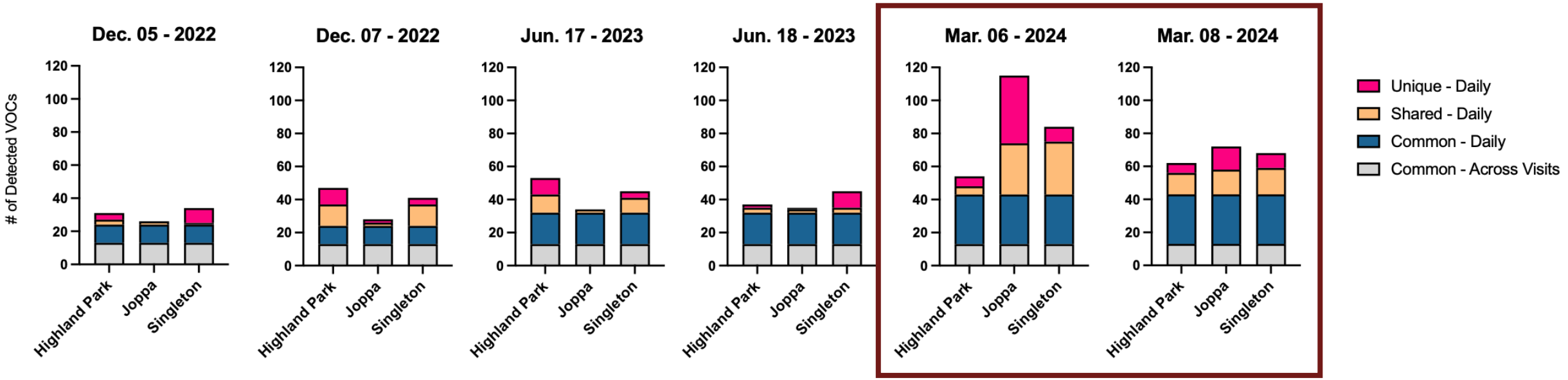


- No overwhelming difference in average BTEX concentration between communities
- Fenceline communities tend to have larger variability in BTEX concentrations
- All average concentrations are within safe exposure limits

* Non-fenceline Community > Fenceline Community

* Fenceline Community > Non-fenceline Community

Non-Targeted Community VOC Detection

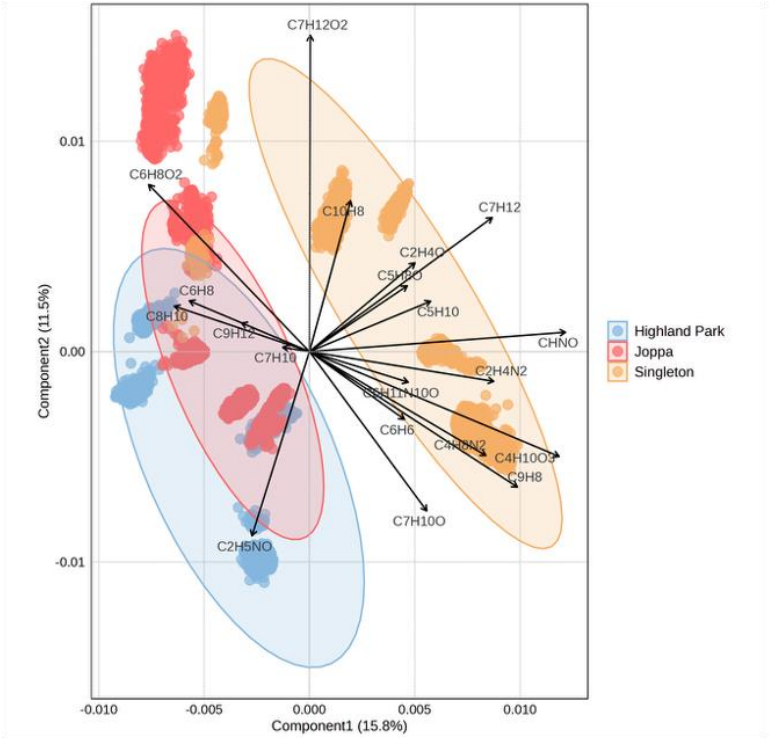


- NTA detects at least 30 different VOCs along community sampling routes
- Many detected VOCs are common across communities
- Larger VOC detection in March suggests potential diurnal and/or seasonal impact

Non-Targeted VOC Analysis Suggests Community Specific VOC Emissions

Dec ‘22 – Mar ‘24

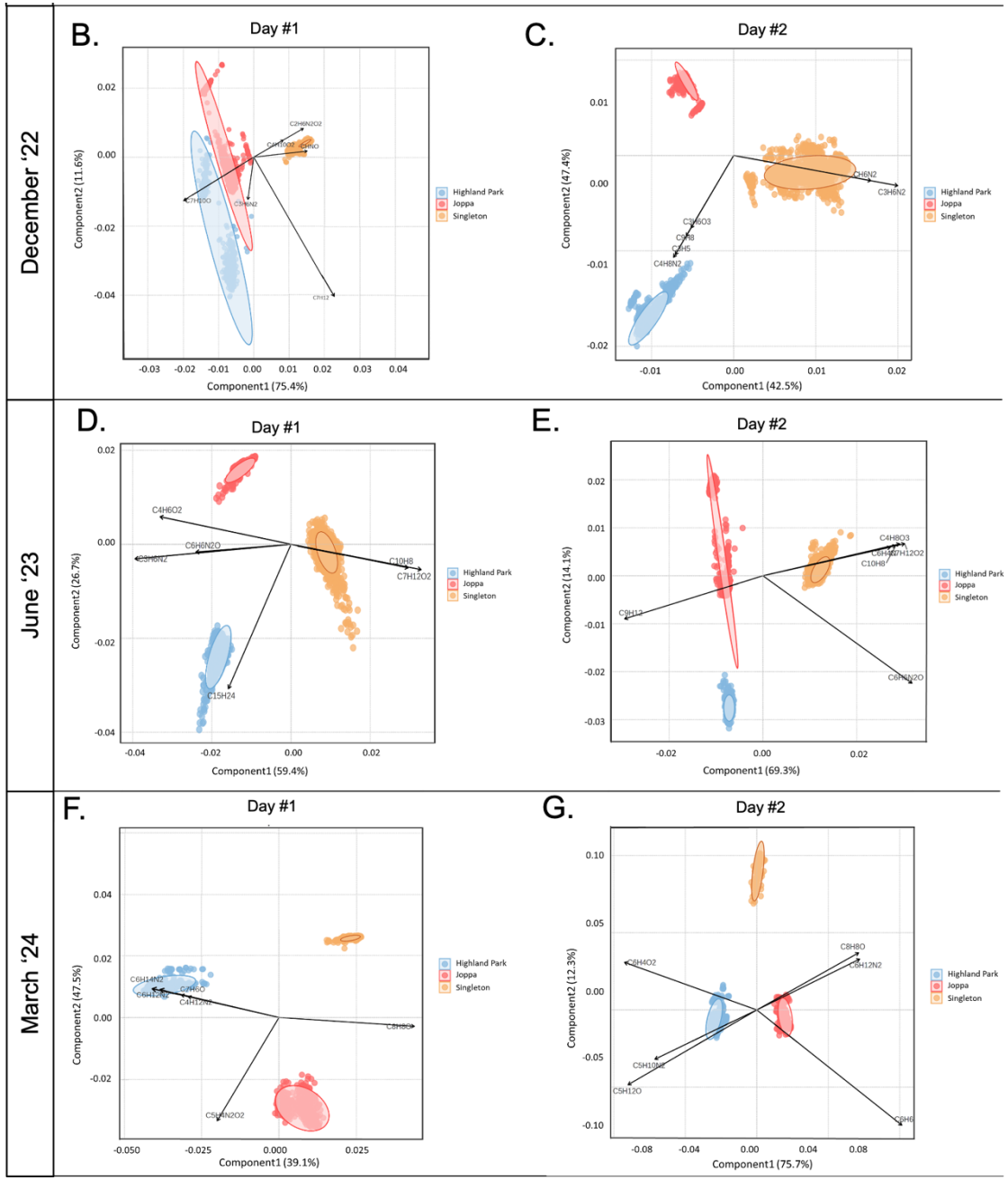
A.



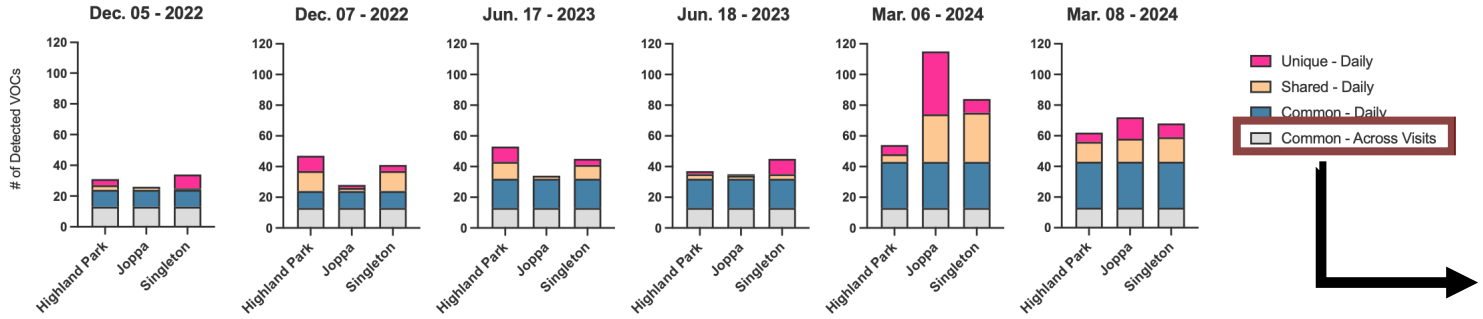
- Partial Least Squares Discriminant Analysis (PLS-DA), a supervised dimensionality reduction technique, can investigate the temporal and spatial variation of (VOCs) across communities and days
- Singleton community frequently has a unique total VOC profile
- Joppa and Highland Park communities have more similar total VOC profiles
- Singleton may stand apart due to a greater detection of VOCs (both quantity and concentration)

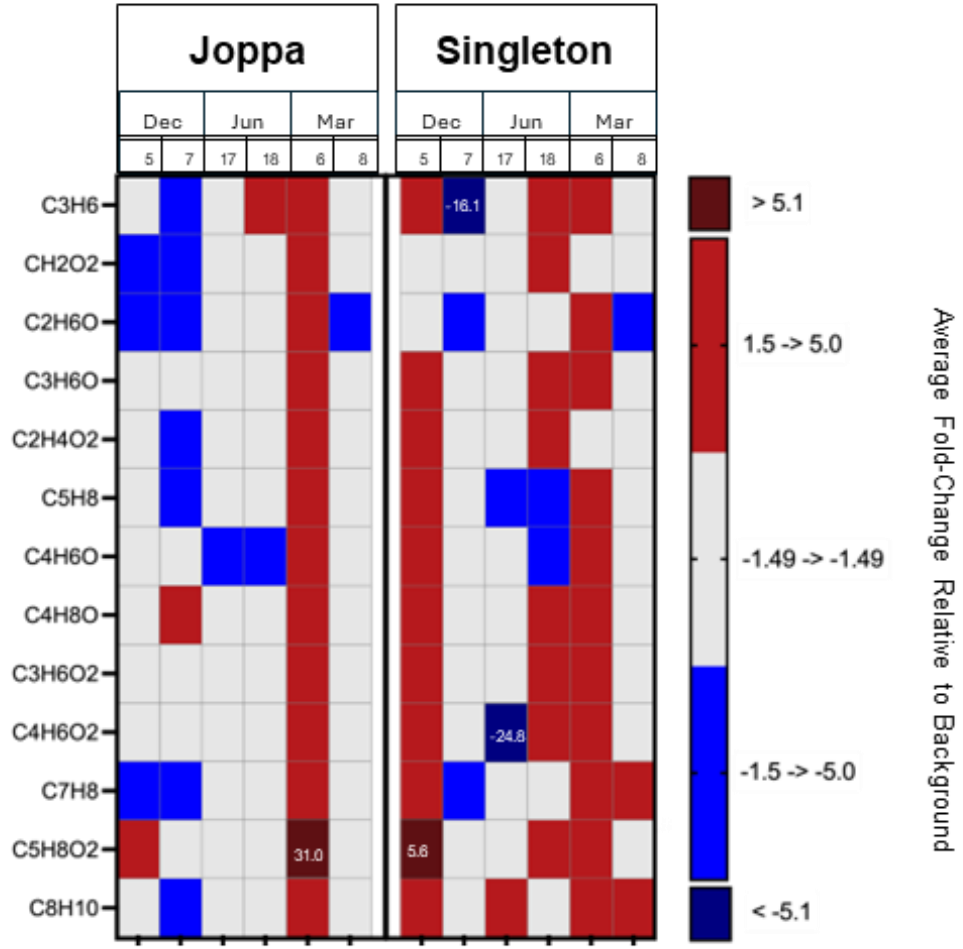
Non-Targeted VOC Analysis Suggests Community Specific VOC Emissions

- Partial Least Squares Discriminant Analysis (PLS-DA), a supervised dimensionality reduction technique, can investigate the temporal and spatial variation of (VOCs) across communities and days
- Singleton community frequently has a unique total VOC profile
- Joppa and Highland Park communities have more similar total VOC profiles
- *Can detect VOCs that are the most important for driving the separation of groups*



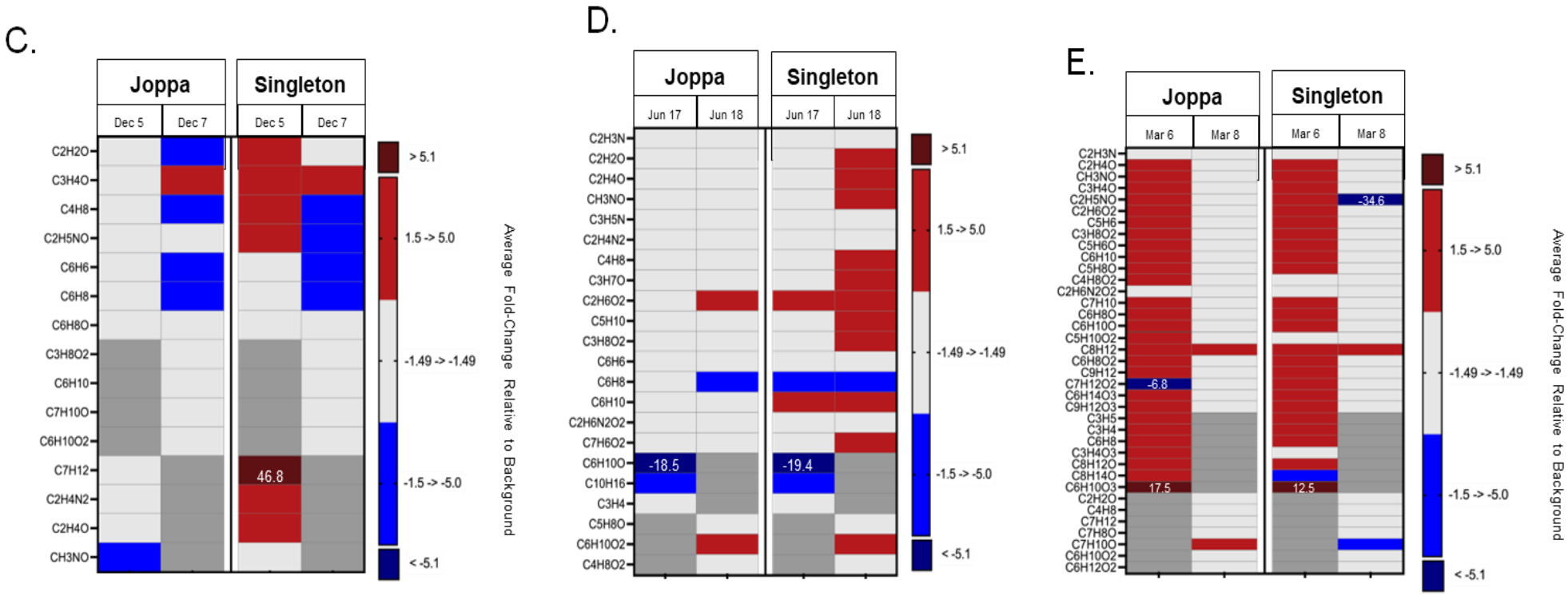
VOC Concentration Frequently Increased In Singleton Community





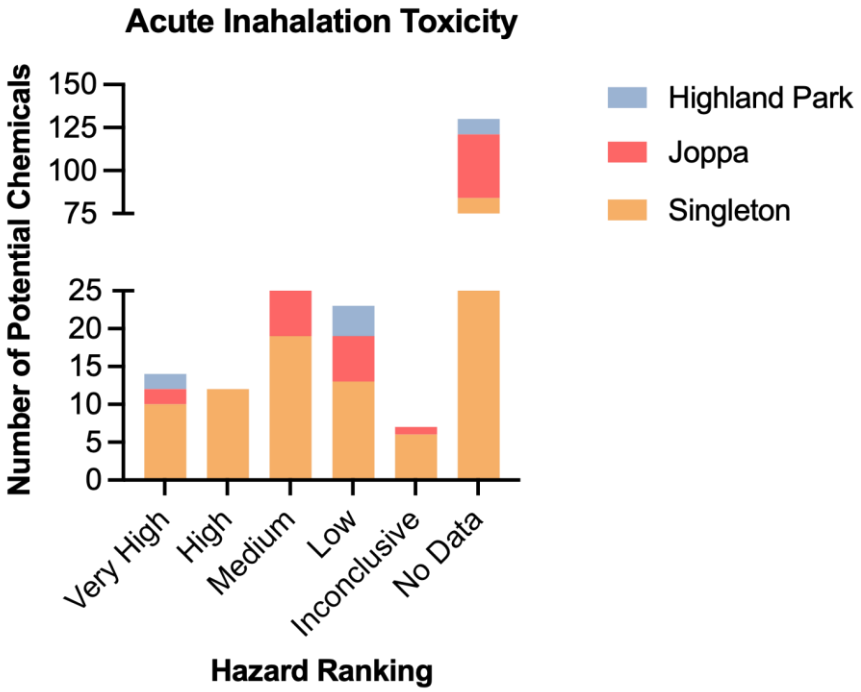
- Of the VOCs found in each community on every visit, many VOCs had average concentrations +1.5 fold elevation in Singleton compared to background
- More VOCs found elevated in Singleton than Joppa

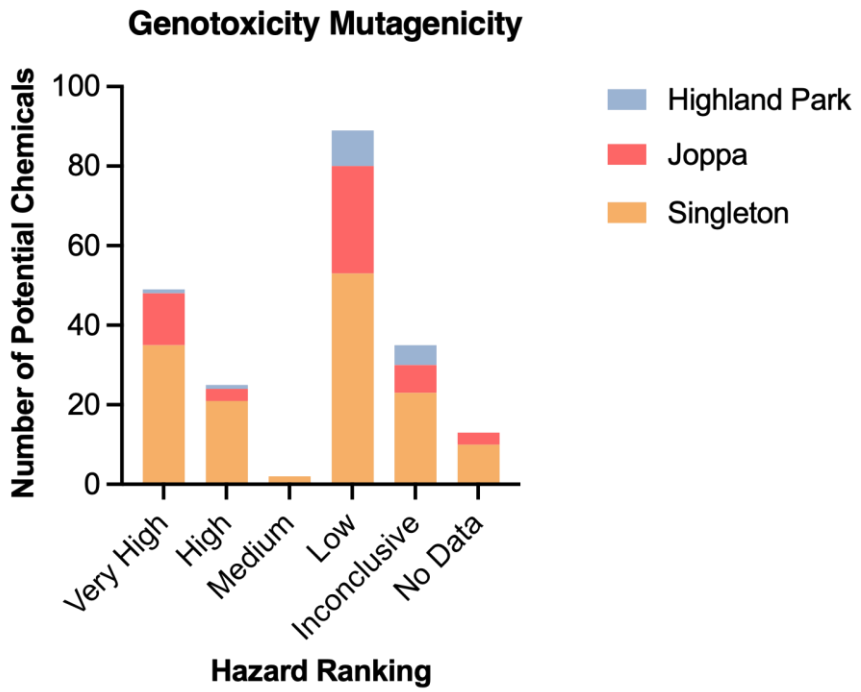
VOC Concentration Frequently Increased In Singleton Community



- Average fold change of VOC concentration found in every community, on individual visits are elevated in Singleton
- More VOCs found elevated in Singleton than Joppa, with the exception of March

Elevated Health Hazards of VOCs in Fenceline Communities



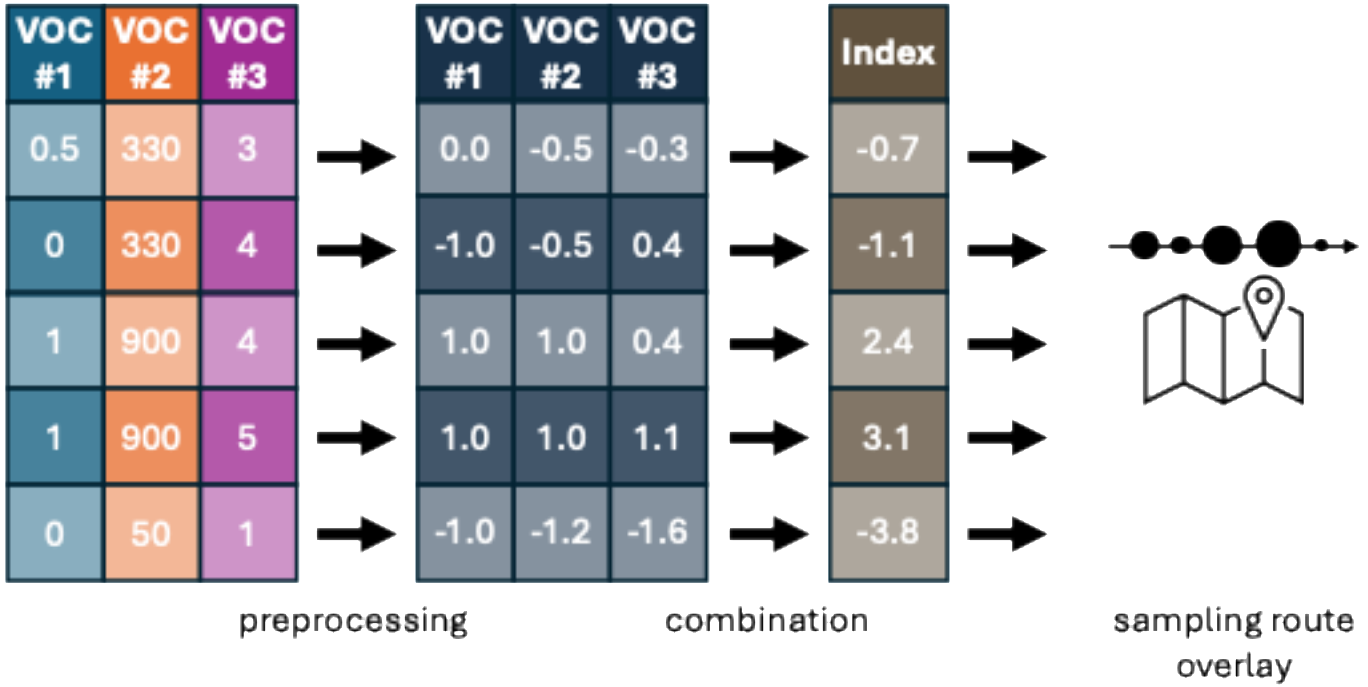


- VOCs detected at elevated concentrations in fenceline communities were more associated with “very high –low” acute inhalation toxicity and genotoxicity risks than the VOCs at elevated concentrations in the non-fenceline background
- Highlights large data gap in acute inhalation toxicity of VOCs

Intermediate Summary

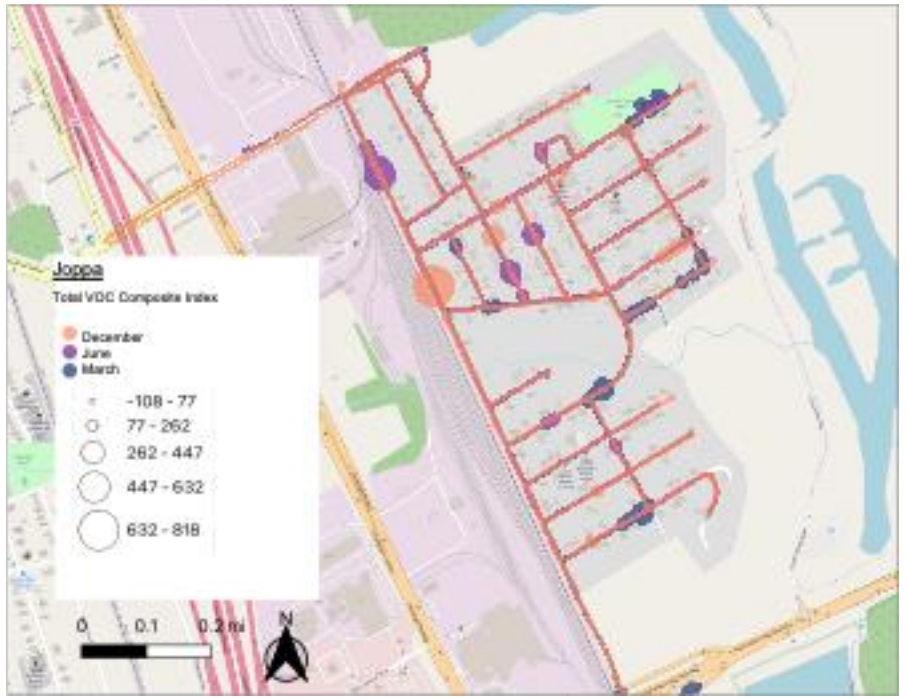
- Targeted Analysis:
  - Small increases in average BTEX concentrations in fenceline communities compared to non-fenceline
  - **Large variation in BTEX concentrations observed in fenceline communities compared to non-fenceline**
- NTA:
  - Fenceline communities may not always have a greater number of VOCs present
  - More VOCs in fenceline communities may have higher VOC concentrations
  - Elevated VOCs in fenceline communities are more associated with adverse health effects

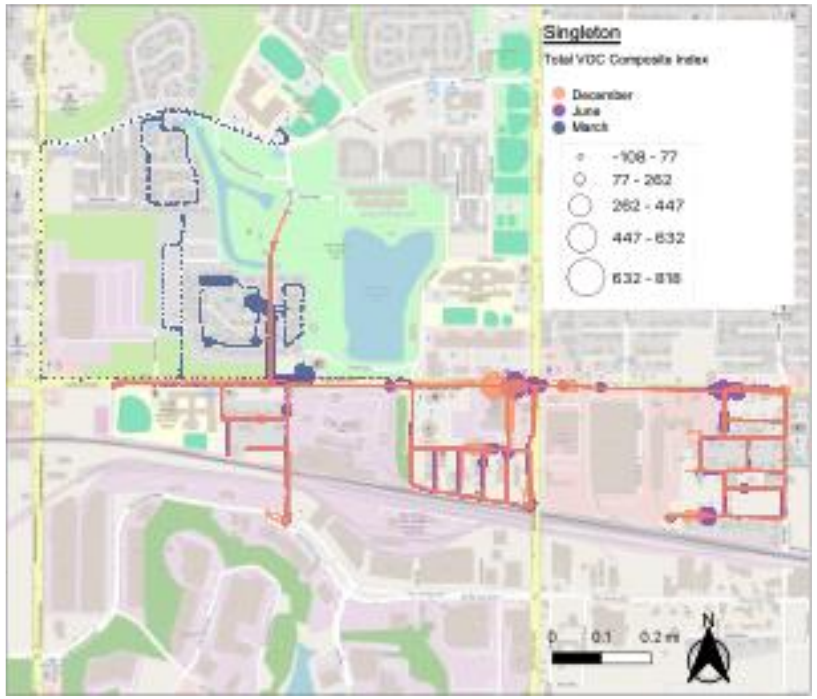
Can We Visualize Hyper-Local Hotspots of VOC Emissions Within Communities?



- Example paradigm of the z-score transformation, indexing, and overlay of indexed z-scores for the total VOCs along each sampling route.

Spatial Analysis Highlights Total VOC Hotspots





- Elevated composite index values (hotspots) are reflected by increasing circle diameter.
- Analysis reveals the frequent presence of hyper-local hotspots in total VOC concentration in the fenceline communities but not in the non-fenceline community
- Hotspots in fenceline communities are not correlated with wind direction and negatively correlated with wind speed

Summary

- Stationary monitoring for BTEX only may not capture the full picture
- Communities near industrial operations may face elevated VOC exposure and health risk
- Mobile VOC monitoring with NTA better informs a community's total VOC profile
- NTA can provide a more comprehensive assessment
- Localized VOC hotspots may be the bigger issue
- Increased frequency of monitoring would improve community VOC assessment

Future Directions

- Why does Singleton stand out?
- Is it the industry or other community factors i.e. tree coverage, green space, etc.?
- How does time of day impact results?
- Mobile VOC monitoring with NTA better informs a community's total VOC profile
  - Increased frequency of monitoring would improve community VOC assessment
- Stationary monitoring for BTEX only may not capture the full picture
  - NTA can provide a more comprehensive assessment
  - Localized VOC hotspots may be the bigger issue

Reporting Back

- Staying in touch with community leaders
  - Monthly meetings
  - Participation in town hall events
  - Report back documentation for community members

AIR QUALITY EVALUATION IN DALLAS NEIGHBORHOODS

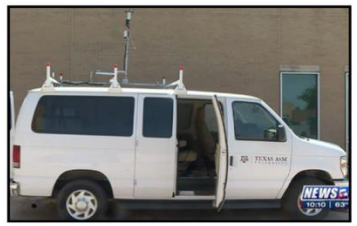
This document describes a portion of the results of the application of mobile air monitoring to evaluate local air quality in environmental justice neighborhoods in Dallas County, TX.

Introduction

There is a high prevalence of industrial manufacturing surrounding the environmental justice communities, Singleton and Joppa, in Dallas County, TX. Communities near industrial manufacturing face elevated concentrations of air pollutants.

Mission

1) Provide accurate concentrations of air pollutants in the communities neighboring these manufacturing facilities.
2) Communicate how these concentrations compare to safe exposure levels.



What Did We Do?

- Performed mobile air monitoring with the mRAPID van *(pictured above)*
- mRAPID air monitoring was conducted across Dallas communities:
  - *Highland Park, Joppa, and Singleton*
- mRAPID air monitoring occurred on various days between Dec. 2022 - Mar. 2024 to collect data over time
- mRAPID air monitoring estimated the concentration of the following air pollutants, volatile organic compounds (VOCs):
  - *benzene, toluene, ethylbenzene, xylene*

Background

The major air pollutants that we will cover in this report are Benzene, Toluene, Ethylbenzene, and Xylene, commonly referred to as BTEX. Common sources of BTEX are:

- **Benzene**
  - *Outdoor Sources:* Industrial and vehicle emissions, gas stations
- **Toluene**
  - *Outdoor Sources:* Vehicle emissions
- **Ethylbenzene**
  - *Outdoor Sources:* Vehicle emissions, gas stations, gasoline, industrial waste water
- **Xylene**
  - *Outdoor Sources:* Industrial and vehicle emissions

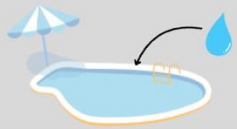
These compounds are associated with poor health conditions based on the duration and the concentration of exposure. These health conditions include:

- Respiratory effects such as difficulty breathing and nose and throat irritation
- Neurological effects such as dizziness, headaches, or even brain damage
- Anemia
- Some cancers such as leukemia

***More information about BTEX can be found on back**

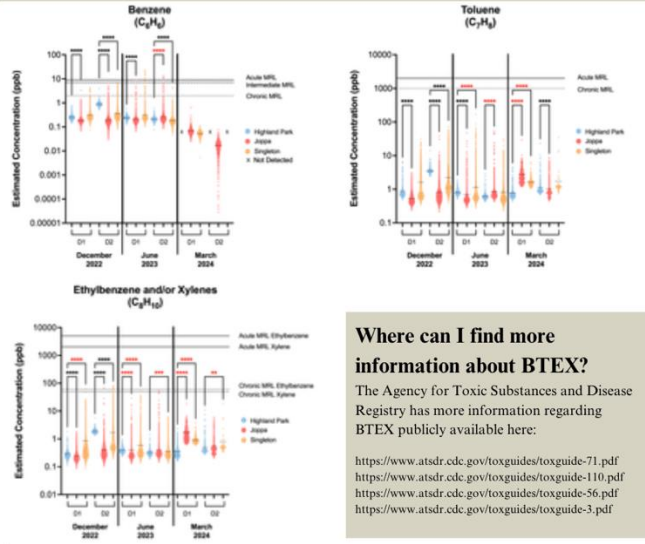
All concentrations here are measured in parts per billion by volume (ppbv). How much is that?

1 ppbv is like a single drop of water in an entire swimming pool. However, even these small amounts of pollutants can affect health.



What Results Did We Find?

Air was monitored in each community for 30 min - 2 hrs. The graphs show the estimated concentration of each compound detected on each sampling day across seasons. Each community is represented by an individual color. The concentration of compounds is demonstrated on an logarithmic scale which increases by a factor of 10. The average estimated concentration of BTEX were within safe exposure levels in each community. In December, BTEX concentrations in Joppa and Singleton were mostly comparable or lower (black asterisks) than concentrations in a community without industrial manufacturing (Highland Park). In June and March, BTEX concentrations in Joppa and Singleton were comparable or mostly higher (red asterisks) than concentrations in Highland Park. In Joppa and Singleton there were short periods of time (seconds) in December and June where benzene, ethylbenzene, and/or xylene concentrations reached or exceeded established Minimal Risk Levels (MRLs).



Where can I find more information about BTEX?

The Agency for Toxic Substances and Disease Registry has more information regarding BTEX publicly available here:

https://www.atsdr.cdc.gov/toxguides/toxguide-71.pdf
https://www.atsdr.cdc.gov/toxguides/toxguide-110.pdf
https://www.atsdr.cdc.gov/toxguides/toxguide-56.pdf
https://www.atsdr.cdc.gov/toxguides/toxguide-3.pdf

What Are the Implications?

-The Joppa and Singleton communities are more frequently exposed to a greater range in BTEX concentrations than a community that doesn't neighbor multiple industrial manufacturing facilities.

-While the BTEX concentration range is much larger, majority of the measurements are within safe exposure limits that are not associated with causing health risks

What's Next?

-Ongoing efforts are investigating additional VOCs to generate a more comprehensive characterization of the air quality in these communities.

Acknowledgements and Research Funding

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- Environmental Justice Data Fund (Dallas)

The team: Natalie Johnson, Navada Harvey, Alex Svetlik, Olivia Lampe, Eva Vitucci, Kaylyn Dinh, and Tate Matthews
Not pictured: Ally Sprague, Oladayo (Dayo) Oladeji

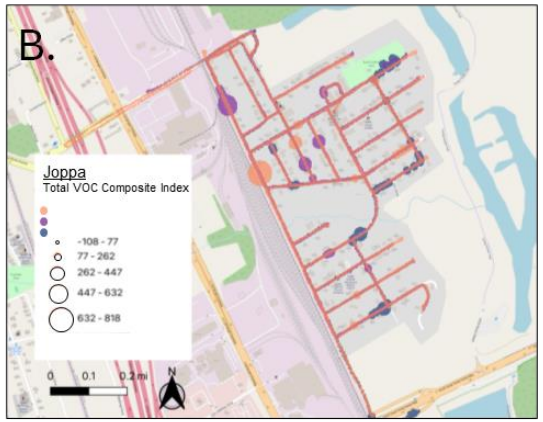
TEXAS A&M UNIVERSITY SUPERFUND RESEARCH CENTER

Community Partners in Dallas

NIH National Institute of Environmental Health Sciences
Your Environment. Your Health.

Extra Slides


A.
Highland Park
Total VOC Composite Index
-108 - 77
77 - 262
262 - 447
447 - 632
632 - 818
0 0.1 0.2 mi
N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Joppa
Total VOC Composite Index
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447 - 632
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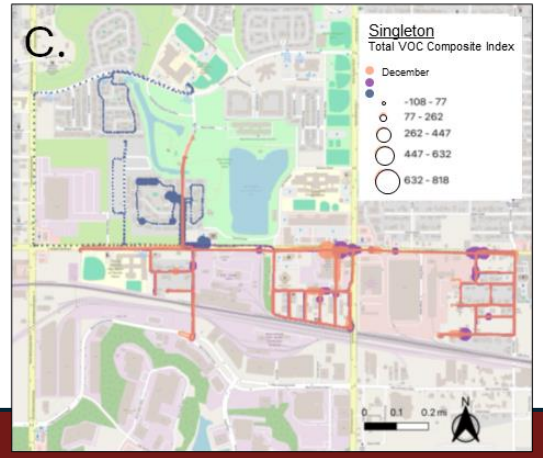
C.
Singleton
Total VOC Composite Index
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262 - 447
447 - 632
632 - 818
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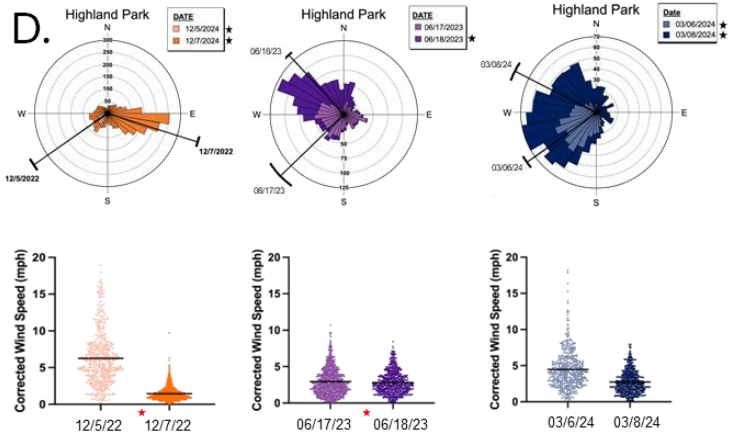
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06/17/2023
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06/18/23
Highland Park
Date
03/06/2024
03/08/2024
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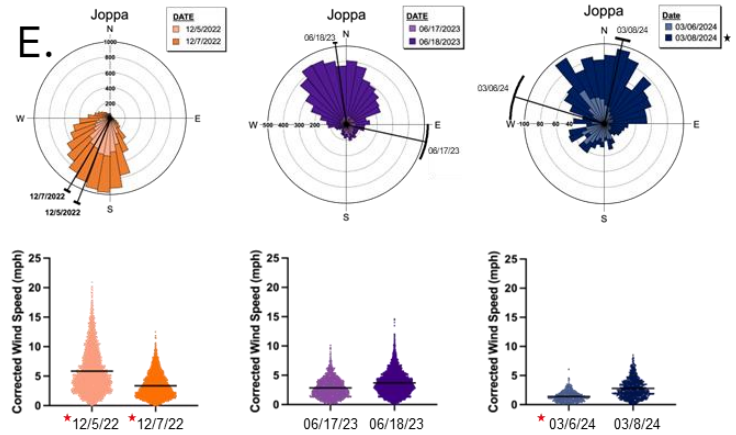
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Corrected Wind Speed (mph)
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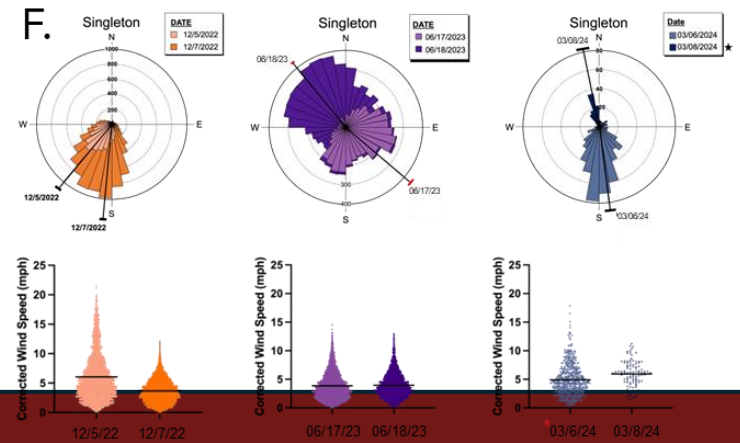
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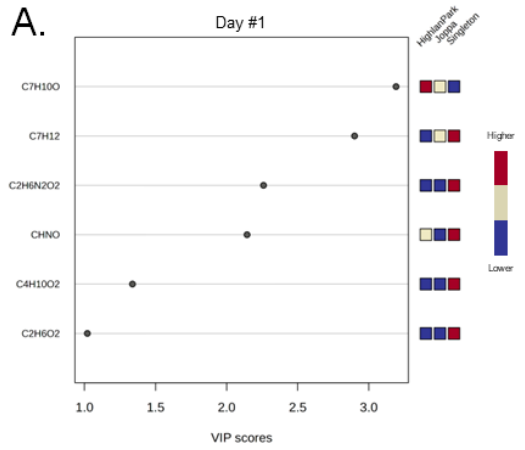
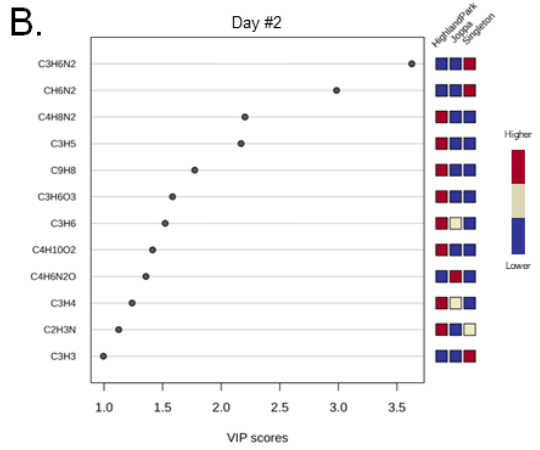
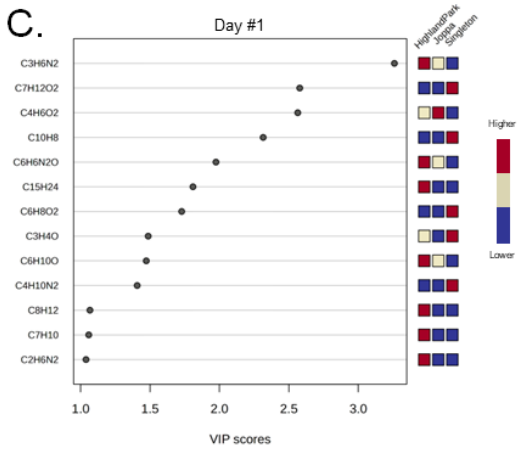
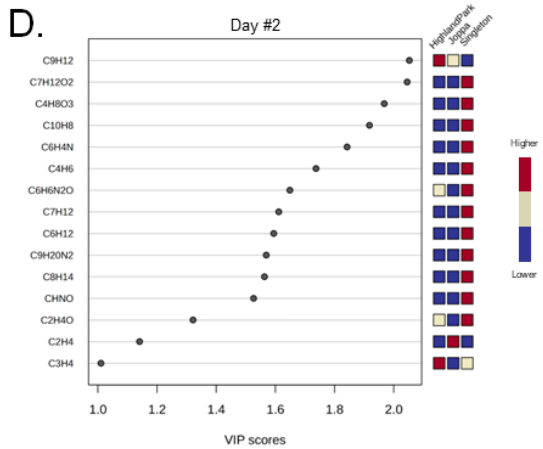
December '22





June '23





March '24