Using IoT To Measure Air Quality

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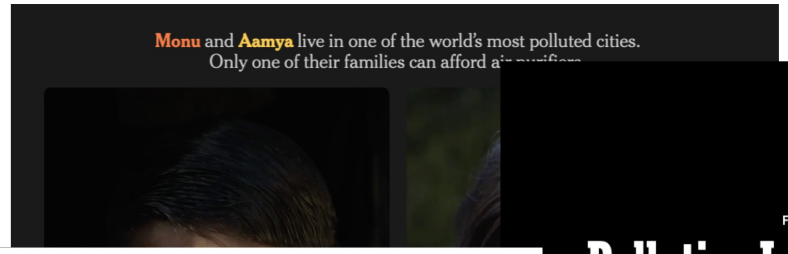
Outline

- Inspiration For Study
- Introduction/Problem
- Methodology
- Sensor Prototype
- Testing
- Results
- Next Steps
- Let’s Talk Data
- Q&A

Inspiration For Study



In Landmark Ruling, Air Pollution Recorded as a Cause of Death for British Girl

Legal and environmental experts hailed a coroner's ruling that, for the first time in Britain, directly linked a specific person's death to air pollution.

Ella Adoo-Kissi-Debrah in a photo shown by her mother, Rosamund. Hollie Adams/Agence France-Presse — Getty Images

FEATURE

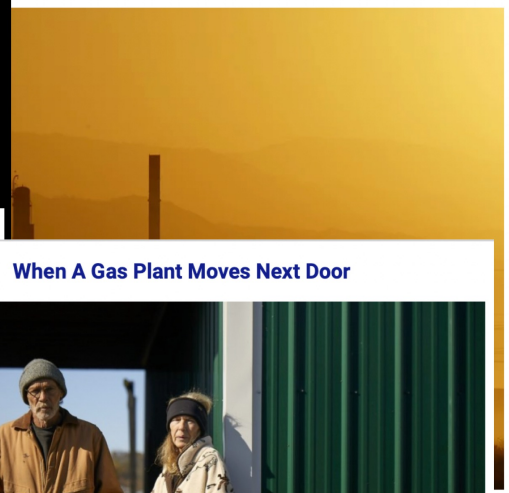
Pollution Is Killing Black Americans. This Community

E.P.A. Chief Vows to 'Do Better' Protect Poor Communities

The Environmental Protection Agency on Wednesda announce stepped-up enforcement and monitoring t disadvantaged communities struggling with polluted water.

SCIENCE

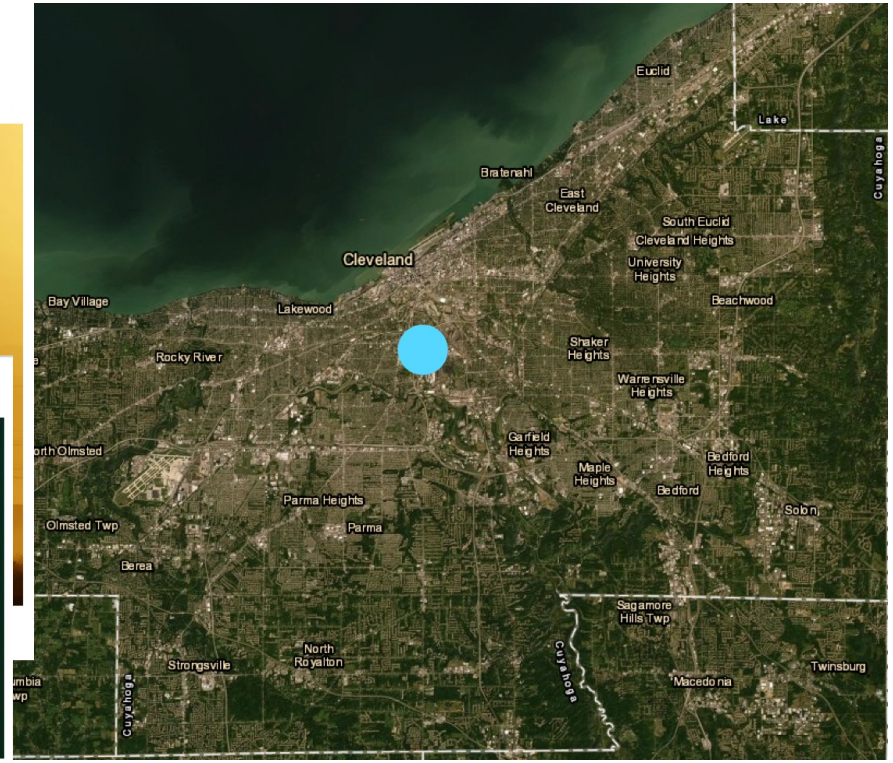
Air Quality Disparities Persist Despite Overall Gains



When A Gas Plant Moves Next Door

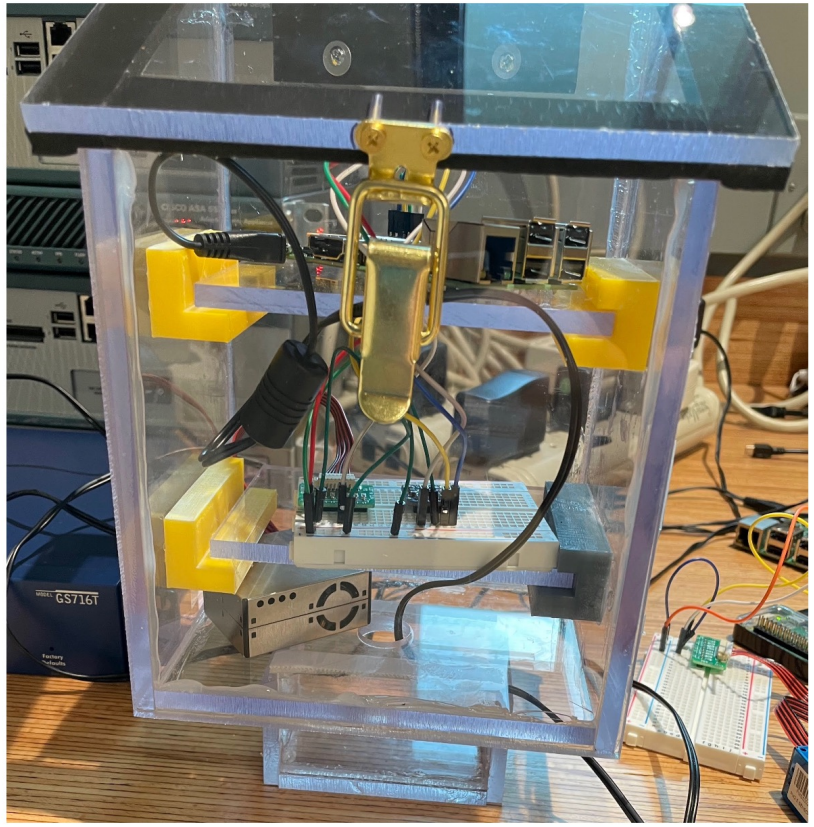
Kevin and Marlene Young's land sits beside the future Guernsey Power Station. [Kevin Kopanski for The Allegheny Front]

News By Julie Grant, The Allegheny Front SUPPORT PROVIDED BY



Introduction/Problem

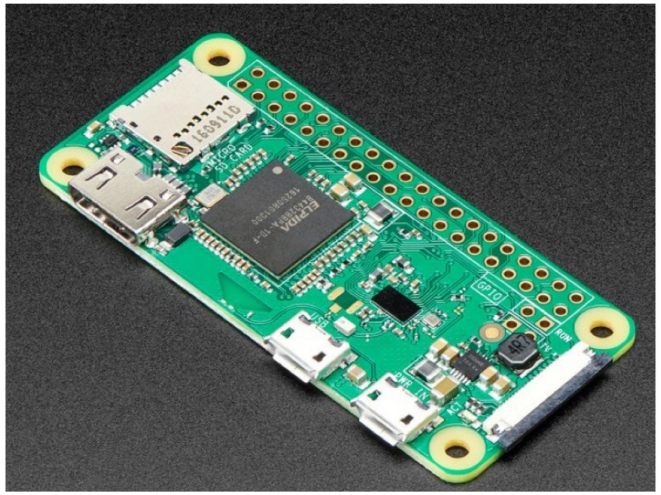
- Fine-Grained to increase urban reporting
  - Only one PM 2.5 sensor for Cleveland/Cuyahoga
- Aim for historically redline communities
  - Research shows these areas are affected the most
  - Corresponds with Steel Mill Pollution in Cleveland
- Enclosure to protect hardware from the elements
  - Clear housing to show what's inside
    - Mistaken for surveillance

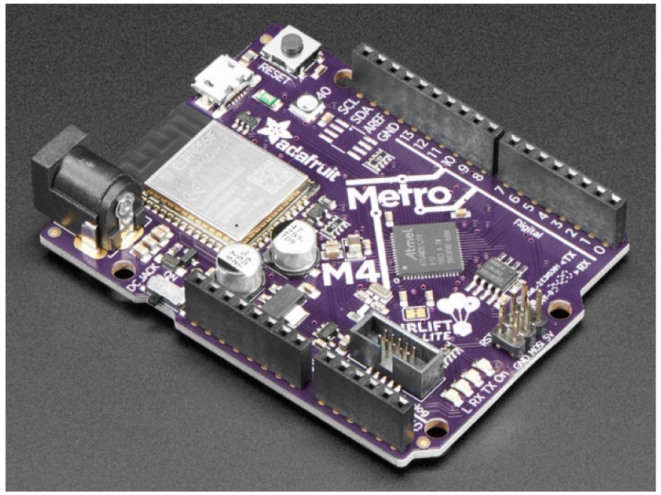


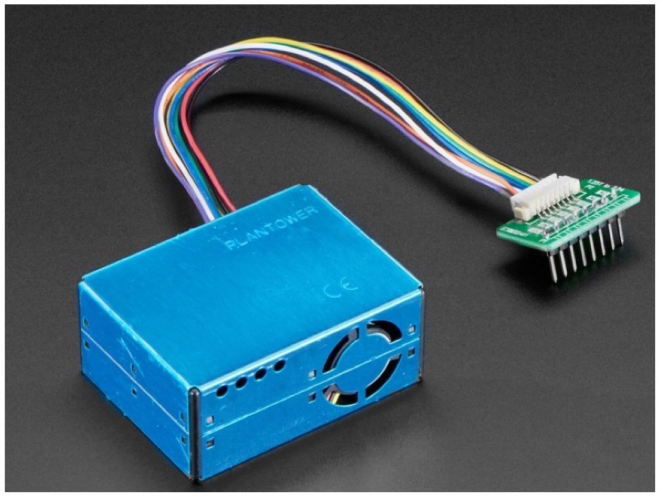
Methodology

- Low-cost
  - less cost to build = more sensors
  - Encourage $30-40 sensor instead of COTS $200+ sensor
  - Partnered with PCsForPeople
- Low-power
  - Power is expensive and limits placement of sensors
  - Encourage community partners (Slavic Village)
- Generally Available boards
  - Raspberry Pi/Arduino
  - Easy for younger computing students to learn
- Accuracy
  - 6 feet about ground (adult human level)
  - Previous research papers show that although low-cost sensors may not be as precise as Purple Air, EPA or COTS sensors, it accurately shows general trends in air quality

Sensor Prototype







Version 1 & 2: Raspberry Pi Zero W/4B, Adafruit Metro M4 Airlift, Plantower PMS5003 PM Sensor

(Current) Version 3: Raspberry Pi Pico W with Plantower PMS5003 PMSensor

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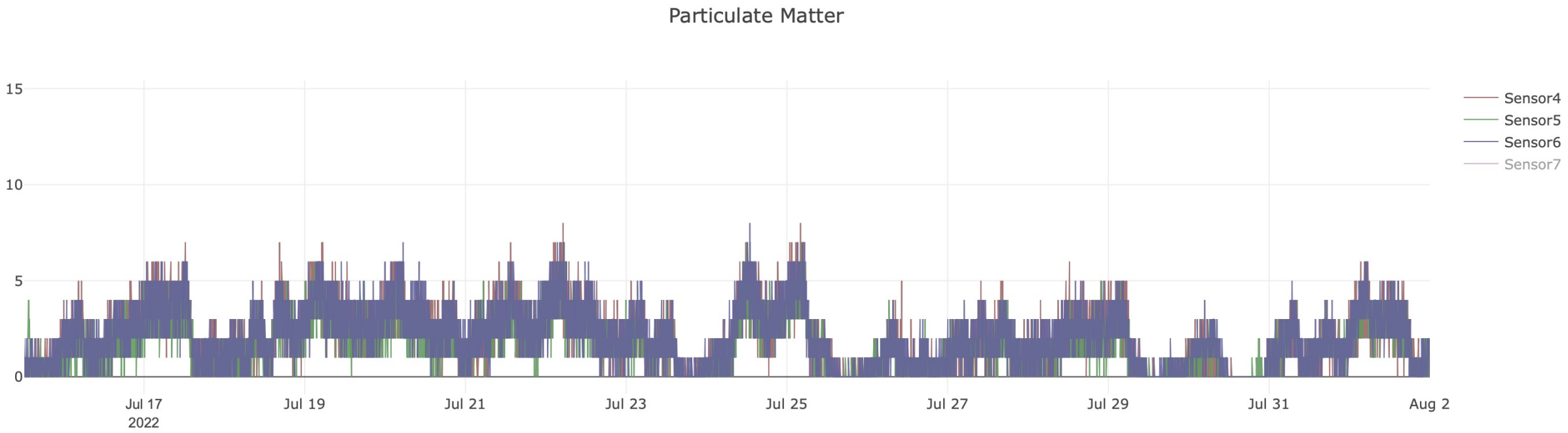
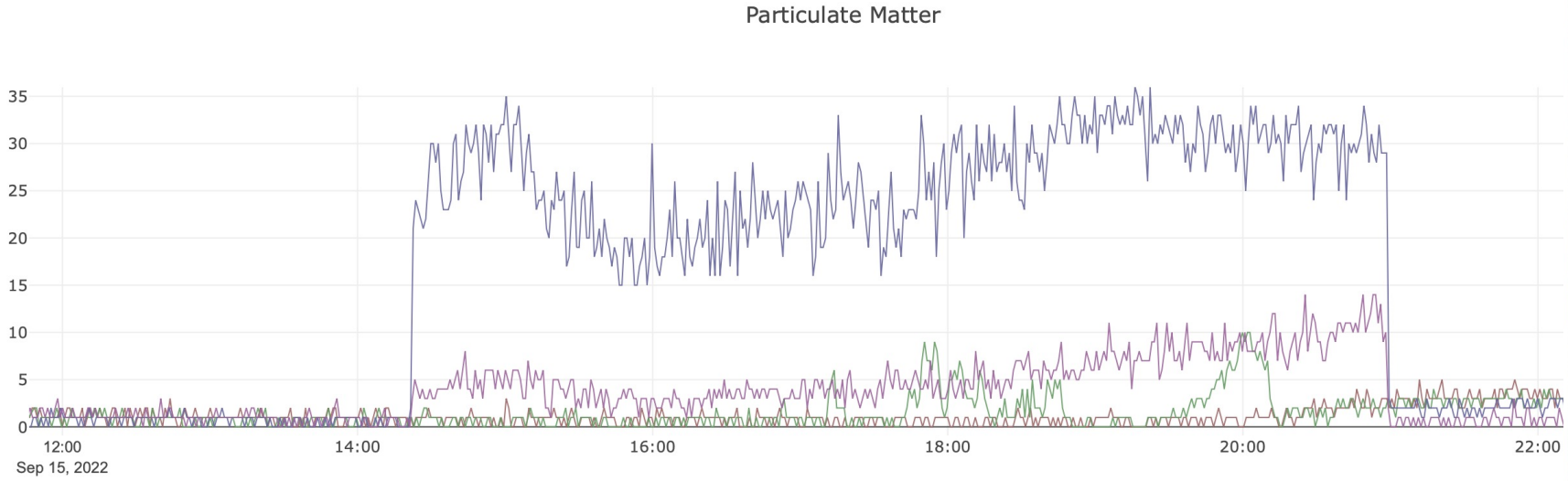
Testing

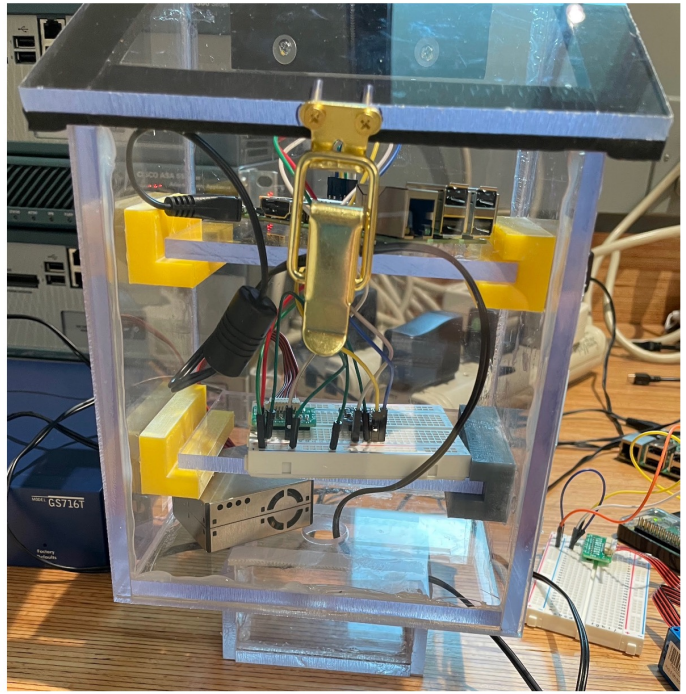
- Testing in Controlled Lab Environment showed similar PM 2.5 readings



Testing

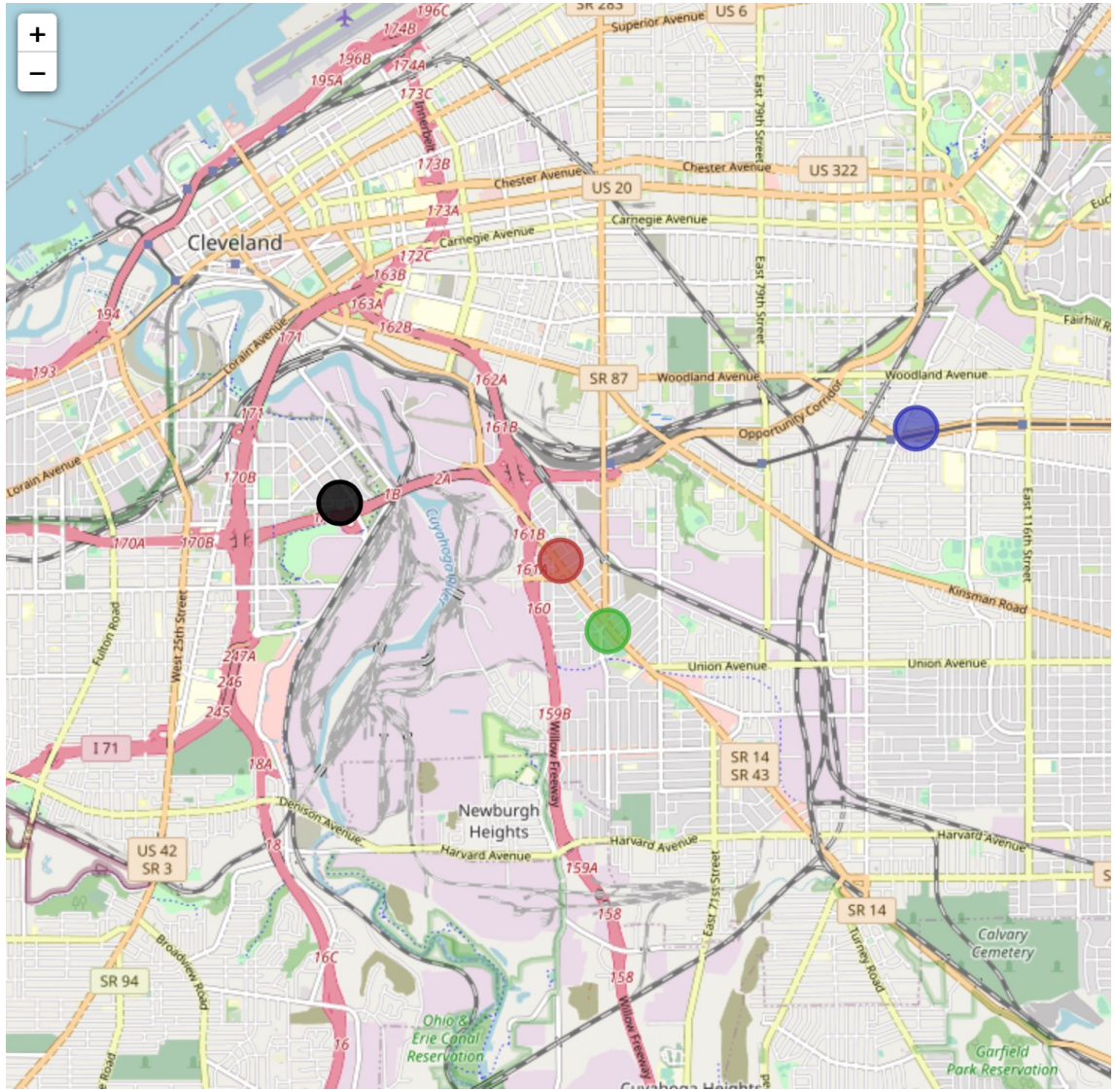
- Testing in the Engineering Students' enclosure gave linear offset





Testing

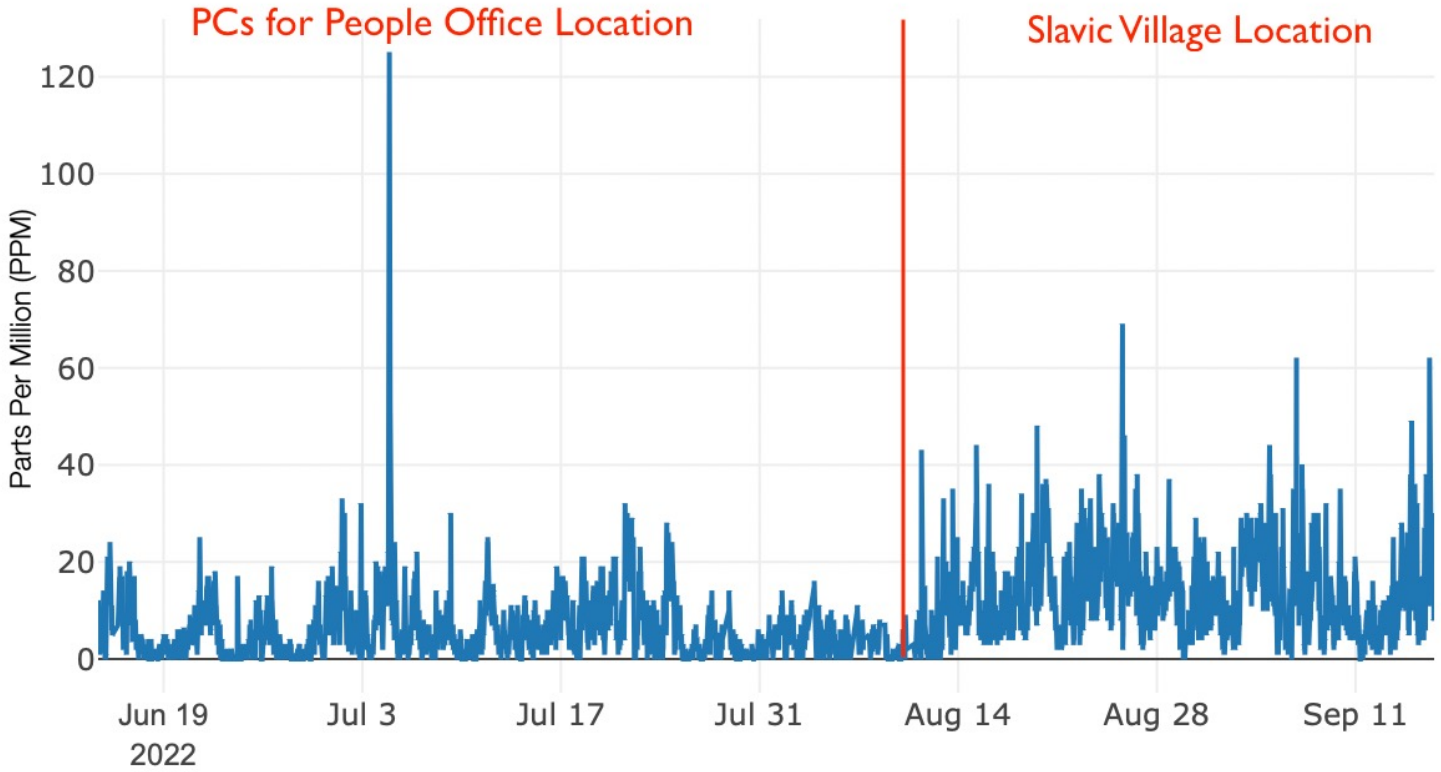
- Pilot study with PCsForPeople around Cleveland



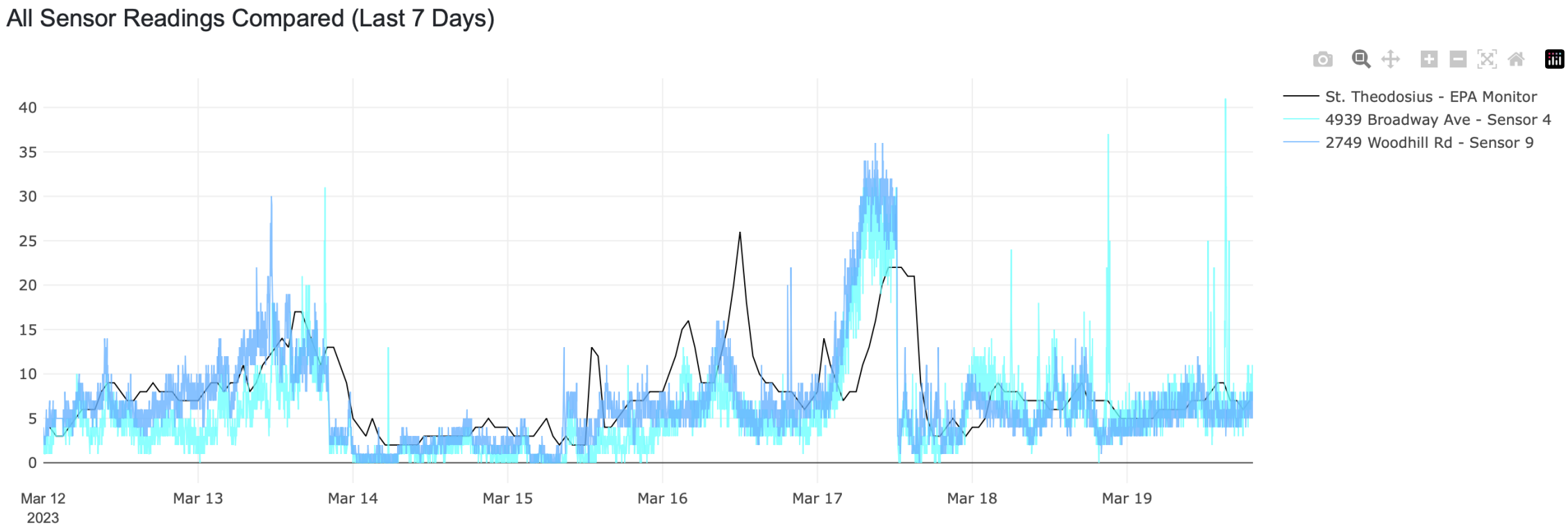
Deployment Results

- Trends matched expectations
  - Cleveland firework show
  - Daily rush hour
- 2x difference <4 miles
  - Steel Mill pollution
- Similar readings to EPA
  - More fine-grained
  - Focused on Urban Environment
  - Showed Steel Mill pollution
- Publicly available data
  - https://mopsdev.bw.edu/~bkrupp/aq/view.php

Poster Accepted into ACM SenSys 2022



Results


All Sensor Readings Compared (Last 7 Days)
St. Theodosius - EPA Monitor
4939 Broadway Ave - Sensor 4
2749 Woodhill Rd - Sensor 9
40
35
30
25
20
15
10
5
0
Mar 12
2023
Mar 13
Mar 14
Mar 15
Mar 16
Mar 17
Mar 18
Mar 19

Next Steps

- Build K-12 CS AQ Curriculum
- Implement Opportunistic Sensing
- Pilot Study at BW
- Increase Sensors around Cleveland

Let’s Talk Data!

- How can we have the K-12 Curriculum incorporate Data Analysis?
- Data matches general trends, despite the accuracy being error-prone
- Basically… what should we do with this data?

Questions?

Thank You!

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