SENSOR STORIES

How sensors can help individuals and communities understand and reduce exposure to air pollution

What we will do today

1) Learn about **particle pollution**

2) Explore **how sensors are used** by individuals & community groups

3) Develop an *Action Plan* for using an air sensor in <u>your</u> community

What is particle pollution?

- **Mixture** of solid particles and liquid droplets in air

- Also called **particulate matter** or **PM**

Why are we talking about particle pollution?

Particle pollution…

- can be **invisible**

- is **all around us**

- is linked to **negative health effects**

- can be **measured** and **reduced**

Sources of particle pollution

Natural

Pollen

Wildfires
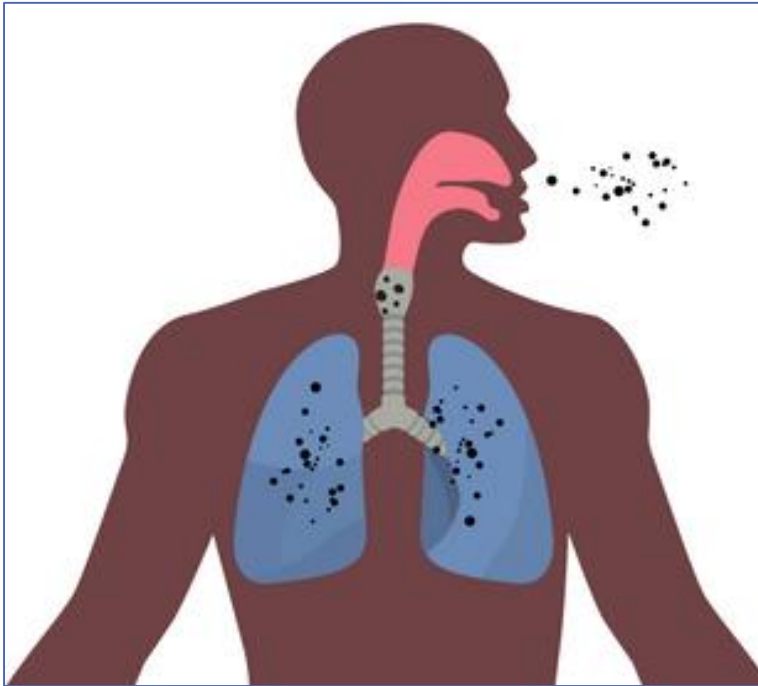
Outdoor Activities

Cars, trucks, buses

Factories and power plants

Indoor Activities

Cooking

Candle burning

Particulate matter (PM) comes in different sizes

HUMAN HAIR
50-70 μm
(microns) in diameter

● PM2.5
Combustion particles, organic
compounds, metals, etc.
< 2.5 μm *(microns)* in diameter

FINE PARTICULATE MATTER

● PM10
Dust, pollen, mold, etc.
<10 μm *(microns)* in diameter

90 μm *(microns)* in diameter
FINE BEACH SAND

www.epa.gov

Why does particle size matter?

- **Smaller** particles are **more easily inhaled**

- PM2.5 can be **inhaled deeply** into the lungs

- Particle concentration, length of exposure, and breathing rate also influence how much PM gets into your body

How does PM exposure affect health?

PM exposure causes:

- Eye, nose and throat irritation

- Worsening of heart and lung disease

- Premature death in people with heart or lung disease

Some people have **no symptoms** even when PM is **at unhealthy levels**.

Who is at greatest risk?

People with…

- Cardiovascular disease
- Lung disease, such as asthma and COPD
- Diabetes

Children

Elderly adults (65 years and older)

People of lower socio-economic status

What amount of PM2.5 is safe?

National Ambient Air Quality Standards (NAAQS): PM2.5

Daily (24 hour) average concentration	**35 µg/m³**
Annual average concentration	**12 µg/m³**

The Environmental Protection Agency set these standards to **protect public health**, including sensitive populations.

The standards are for **outdoor air**; there are **no PM standards for indoor air**.

PM2.5 pollution is monitored by the EPA

Active PM2.5 Monitors (US EPA Air Data Air Quality Monitors)
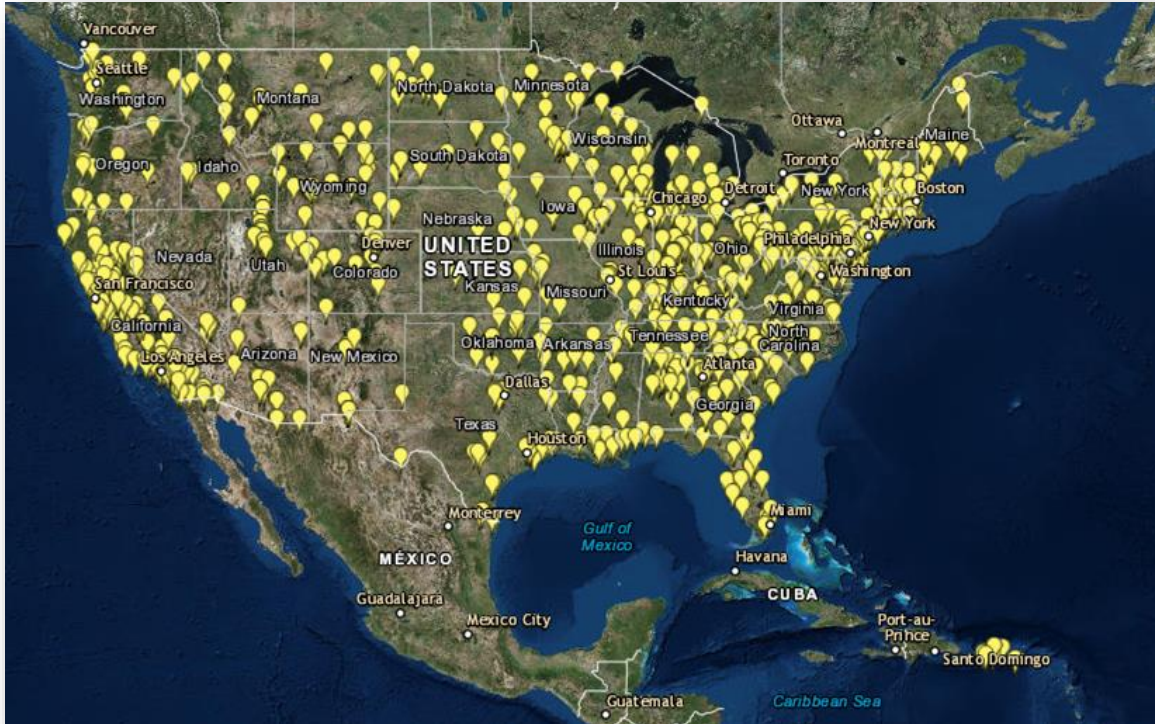
Where are PM2.5 monitors in my state?
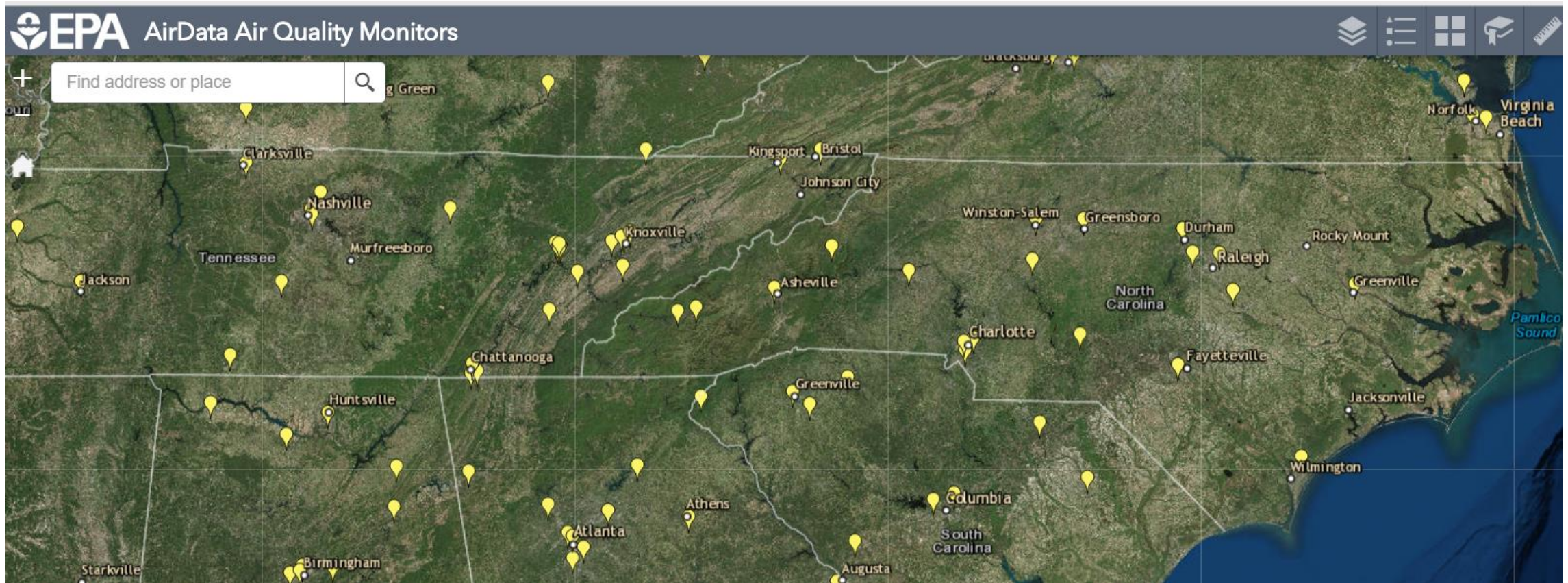
Air Quality Index (AQI)

PM and other pollutants are **monitored daily** to calculate the AQI

The AQI tells you how clean the air is & **informs actions** to protect health

| Air Quality Index	Who Needs to be Concerned?	What Should I Do?
Good 0-50	It's a great day to be active outside.	
Moderate 51-100	Some people who may be unusually sensitive to particle pollution.	**Unusually sensitive people:** *Consider reducing* prolonged or heavy exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. **Everyone else:** It's a good day to be active outside.
Unhealthy for Sensitive Groups 101-150	Sensitive groups include **people with heart or lung disease, older adults, children and teenagers.**	**Sensitive groups:** *Reduce* prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. **People with asthma** should follow their asthma action plans and keep quick relief medicine handy. **If you have heart disease:** Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your heath care provider.
Unhealthy 151 to 200	**Everyone**	**Sensitive groups:** *Avoid* prolonged or heavy exertion. Move activities indoors or reschedule to a time when the air quality is better. **Everyone else:** *Reduce* prolonged or heavy exertion. Take more breaks during all outdoor activities.
Very Unhealthy 201-300	**Everyone**	**Sensitive groups:** *Avoid all* physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. **Everyone else:** *Avoid* prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.
Hazardous 301-500	**Everyone**	**Everyone:** *Avoid all* physical activity outdoors. **Sensitive groups:** Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.

How can I find out about PM2.5 in my area?

- EPA's AirNow website enables users to see the **AQI for their area**
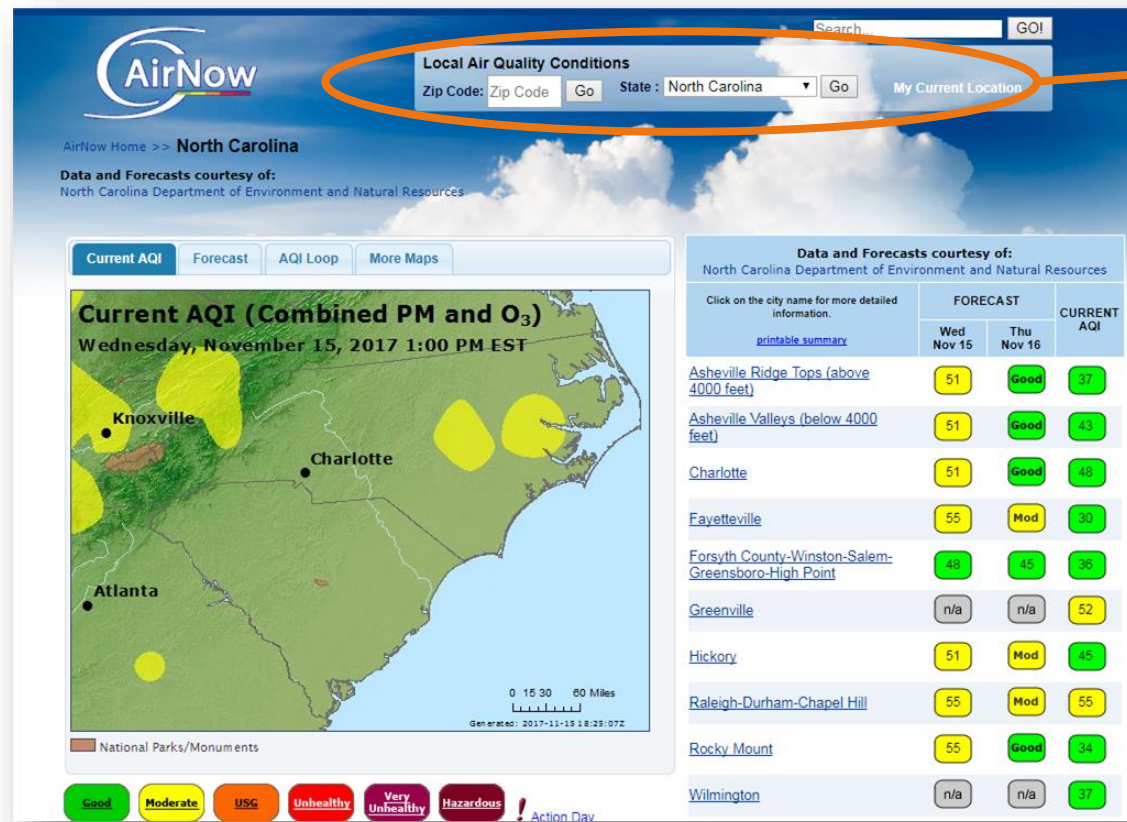
Search for local air quality conditions

https://airnow.gov/

How can I find out about PM2.5 in my area?
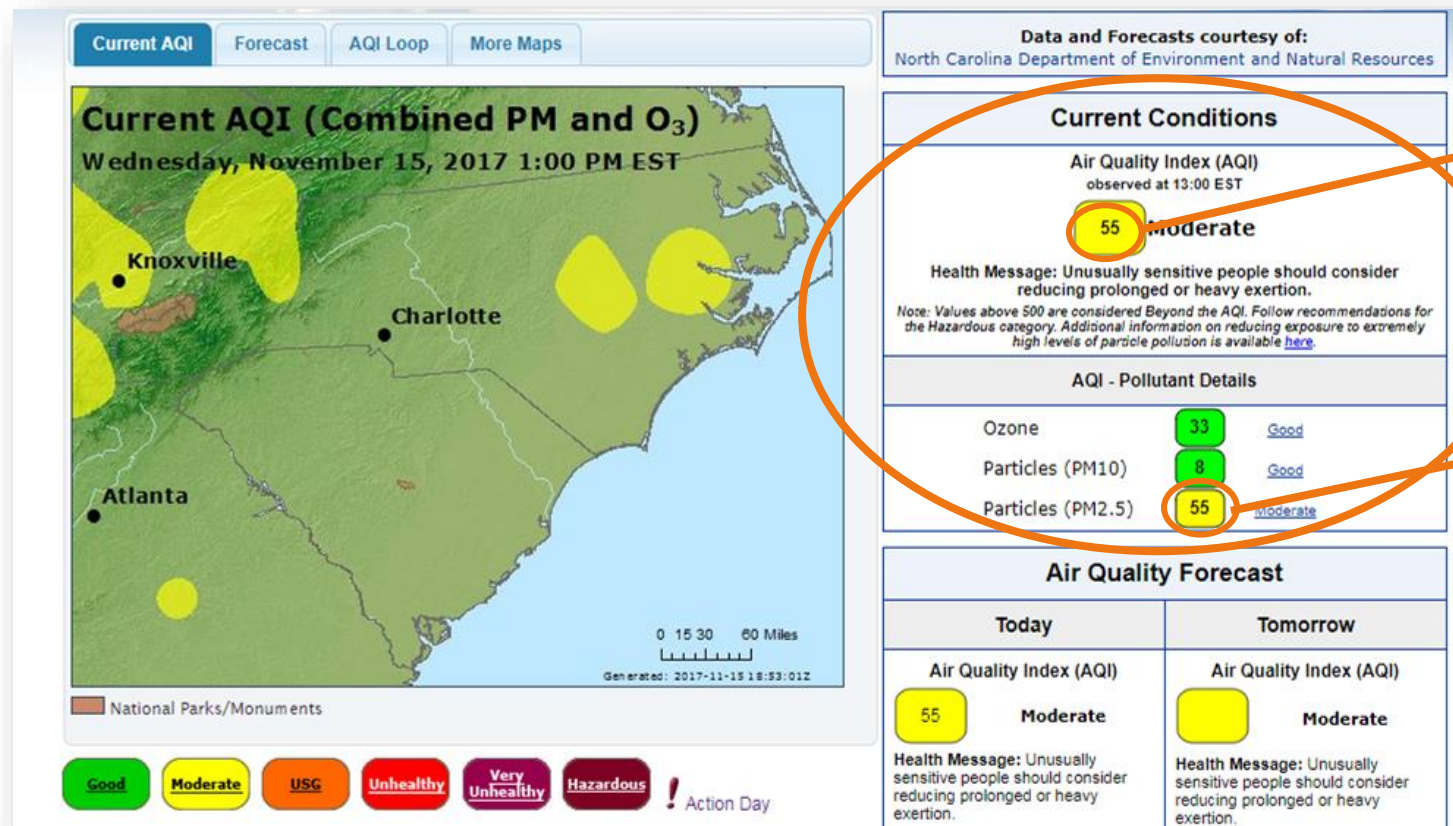
Today's AQI

Details for PM$_{2.5}$

https://www.airnow.gov/

If we can access AQI, why use a PM sensor?

AQI **may not reflect local conditions** and **does not address indoor air quality**

Sensors can help:

- **Educate others** about air quality
- Monitor **personal exposure** indoors and outdoors
- Identify **local sources** of air pollution
- Facilitate **community action** to reduce exposure

https://www.specksensor.com/

Sensors can **reveal patterns** of exposure

Kennedy

Lisa
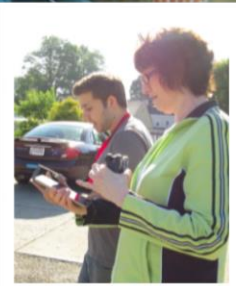
Donna

Marta

& **inform actions** to reduce exposure

Sensors help **educate others**
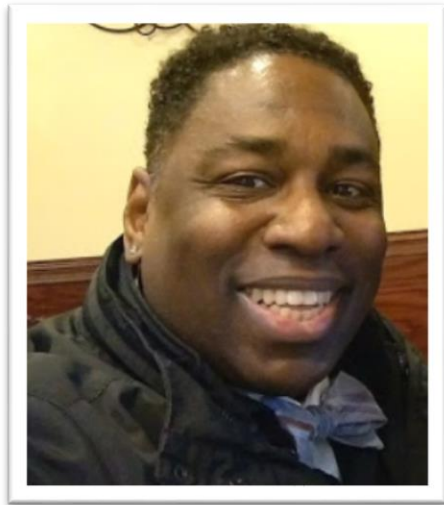
Kennedy teaches middle and high school students **about air quality**

- Needed **reliable, easy to use, low-maintenance** sensor

- Wanted to monitor air quality in **varied locations**

- Used Dylos sensors to measure **small and large particles**

Data helped students "see" air pollution

Kennedy's students discovered **varied PM2.5 concentrations**

- Saw peaks at **intersections** and close to **sources of PM**
- Recorded highest readings inside **subway stations**, where thousands of people wait for trains every day

"When trains entered the subway station, the sensor readings got all spikey."

Sensors inform **personal choices**

Lisa wondered whether PM exposure **worsened her family's health**

- Husband and daughter had **health problems potentially affected by PM exposure**

- Wanted to monitor air quality in **varied locations**, outdoors and indoors

Using a portable sensor to estimate outdoor PM
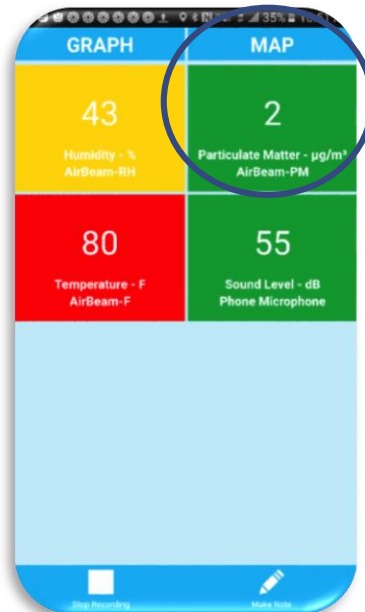
AirBeam Sensor + **Android App** = **PM2.5 readings** + **Map and graph**
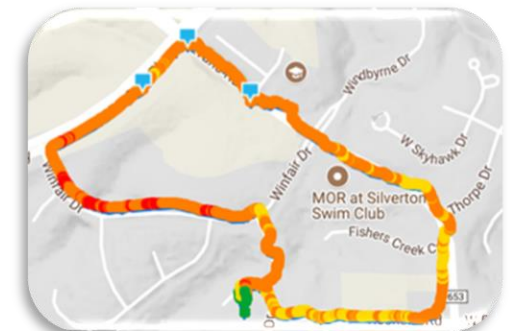
What are some potential sources of particle pollution Lisa might encounter on her walks?

School bus

Yard waste

Backyard fire pit

Traffic
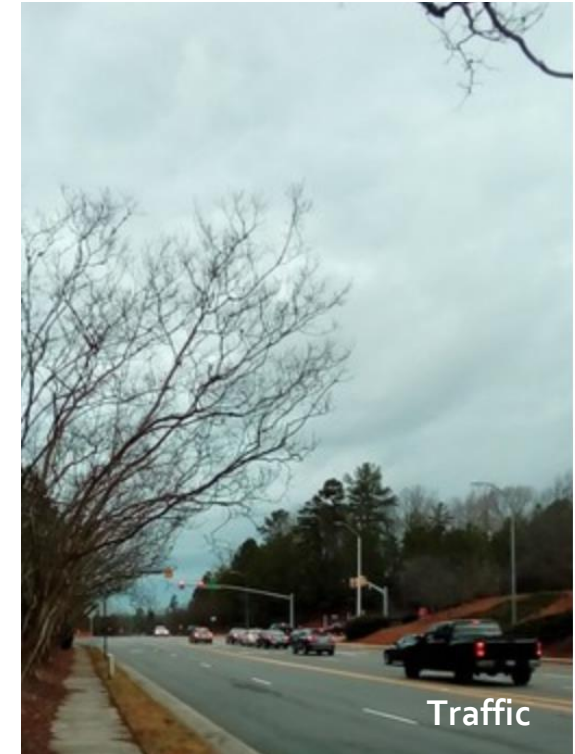
What might explain this area of high PM2.5?
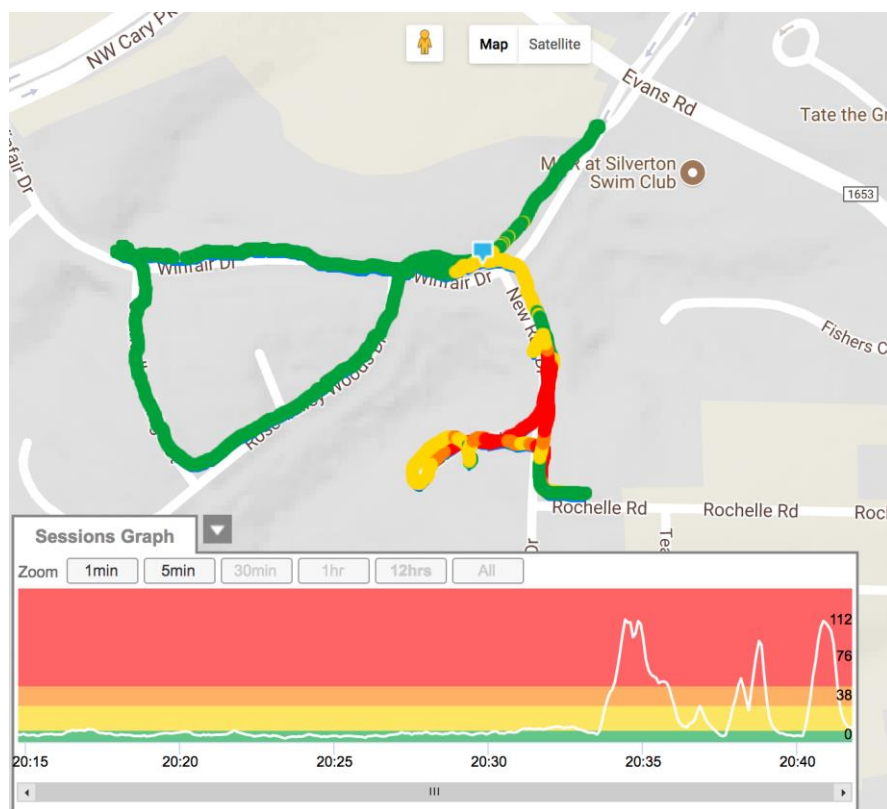
Air Beam Data
Peak PM: 112 µg/m³
    Friday, Jan 26, 2018
AQI: Good
    Evening: 25 minute walk
    Temp: 53°F
    Relative humidity: 35%
    Sky: after dark, not windy

Wood smoke can impact PM2.5 levels
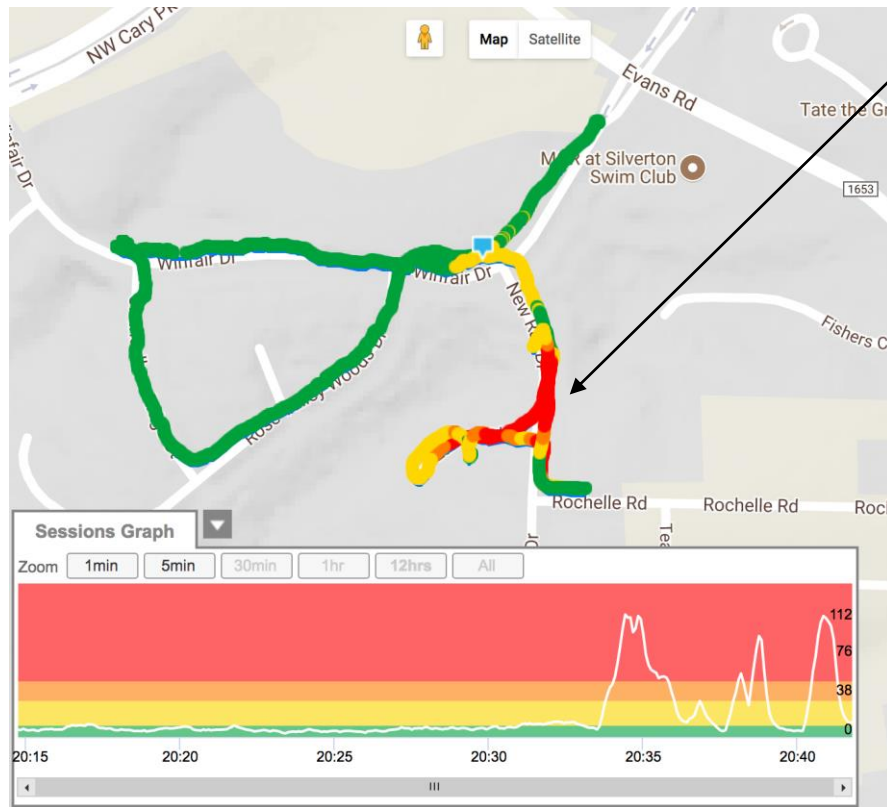
Strong smell of **wood smoke** during Friday evening walk

Data informed choices to reduce PM exposure

PM2.5 varied:

- **By time of day** and **weather conditions**
- Higher near roads with **heavy traffic** and sources of **wood smoke**

Lisa and family **spend less time near these sources** at times with high readings
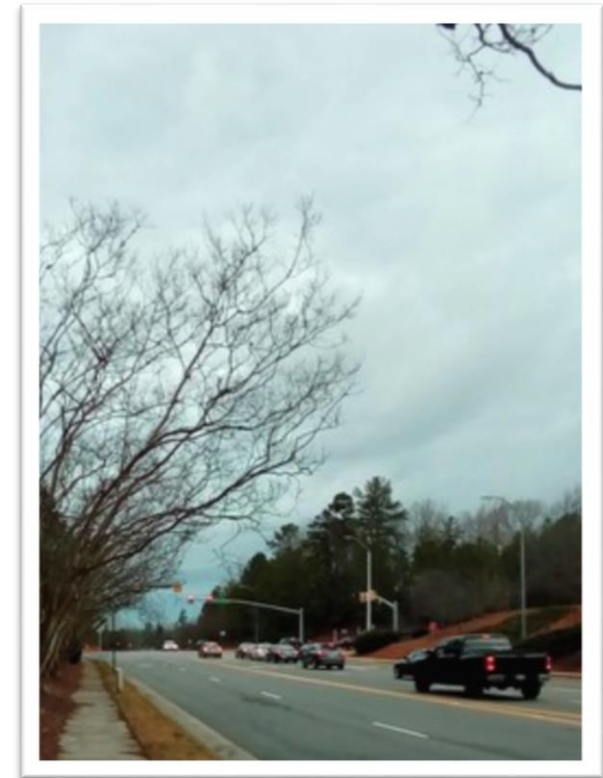
Sensors help **investigate local sources**
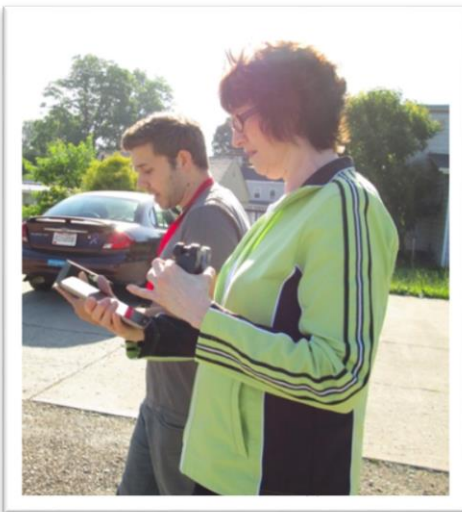
Donna wondered whether BBQ restaurant was **harming neighbors' health**

- Neighborhood got **smoky** when BBQ was cooking

- Wanted **fast measurements** that **could be shared with others**, including media

Data identified restaurant as local PM source
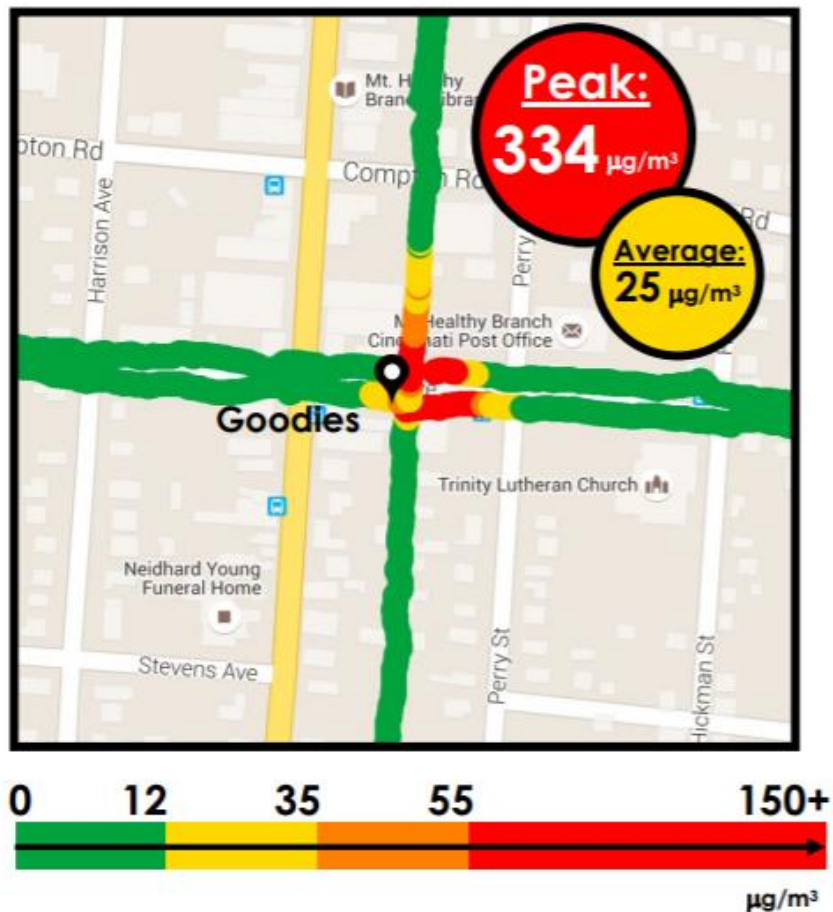
Chronic exposure to these levels **may pose a health risk**, especially for sensitive populations

"The sensor helped us draw attention to this local source of air pollution."

Interpreting sensor readings

334 μg/m³

1-minute particle pollution (PM₂.₅) readings

Not for regulatory purposes

Low 0-29 μg/m3	Enjoy your outdoor activities.
Medium 30-69 μg/m3	If medium readings continue (for an hour or more), use the Air Quality Index to plan outdoor activities.
High 70 – 499 μg/m3	You may be near a source of particle pollution like dust, smoke or exhaust. Check the Air Quality Index to plan outdoor activities.
Very High ≥500 μg/m3	You may be near a source of particle pollution like dust, smoke or exhaust. Check the Air Quality Index to find out if you should adjust outdoor activities. Very high readings may mean the sensor is not working properly.

These readings prompted the Health Department to collect its own data

https://www.epa.gov/air-sensor-toolbox/what-do-my-sensor-readings-mean-sensor-scale-pilot-project

Sensors **enable community action** to reduce exposure

Marta and other parents were concerned about **PM exposure in the schoolyard**

- Neighborhood is near a **major port** that hosts a **large container terminal**

- **High volume** of **daily truck traffic**

Trucks Waiting to Enter Port

School

Marta's House

"I worry that exhaust from idling trucks is increasing PM around my daughter's school, possibly affecting some children's breathing."
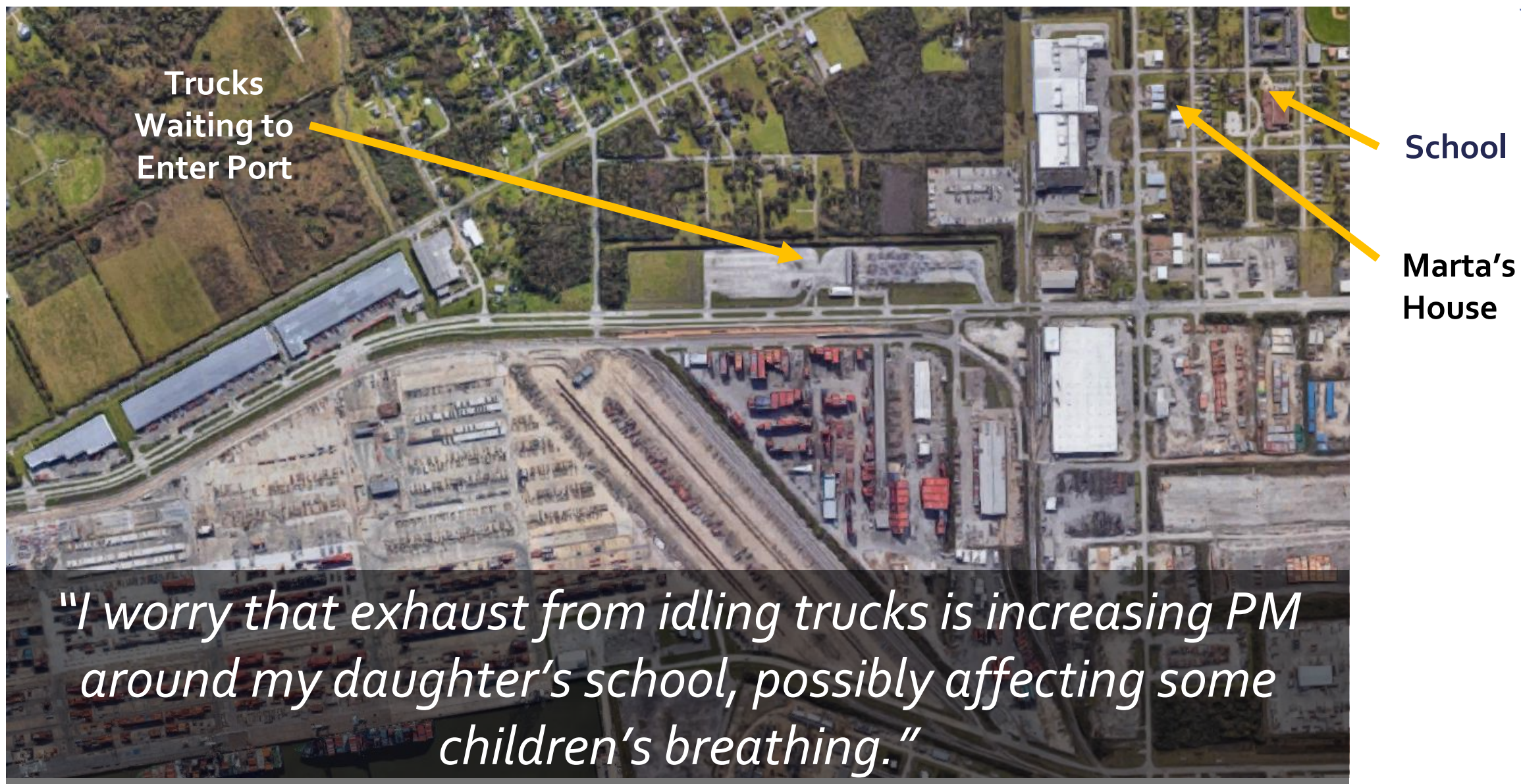
Using a stationary indoor sensor to estimate PM

Speck sensor with data display
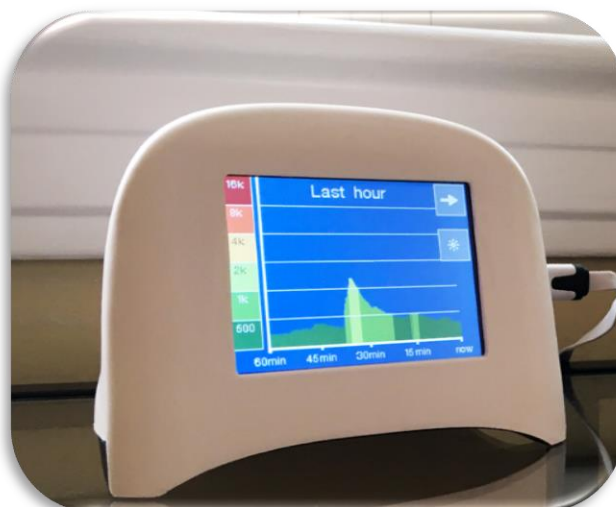
Online display dashboard (map and graph)

Data demonstrated daily PM patterns

There were **increases in** PM2.5 in homes around the school **during times of heavier truck traffic** at the port
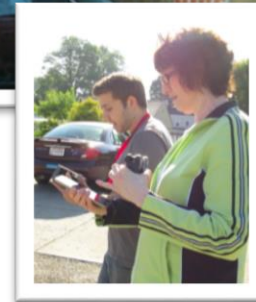
Sensors **reveal patterns** & **inform action**
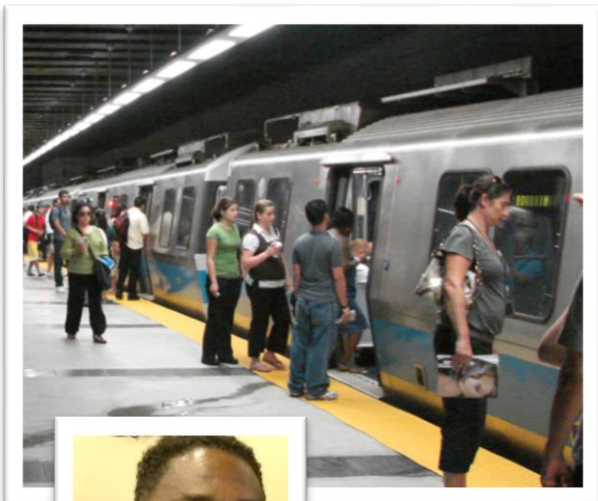
**Educate about particle pollution**
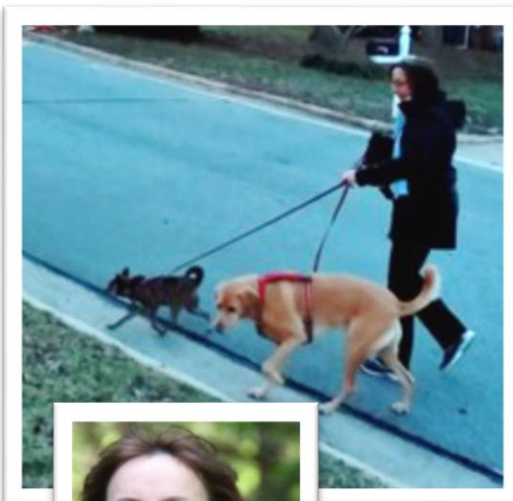
Understand personal exposure

Identify local sources & advocate for cleaner air

Limits of sensor results

- **Differ from AQI** values
  - 1-minute sensor readings ≠ 24 hr averages (as reported on the AQI)

- **Can be inaccurate** due to
  - Environmental factors, such as temperature & high humidity
  - Low PM2.5 concentrations
  - Calibration (or "tuning") error
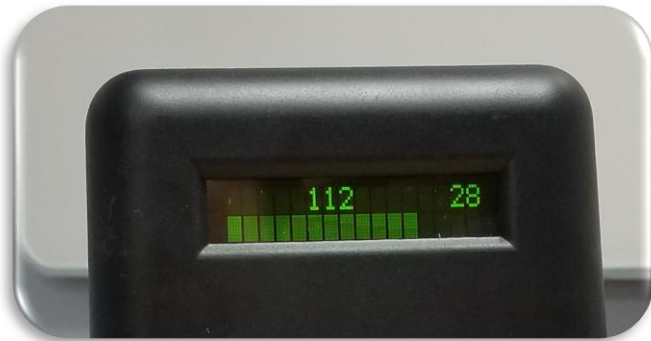
Despite limitations, sensors can show patterns and help identify questions for further exploration.

Take action to reduce exposure to particle pollution

- **Be aware of PM sources**
  - **Eliminate sources** when possible or **minimize exposure**
- **Use AQI forecast** to plan outdoor activities
  - Remember: when **PM is high outdoors**, it may be **high indoors** – unless building has a good filtration system
- **Create partnerships** to address community-wide exposures
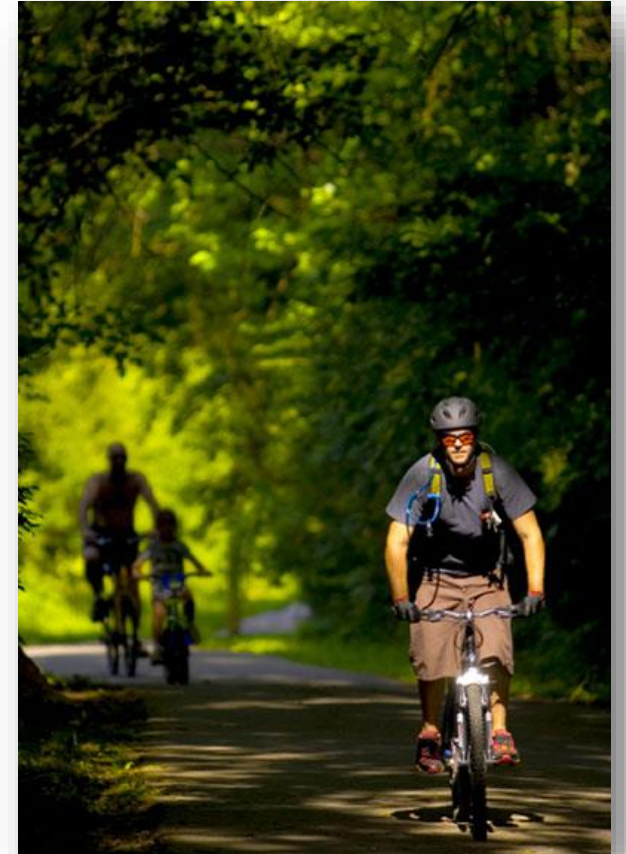
Acknowledgements

Project team

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- **Columbia University** Center for Environmental Health in Northern Manhattan and **West Harlem Environmental Action, Inc.** (WE ACT for Environmental Justice) (P30-ES009089)

What's YOUR sensor story?

Let's complete an action plan to find out

Each of us encounters
different mixtures of particle pollution

Exposure to car and truck exhaust

Exposure to cigarette smoke

Exposure to pollen and dust

Making an Action Plan | Questions to Ask

References

US EPA: Criteria Air Pollutants
https://www.epa.gov/criteria-air-pollutants#self

US EPA: Indoor Particulate Matter
https://www.epa.gov/indoor-air-quality-iaq/indoor-particulate-matter

US EPA: Particle Pollution and Your Patients' Health
https://www.epa.gov/pmcourse

National Academies of Sciences, Engineering, and Medicine: Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary
https://www.nap.edu/catalog/23531/health-risks-of-indoor-exposure-to-particulate-matter-workshop-summary

Air Sensor Toolbox
https://www.epa.gov/air-sensor-toolbox