



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 your 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

Outdoor Activities



Cars, trucks, buses

Indoor Activities



Cooking



Wildfires

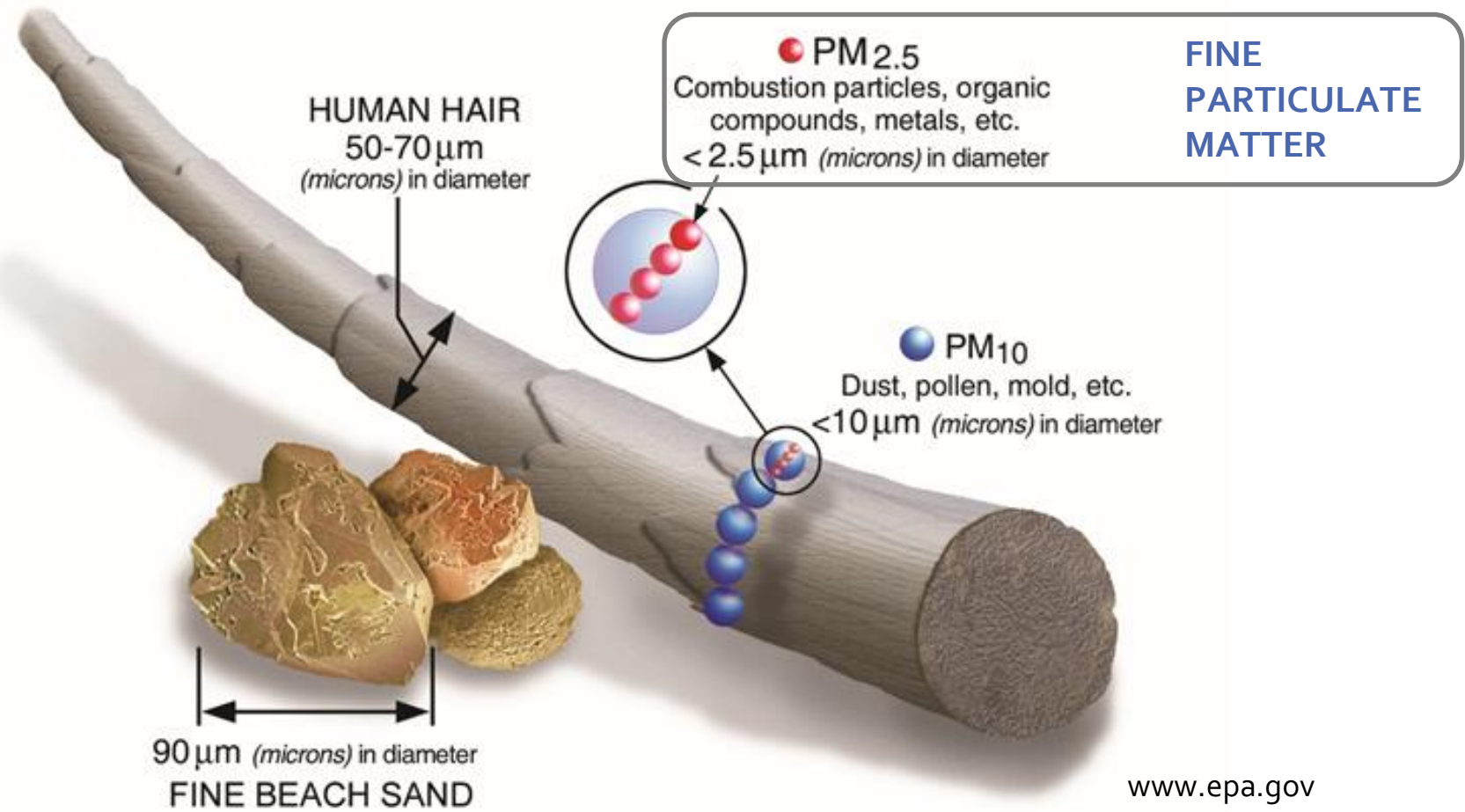


Factories and power plants



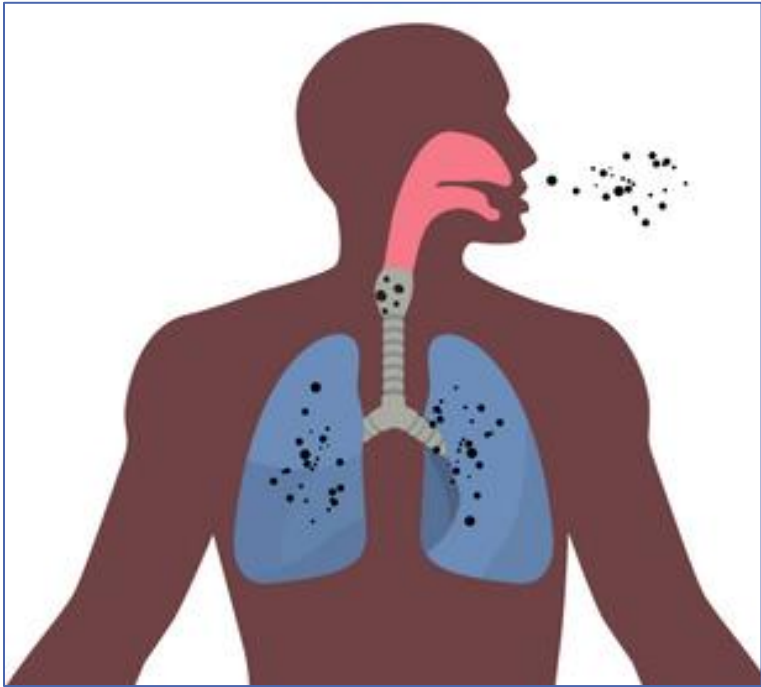
Candle burning

Particulate matter (PM) comes in different sizes



www.epa.gov

Why does particle size matter?



- **Smaller** particles are **more easily inhaled**
- PM_{2.5} 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

Older adults (65 years and older)

People of lower socio-economic status



What amount of PM_{2.5} is safe?

National Ambient Air Quality Standards (NAAQS): PM_{2.5}

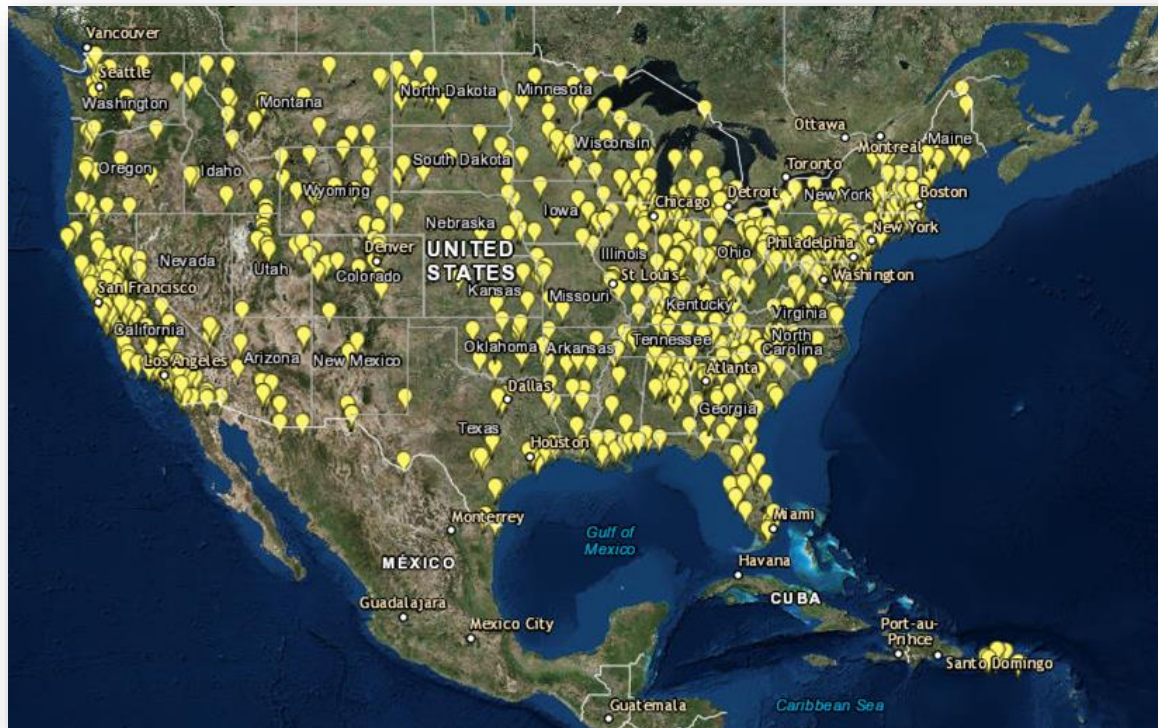
Daily (24 hour) average concentration	35 $\mu\text{g}/\text{m}^3$
Annual average concentration	9 $\mu\text{g}/\text{m}^3$

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

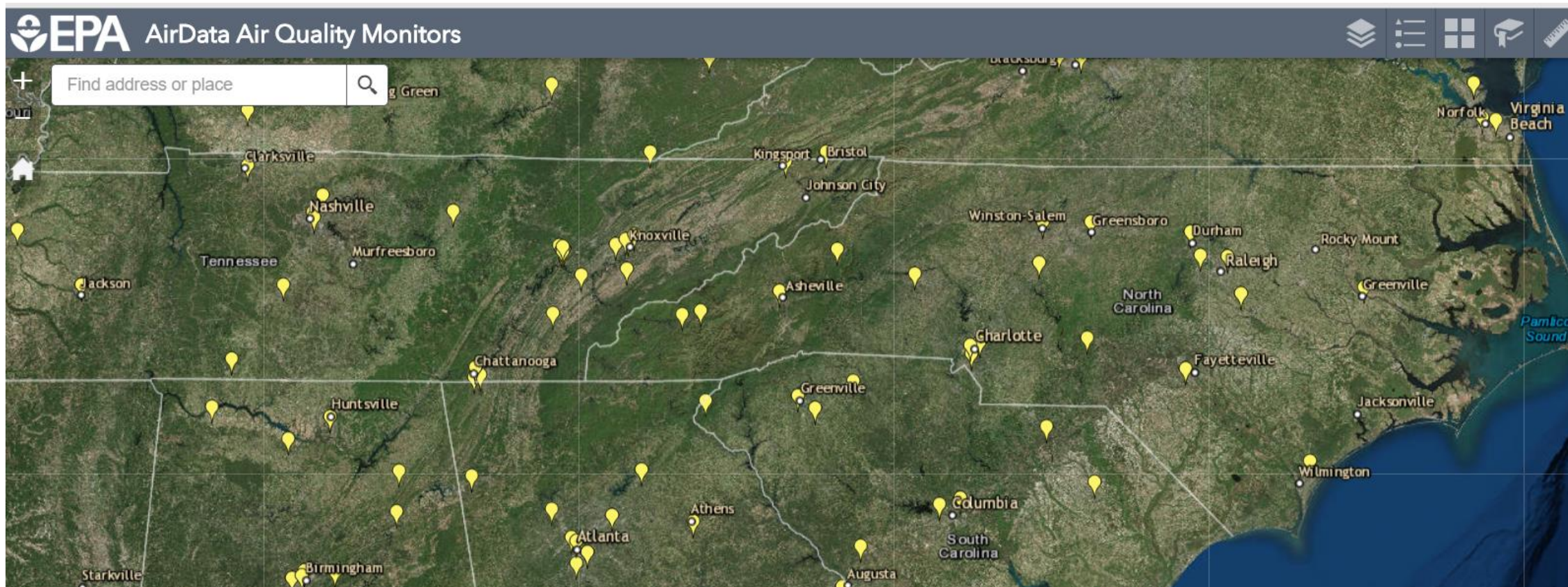
The standards are for **outdoor air**; there are **no PM standards for indoor air**.

PM_{2.5} pollution is monitored by the EPA

Active PM_{2.5} Monitors (US EPA Air Data Air Quality Monitors)



Where are PM_{2.5} monitors in my state?



Air Quality Index (AQI)

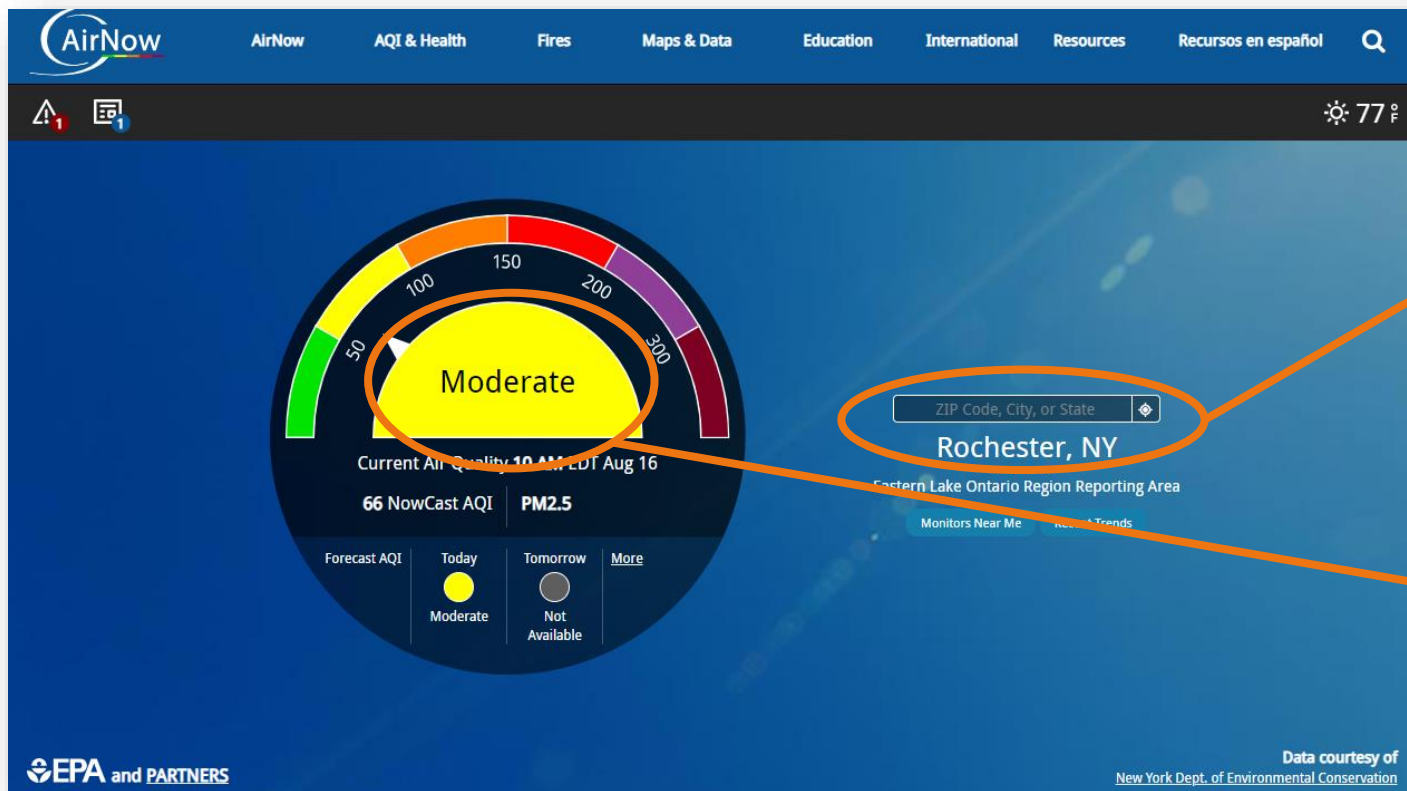
PM and other pollutants are **monitored daily** to calculate the AQI

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 making outdoor activities shorter and less intense. 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, pregnant people, minority populations, and outdoor workers.	Sensitive groups: Make outdoor activities shorter and less intense. It's OK to be active outdoors, but take more breaks. Watch for symptoms such as coughing or shortness of breath. People with asthma: Follow your asthma action plan and keep quick relief medicine handy. People with 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 health care provider.
Unhealthy (151-200)	Everyone	Sensitive groups: Avoid long or intense outdoor activities. Consider rescheduling or moving activities indoors.* Everyone else: Reduce long or intense activities. Take more breaks during outdoor activities.
Very Unhealthy (201-300)	Everyone	Sensitive groups: Avoid all physical activity outdoors. Reschedule to a time when air quality is better or move activities indoors.* Everyone else: Avoid long or intense activities. Consider rescheduling or moving activities indoors.*
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.*

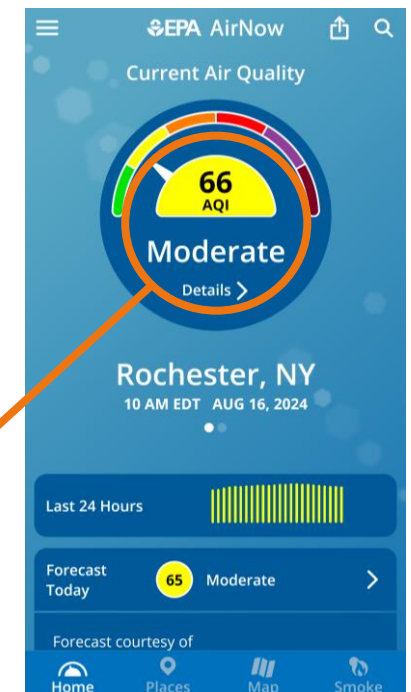
How can I find out about PM_{2.5} in my area?

- EPA's AirNow website and app enable users to see the **AQI for their area**



Search for
local air
quality
conditions

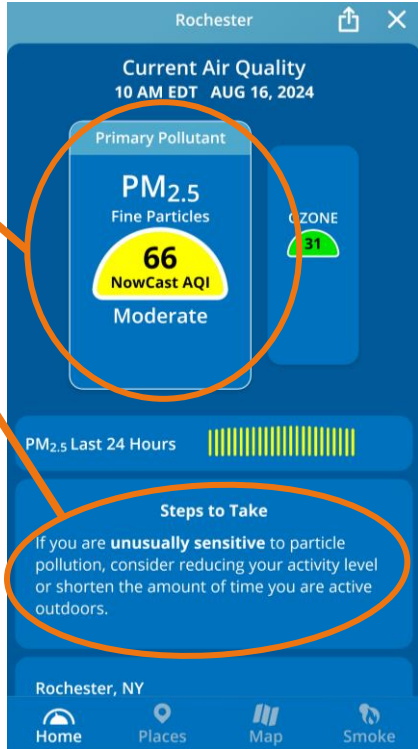
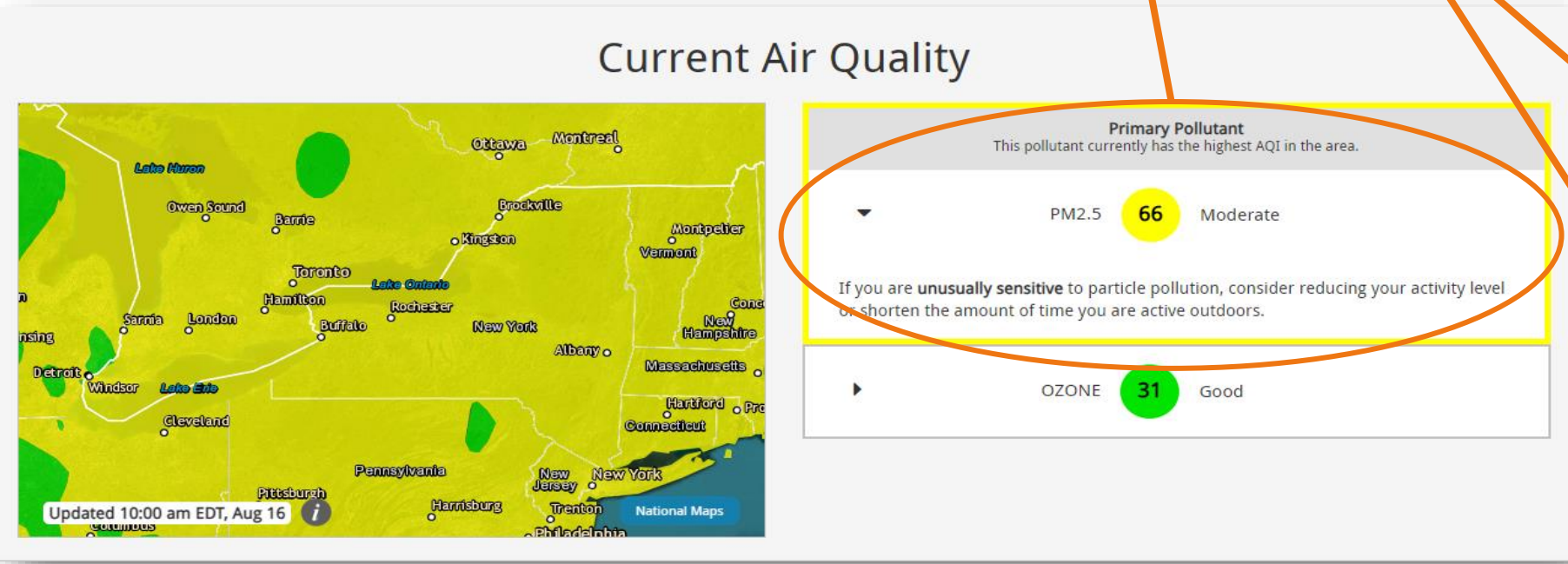
Today's
AQI



<https://airnow.gov/>

How can I find out about PM_{2.5} in my area?

Details for PM_{2.5}



<https://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

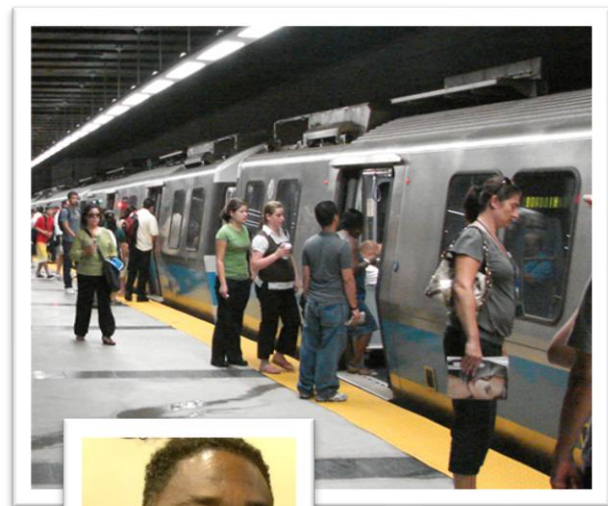
Sensors can help:

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

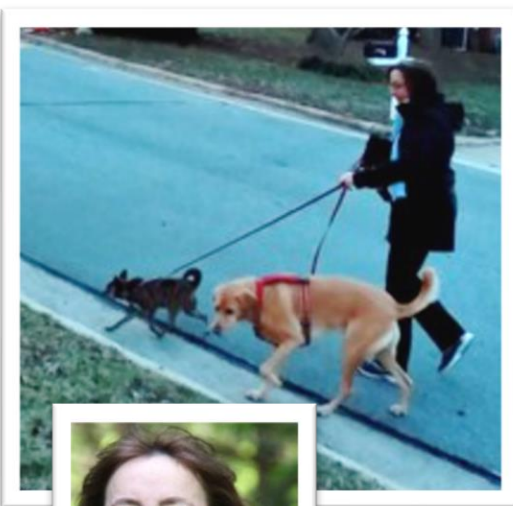


<https://www.specksensor.com/>

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 PM_{2.5} 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



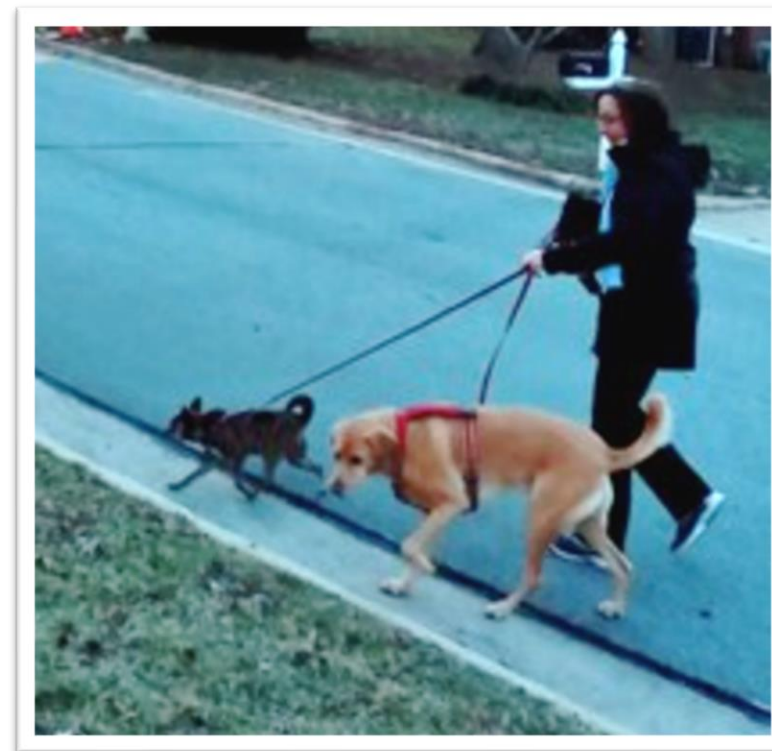
“When trains entered the subway station, the sensor readings got all spikey.”

Sensors inform **personal choices**



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

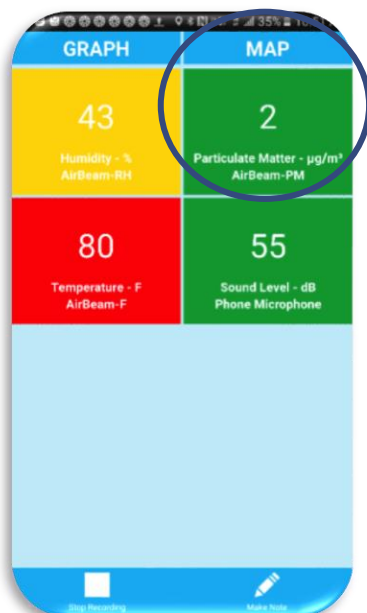
- Husband and daughter had **health problems potentially affected by PM exposure**
- Wanted to monitor air quality in **varied locations**, outdoors and indoors



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

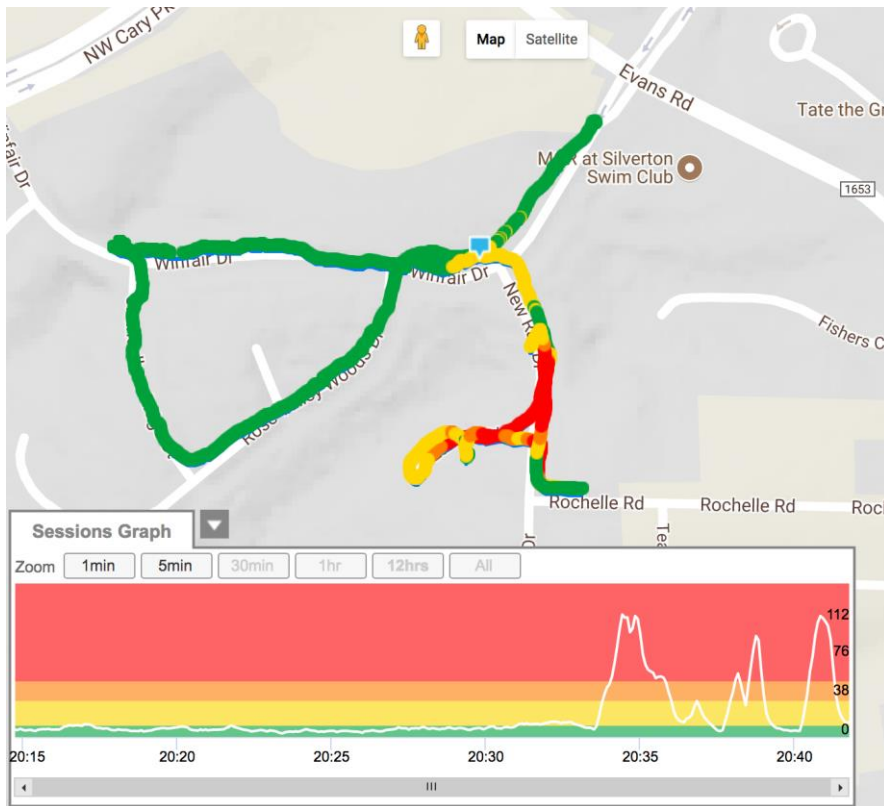


Backyard fire pit



Traffic

What might explain this area of high PM_{2.5}?



Air Beam Data

Peak PM: 112 µg/m³

Friday, Jan 26, 2018

AQI: Good

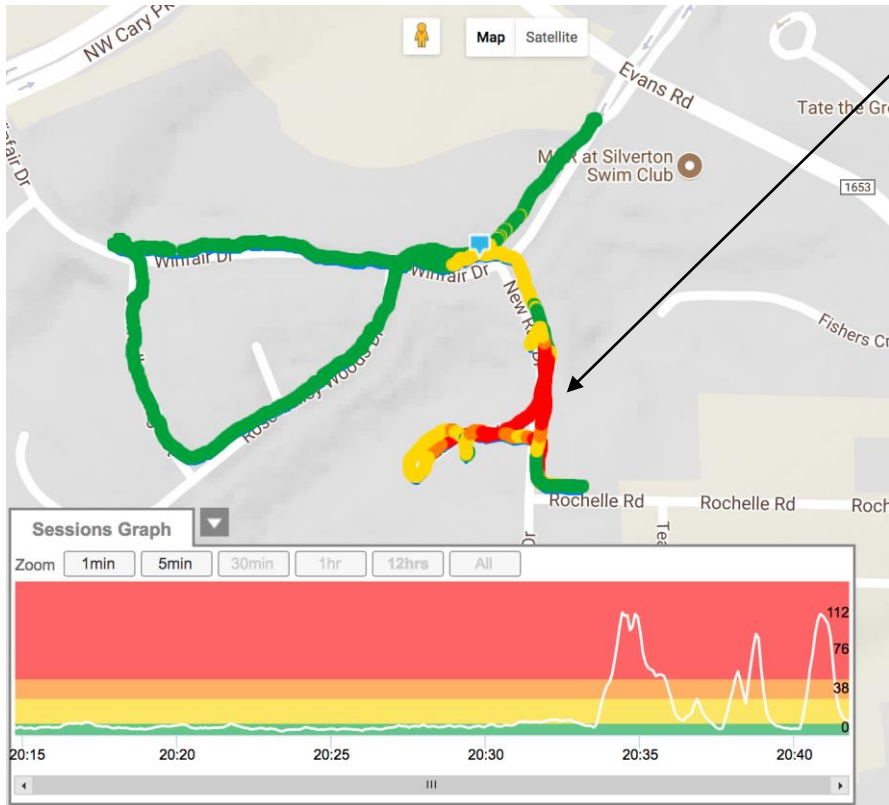
Evening: 25 minute walk

Temp: 53°F

Relative humidity: 35%

Sky: after dark, not windy

Wood smoke can impact PM_{2.5} levels



Strong smell of **wood smoke** during Friday evening walk

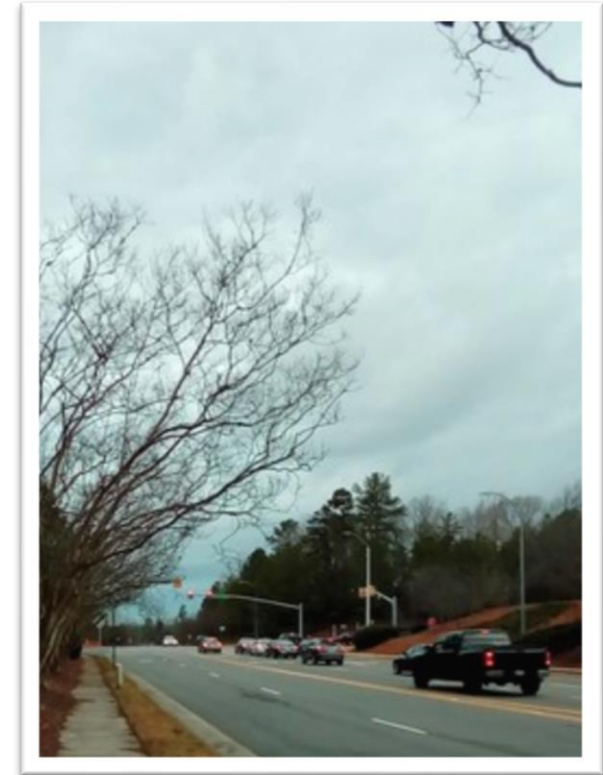


Data informed choices to reduce PM exposure

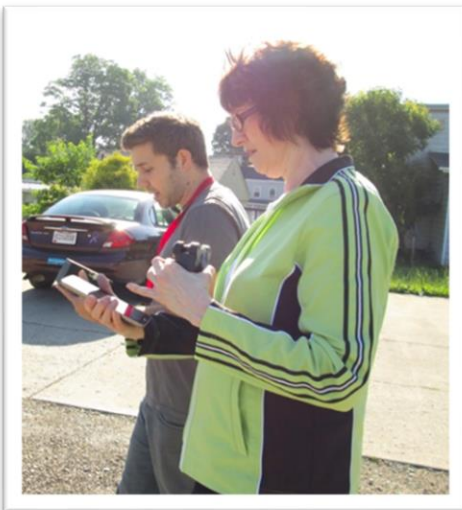
PM_{2.5} varied:

- **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

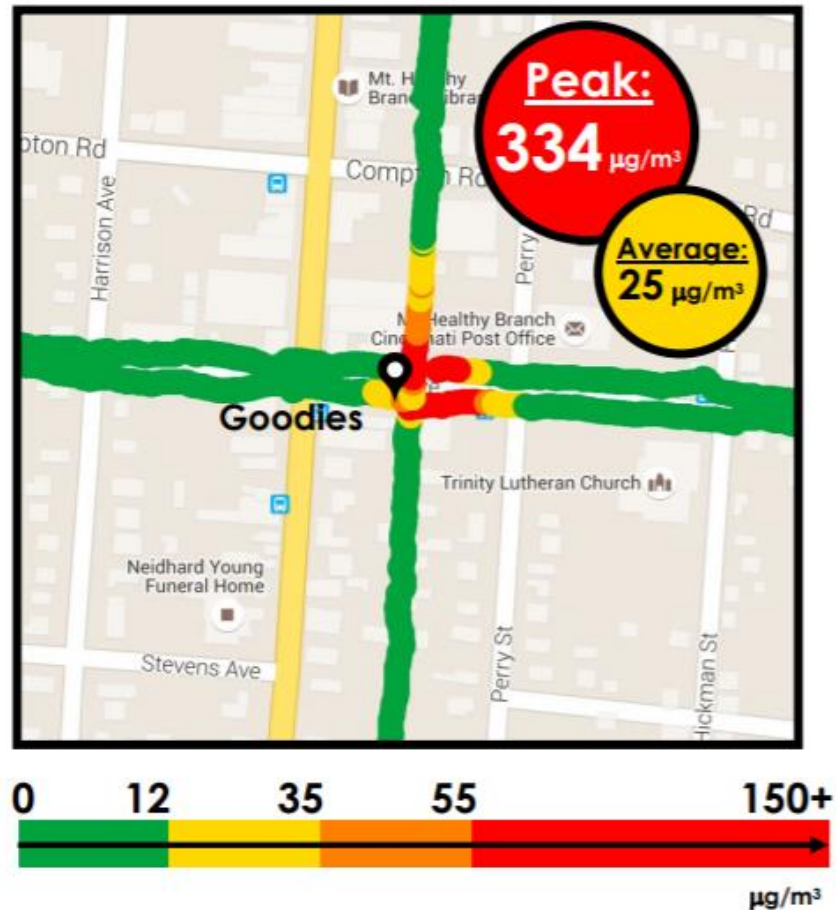


Donna wondered whether BBQ restaurant was **harming neighbors' health**

- 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

1-minute particle pollution (PM_{2.5}) readings

Not for regulatory purposes

334 $\mu\text{g}/\text{m}^3$



Low 0-29 $\mu\text{g}/\text{m}^3$	Enjoy your outdoor activities.
Medium 30-69 $\mu\text{g}/\text{m}^3$	If medium readings continue (for an hour or more), use the Air Quality Index to plan outdoor activities.
High 70 - 499 $\mu\text{g}/\text{m}^3$	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 $\geq 500 \mu\text{g}/\text{m}^3$	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

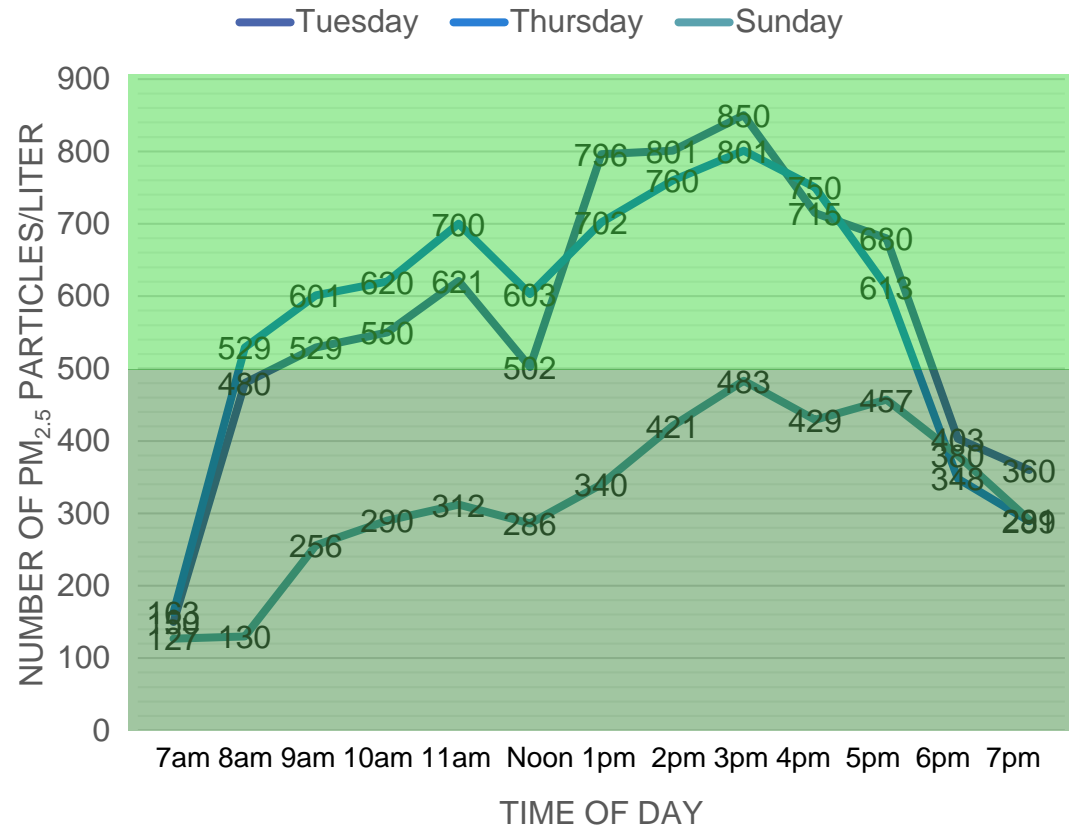


Speck sensor with data display



**Online display dashboard
(map and graph)**

Data demonstrated daily PM patterns

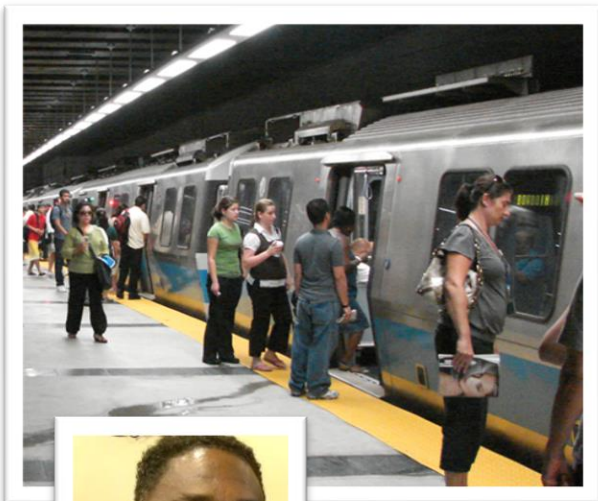


Particle Counts (ppL)	Estimated Mass (µg/m ³)	Rating	Description
8001 - 16000	321 - 640	Very High	This level of particles is unsafe and warrants more serious long-term health effects if sustained.
4001 - 8000	161 - 320	High	Air pollution levels are dangerous and everyone may experience coughing, itchy eyes or other symptoms. This level of particles may significantly trigger asthma and allergy symptoms. Work to decrease values as soon as possible or consider wearing a mask.
2001 - 4000	81 - 160	Elevated	Air pollution is unacceptably high and problematic for all persons due to significant particulate loading in the air. Brief exposures to this level often occur from cleaning, such as vacuuming a carpet. If this level is sustained during the nighttime, consider investing in an air filter for the bedroom.
1001 - 2000	41 - 80	Slightly Elevated	Air quality is problematic for vulnerable populations (elderly, respiratory-compromised individuals or children). This level of pollution warrants taking steps to try to reduce: turn on your kitchen hood vent; consider opening or closing a window as appropriate, etc.
501 - 1000	21 - 40	Moderate	Air quality poses a slightly elevated risk of asthma, allergy and arrhythmia symptoms. Frequently seen moderate level of particulates are often caused by human behavior (cooking, candle burning, etc.).
0 - 500	0 - 20	Good	Air quality is considered good and there is little risk of particulates causing harm to your health.

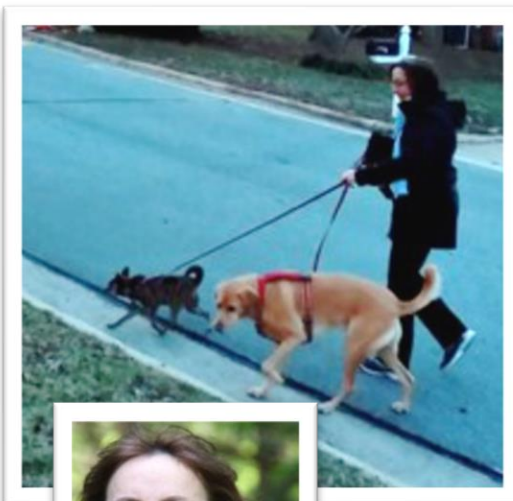
<https://www.specksensor.com/support/tech-specs>

There were increases in PM_{2.5} in homes around the school during times of heavier truck traffic at the port

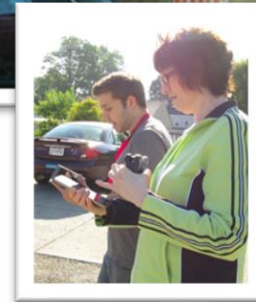
Sensors reveal patterns & inform action



**Educate about
particle pollution**



**Understand
personal exposure**

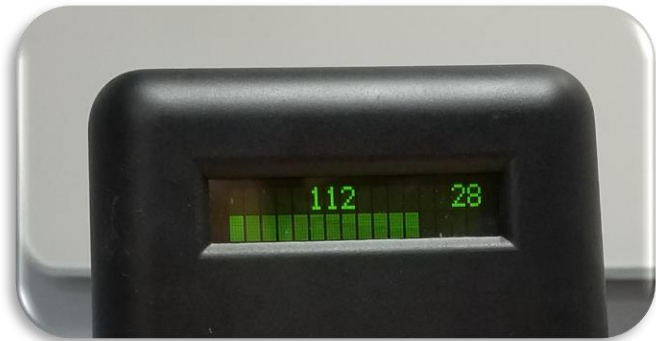


**Identify local sources &
advocate for cleaner air**



Limits of sensor results

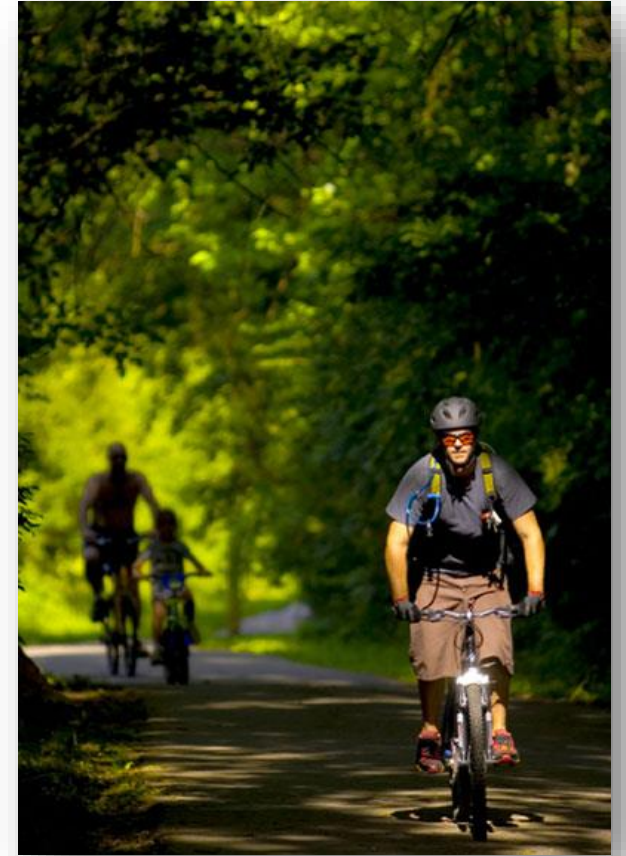
- **Differ from AQI** values
 - 1-minute sensor readings \neq 24 hr averages (as reported on the AQI)
- **Can be inaccurate** due to
 - Environmental factors, such as temperature & high humidity
 - Low PM_{2.5} concentrations
 - Calibration (or “tuning”) error



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

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Project team

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- **University of Texas Medical Branch** Center for Environmental Toxicology (P30-ES006676)
- **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

Air monitoring action plan

Answering these questions will help you make a plan to monitor particle pollution in your environment.

<p>What? Describe your concern about particle pollution.</p>	<p>Where will you monitor?</p>	<p>How long will you monitor? When, how often, and over what time period (hours/days/weeks/year) do you need to monitor?</p>
<p>Where? Describe the location(s) of concern.</p>	<p>What sensor features do you need? Will sensor need to be portable or can it be placed in one location? Do you need access to power, Wi-Fi, and/or a cell phone?</p>	<p>Are there other logistics that need to be considered?</p>
<p>When? When and how often does your concern arise?</p>	<p>So what? Describe what you will do with the monitoring data you collect. How will you share it? With whom? What do you hope the impact will be?</p>	
<p>Why? Describe why you want to learn about particle pollution around you.</p>		

1 What is your concern?

2 Using the air sensor

3 Using the results



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>

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