



# AirKeepers

Citizen Science  
and the  
**Internet of Things**

## Topics

- Clean Air Carolina's programs
- North Carolina's monitor network
- Crowdsourced Citizen Science
- Who are AirKeepers?
- Low cost monitors
- Crowdsourcing in Air Quality

## Our Mission

TO ENSURE  
**CLEANER AIR QUALITY**  
FOR **ALL**  
**NORTH CAROLINIANS**  
THROUGH **EDUCATION**  
AND **ADVOCACY**  
AND BY WORKING WITH OUR PARTNERS  
TO REDUCE SOURCES OF  
**POLLUTION**



## Our Programs



**Medical** Advocates for Healthy Air



**Clear the Air** for Kids!

**Clean Construction** at Hospitals





Particle Falls

# NC BREATHE Conference



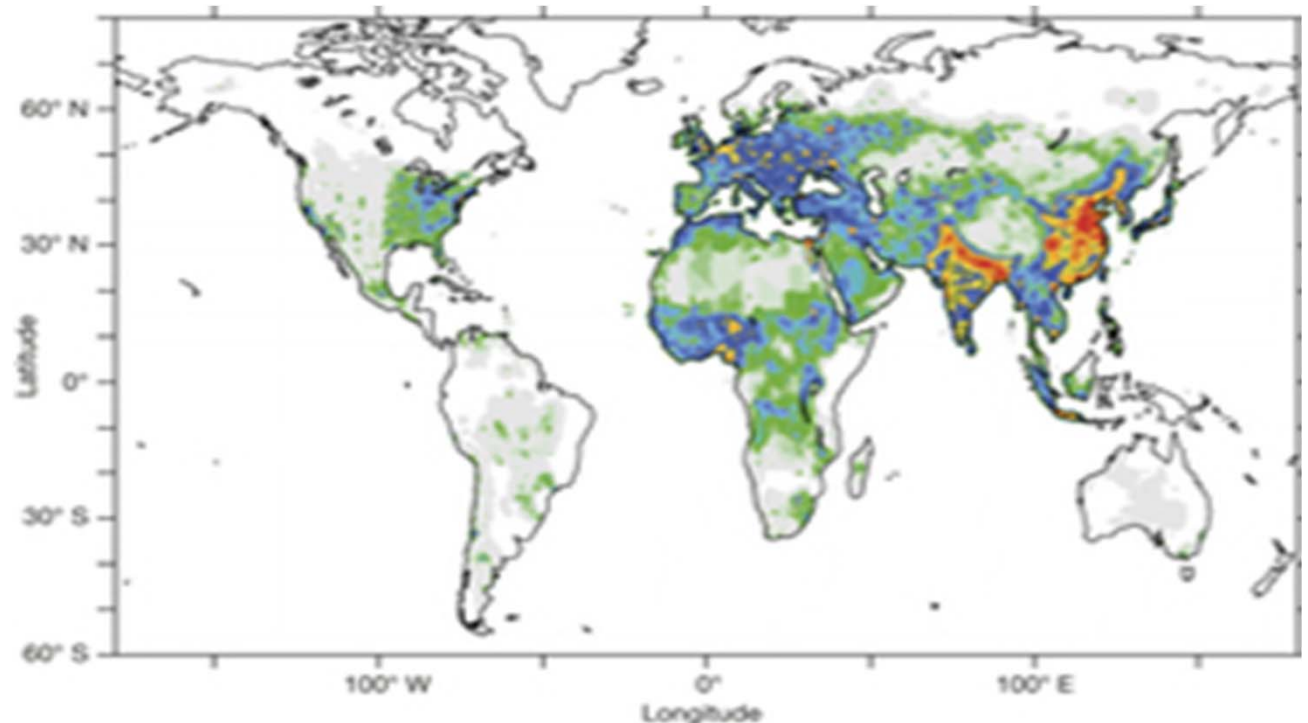
March 8 2018

## Our Challenge

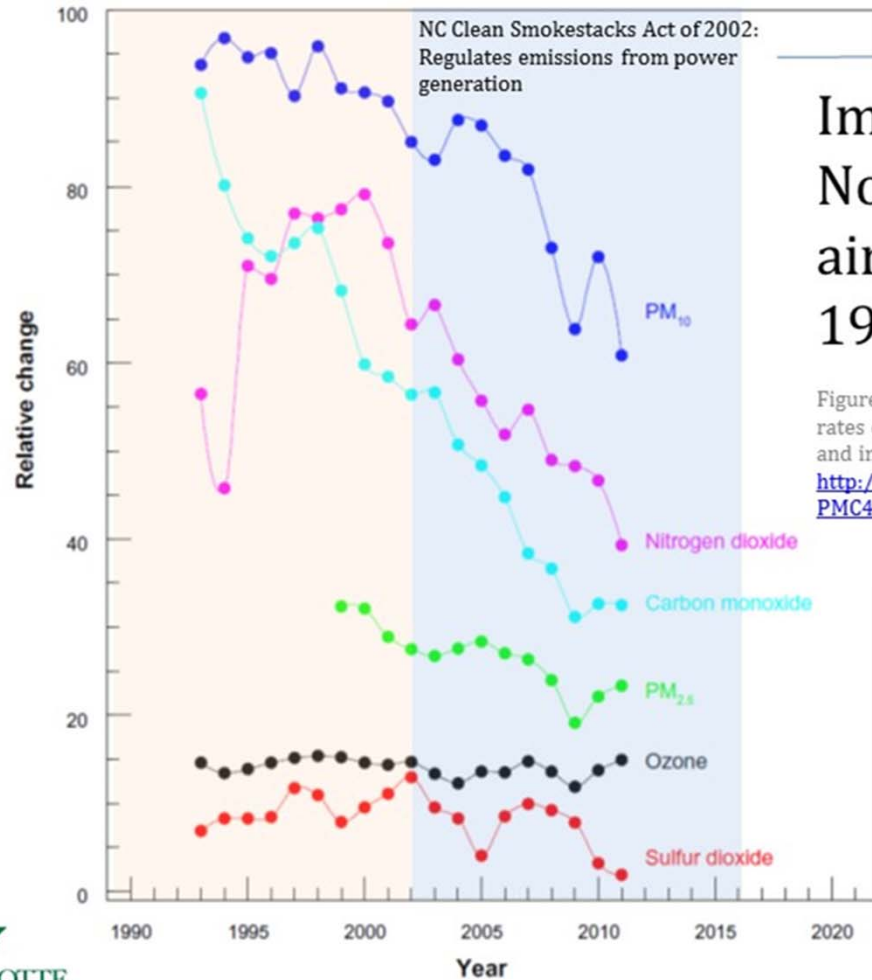
**6.1 million** premature deaths worldwide in 2010 attributed to air pollution – **double by 2050**.

**210,000** premature deaths in the **US annually** due to air pollution.

(Global Burden of Disease Study 2016 *The Lancet*, Vol. 390, No. 10100, p1345–1422 Published September 16, 2017).



Federal Clean Air Act of 1970:  
guarantees right to breathe healthy air

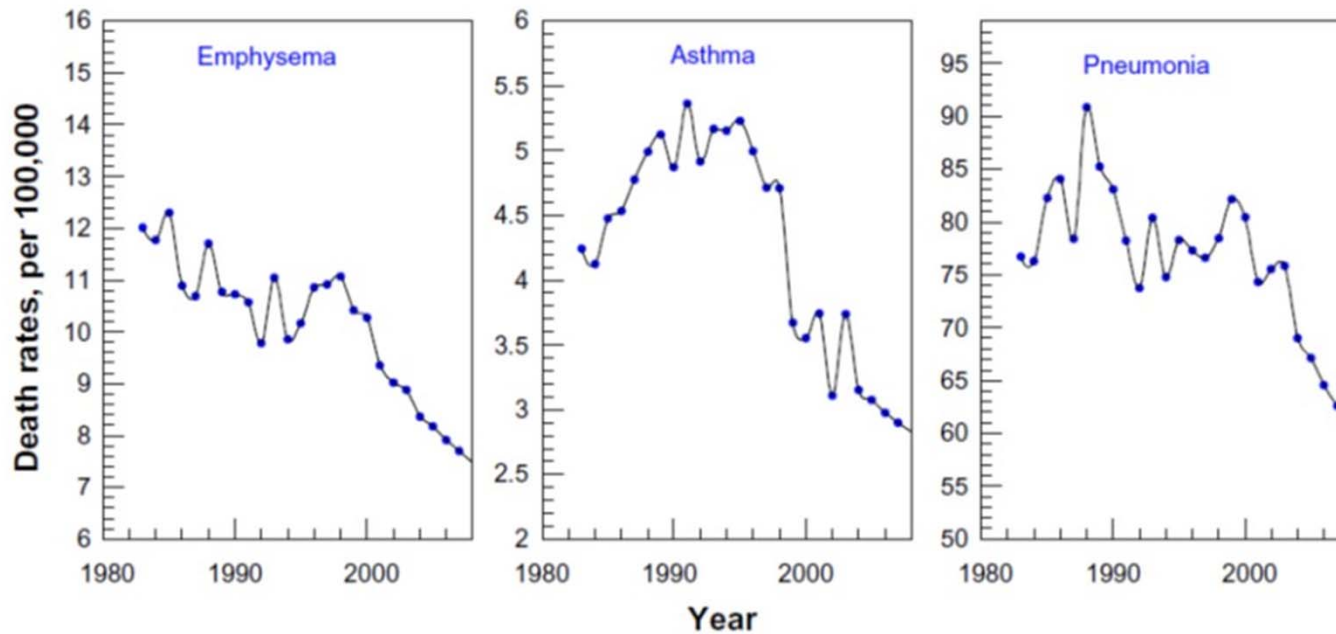


## Improvements in North Carolina air quality since 1990s

Figure source: "Long-term dynamics of death rates of emphysema, asthma, and pneumonia and improving air quality"  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4075234/>



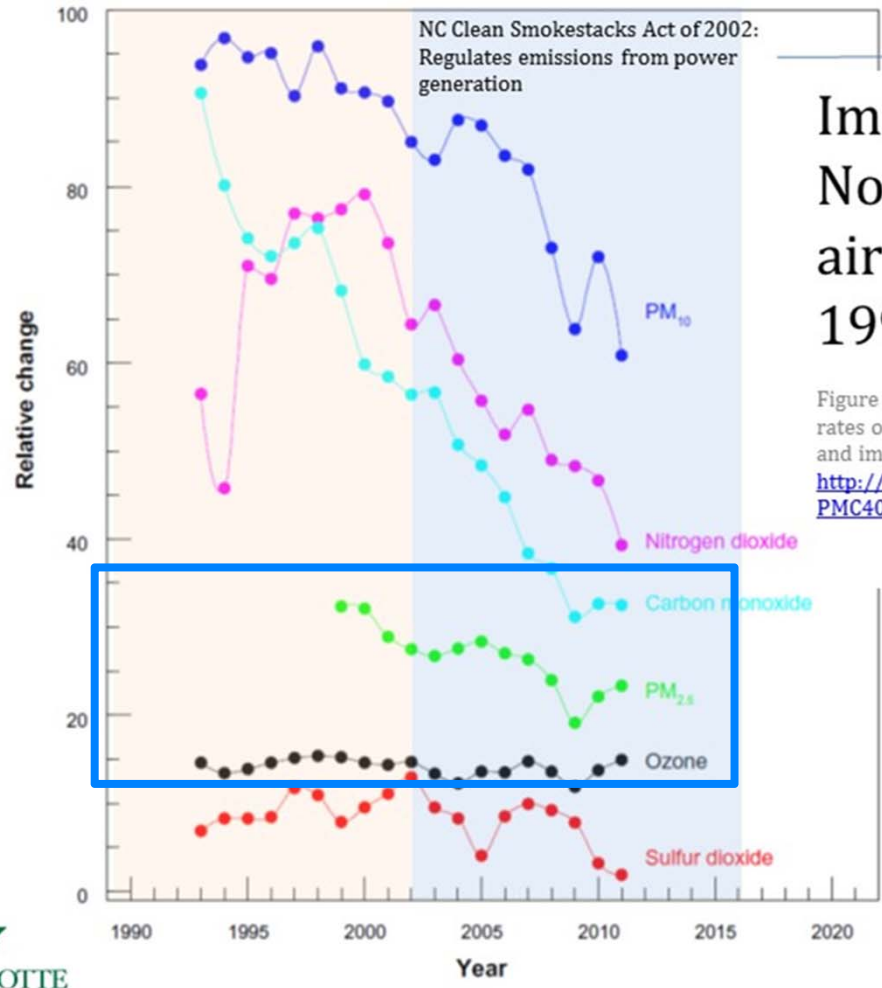




## Associated health trends in North Carolina since 1990s

Figure source: "Long-term dynamics of death rates of emphysema, asthma, and pneumonia and improving air quality" <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4075234/>

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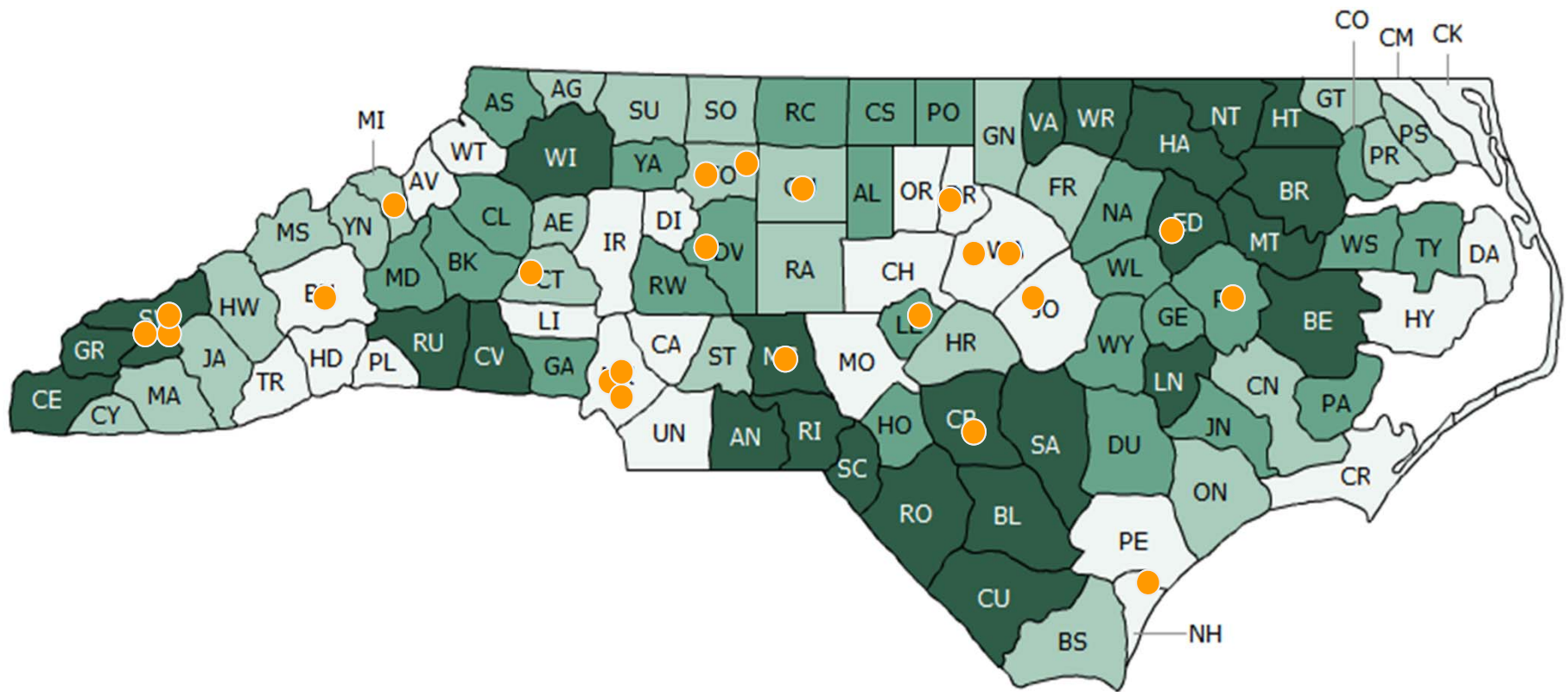


## Improvements in North Carolina air quality since 1990s

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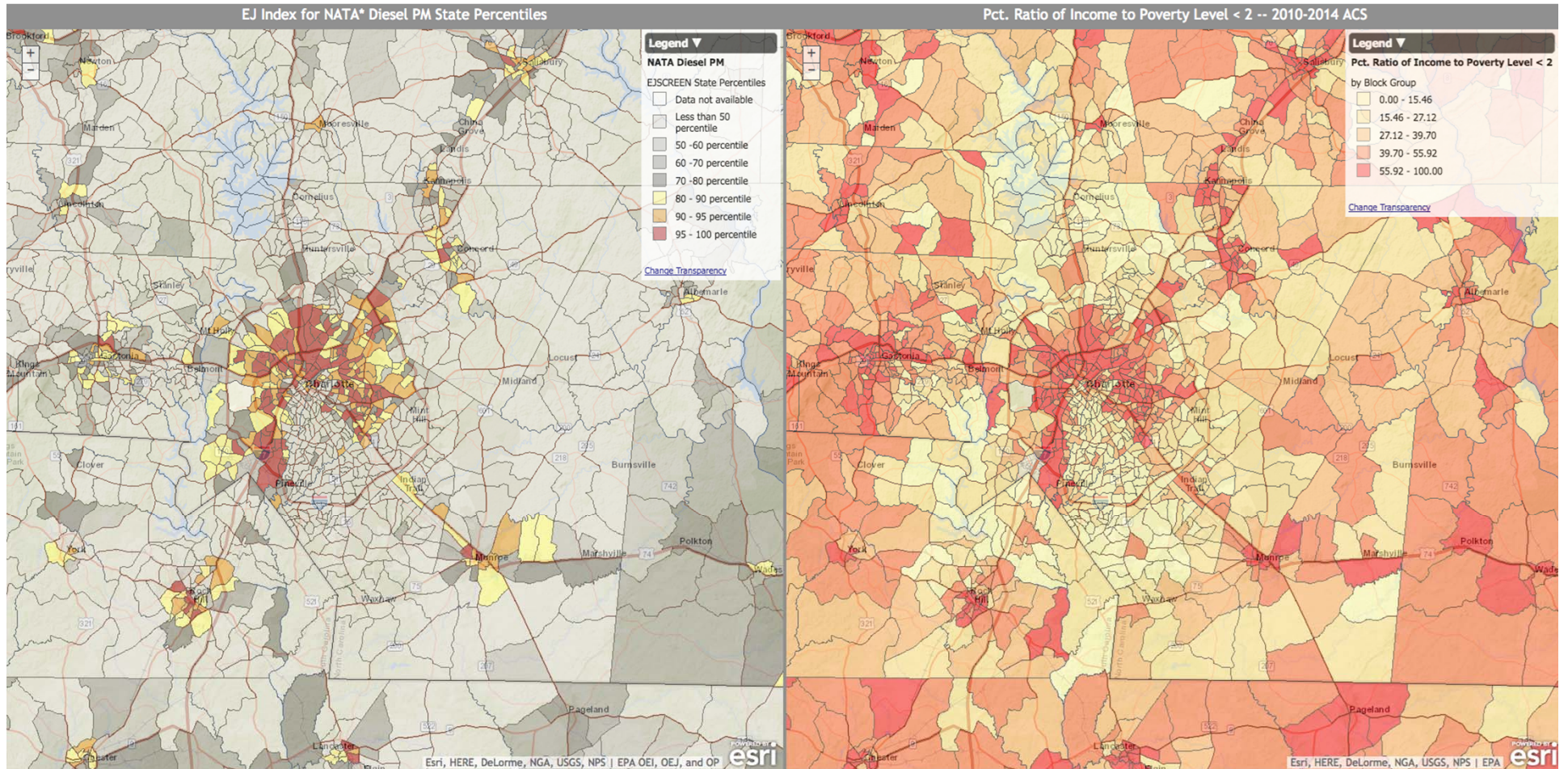
# Our Challenge





Atmos(here)

# Environmental Disparities





**AirKeepers**



## Citizen Science

- Interested members of the general public **contributing** to the collection or analysis of data
- Participating **actively or passively**.
- Citizen Science can provide **expanded capacity and scope** to projects with limited resources.
- The projects offer **STEM learning** opportunities
- **Direct public outreach** through hands on learning, and communication

# Active Examples



## Christmas Bird Count

The nation's longest-running citizen science bird project fuels Audubon science throughout the year.

2015, Central Park, NYC. Photo: Camille Cerreto/Audubon

# Audubon Society

## Geo Tag - X

Ebola response	Emergency Shelter Assessment in the Middle East	Yemeni Cultural Heritage at Risk	Yamuna Monsoon Flooding 2013	Somali Drought

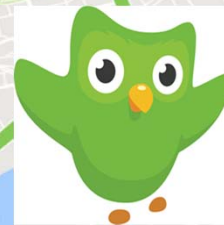
73 TASKS	85 VOLUNTEERS	30 % COMPLETE
Geotag Yamuna photos		

73 TASKS	109 VOLUNTEERS	100 % COMPLETE
Shelter		

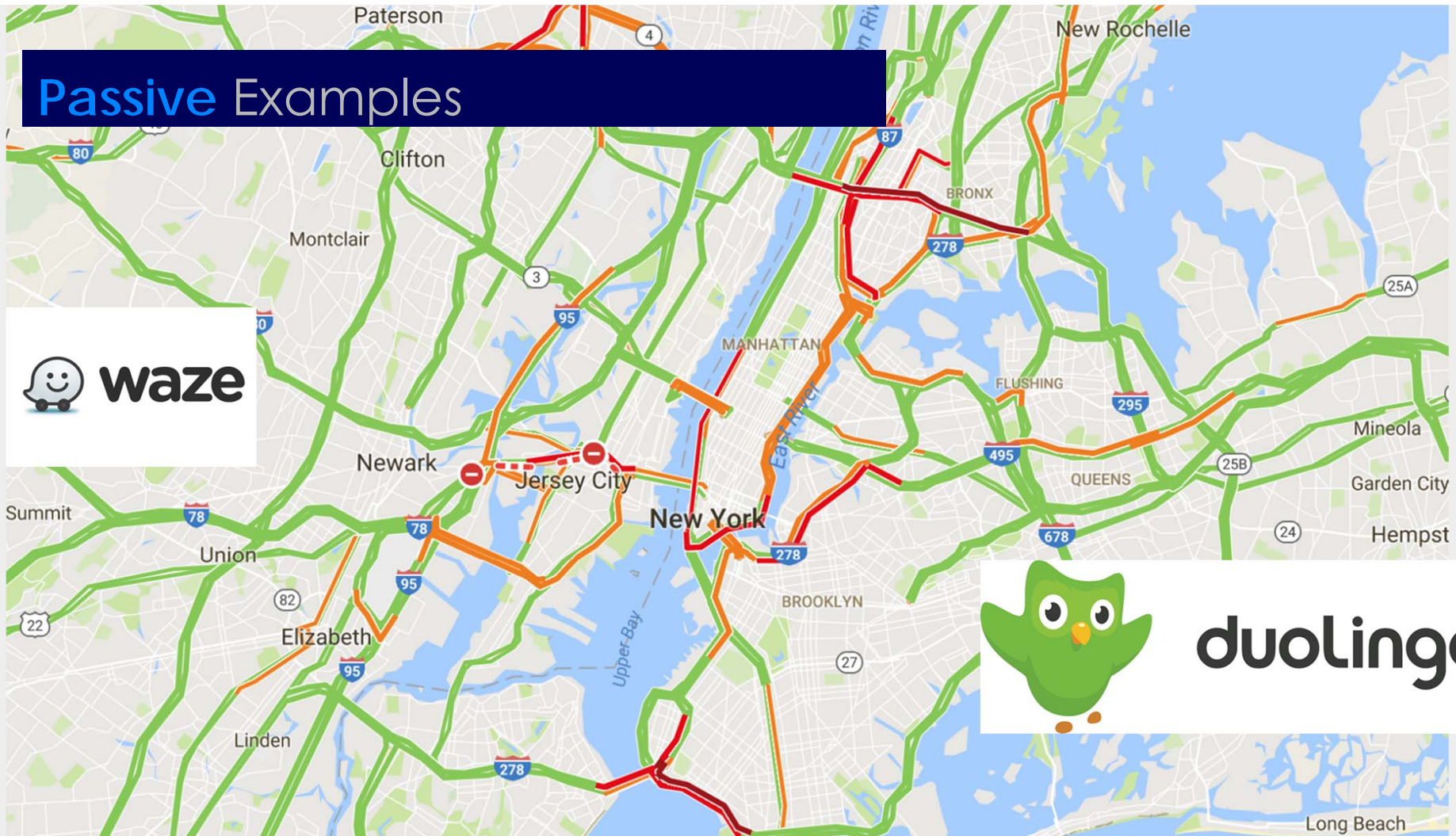
22 TASKS	55 VOLUNTEERS	100 % COMPLETE
Yamuna Flood Waters		



# Passive Examples

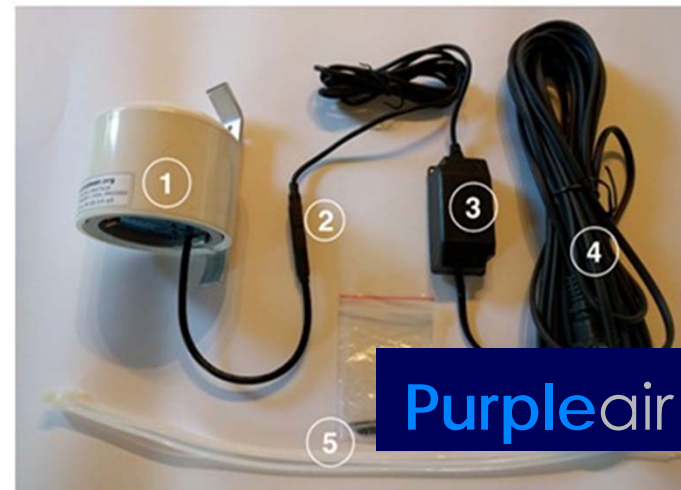


duolingo



## PM 2.5 Monitors

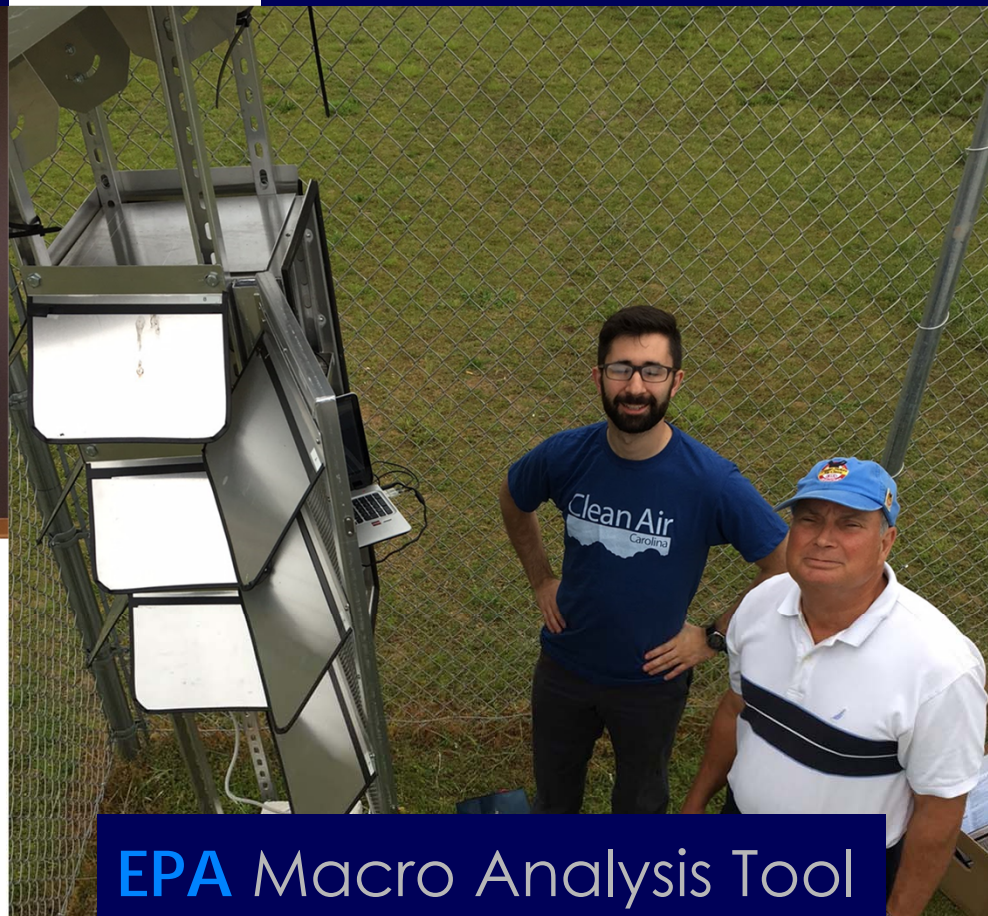
- Fraction of the **Cost**
- **Compact** size
- **Relative Humidity**, and **Temperature**
- **Geotagged** data-points
- Web-based **mapping**



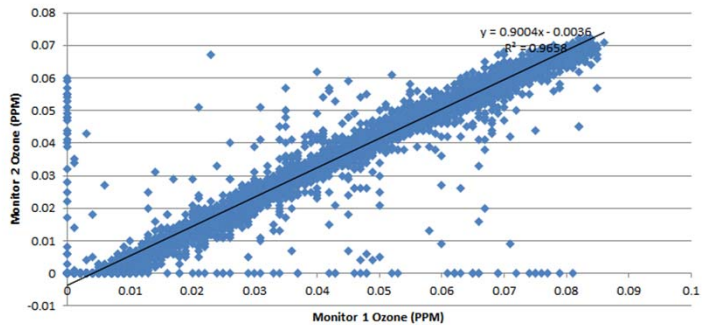
# Citizen Science Partnerships



# Air Sensor Toolbox



Monitor 1 vs Monitor 2 Ozone Levels



# EPA Macro Analysis Tool

# Low Cost Sensor Validation



## Collocation

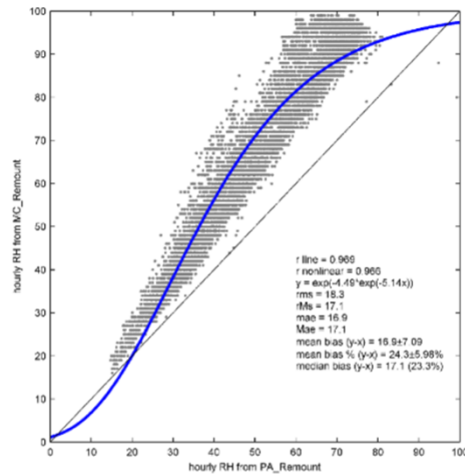
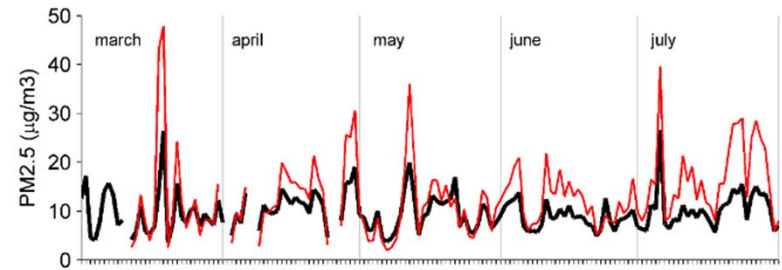



Figure 3: Daily comparison of PA-II with BAM



# Modular Protocols



**THE POWER OF MONITORING**

Clean Air Carolina is reaching out to individuals and organizations across that state who want to participate in the next revolution in understanding our environment through citizen science. We need your help to build a network that addresses environmentally impacted communities across the state, particularly those located near sources of pollution. We are interested in locating monitors in communities whose health is disproportionately affected by air pollution (communities of color, low-income, children, and seniors).

## HOW TO GET A MONITOR

Clean Air Carolina has set a goal to deploy monitoring sites in every single county in North Carolina in 2018. Monitors will be provided **free of charge** for eligible sites in uncovered counties.

**WHAT IS POSSIBLE?**

- Real-time high-resolution mapping of air quality at a far greater density than regulatory monitors
- fenceline monitoring to detect emissions events
- community monitoring to assess hot spots
- personal monitoring
- applications to collect data in remote places, and access it from anywhere.

**WHAT IS THE DEVICE?**

The PurpleAir™ sensor is a device that uses two laser particle counters to capture and record data about microscopic particulate matter (PM<sub>2.5</sub>) suspended in the air. It then calculates the mass of the particles in micrograms per cubic meter (µg/m<sup>3</sup>). The sensor uses Wi-Fi connectivity to report real-time air quality readings to the web, where data can be shared with scientists and the public.

**WHAT IS REQUIRED?**

The sensor needs 3 things:

- Access to an outdoor power source, that is not too close to a source of emissions like a grill, or exhaust pipe.
- A location in range of a Wi-Fi network that is reliable, and on 24/7.
- A position about 6-15ft off the ground, with as much fresh air as possible.

**WHERE IS THE DATA GOING?**

The data collected by the sensors is going directly to our AirKeepers page where it can be viewed anytime (CleanAirCarolina.org/AirKeepers). The data is also being shared with researchers, public health experts, and other stakeholders to advance our understanding of air quality concerns around the state.

<sup>1</sup> Q. Qian, Wang Y, Zanobetti, A, Wang, Y, Koutrakis, P., et al. "Air Pollution and Mortality in the Medicare Population". *New England Journal of Medicine*, June 30, 2017.

www.CleanAirCarolina.org/AirKeepers

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## Clean Air

Carolina

Your advocates for healthy air

### Citizen Science Worksheet

1. List your Group Members:

2. Create a Session Name:

School	Team Name	Date	Session Title
Example: NWSA	Eagles	9/8/16	NWSA Eagles 9/8/16

3. Collect Environmental Conditions (Wait and complete this outside to observe conditions.)

Using the data below, complete the following chart to get your AirCasting "Session Notes"

**Landscape:**

- "U" Dense urban areas surrounded by taller buildings, with roughly 1,000 people or more per square mile.
- "S" Sparse suburban city areas, surrounding a city. Primarily houses and mixed use.
- "R" Areas of mostly natural surroundings, including forests, farmland, and large undeveloped area.

**Cloud Cover:**

- "100%" If no sky is visible through clouds. Completely overcast.
- "75%" If there is less blue sky visible than clouds. Mostly Cloudy.
- "50%" If there is equal amounts of cloud and sky. Lightly Cloudy.
- "25%" If only few clouds are visible, or most clouds are very small.
- "0%" If the sky is clear.

**Wind:**

- "H" Heavy gusts of wind.
- "M" Moderate levels of wind.
- "L" Light wind, steady breeze.
- "C" Calm conditions. Little to no noticeable wind.

**Most Recent Rain:**

- Count the number of days since rainfall at the testing location. "1" if rain fell the previous day, "2" if two days ago, "3" if three days ago, "3+" if longer than three days since last rainfall. Do not record during the rain.

Landscape	Cloud Cover	Wind	Most Recent Rain	Session Notes
Example: U	75%	L	2	U75%L2

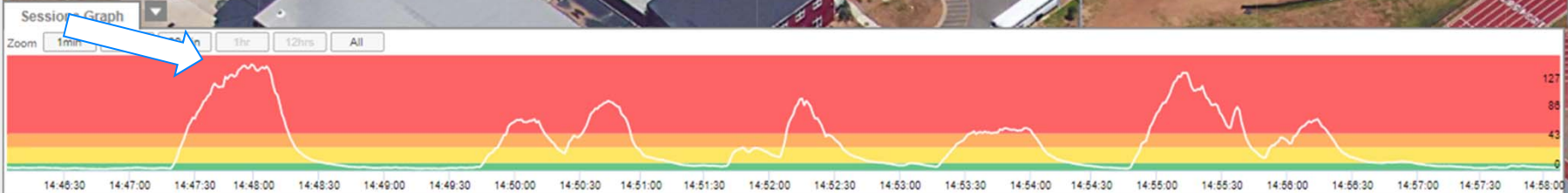
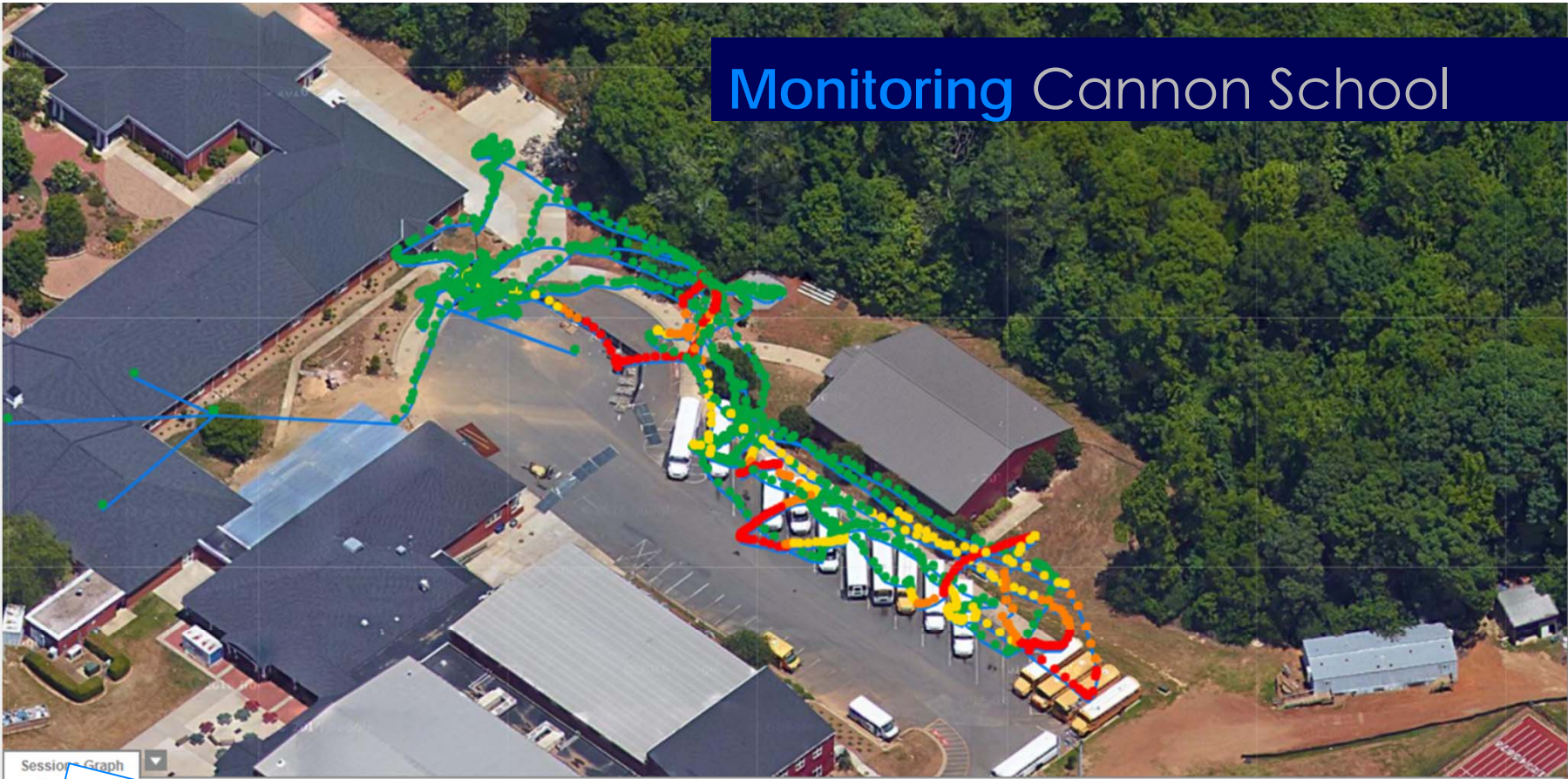
4. Preliminary questions before AirCasting. Discuss as a group and answer.

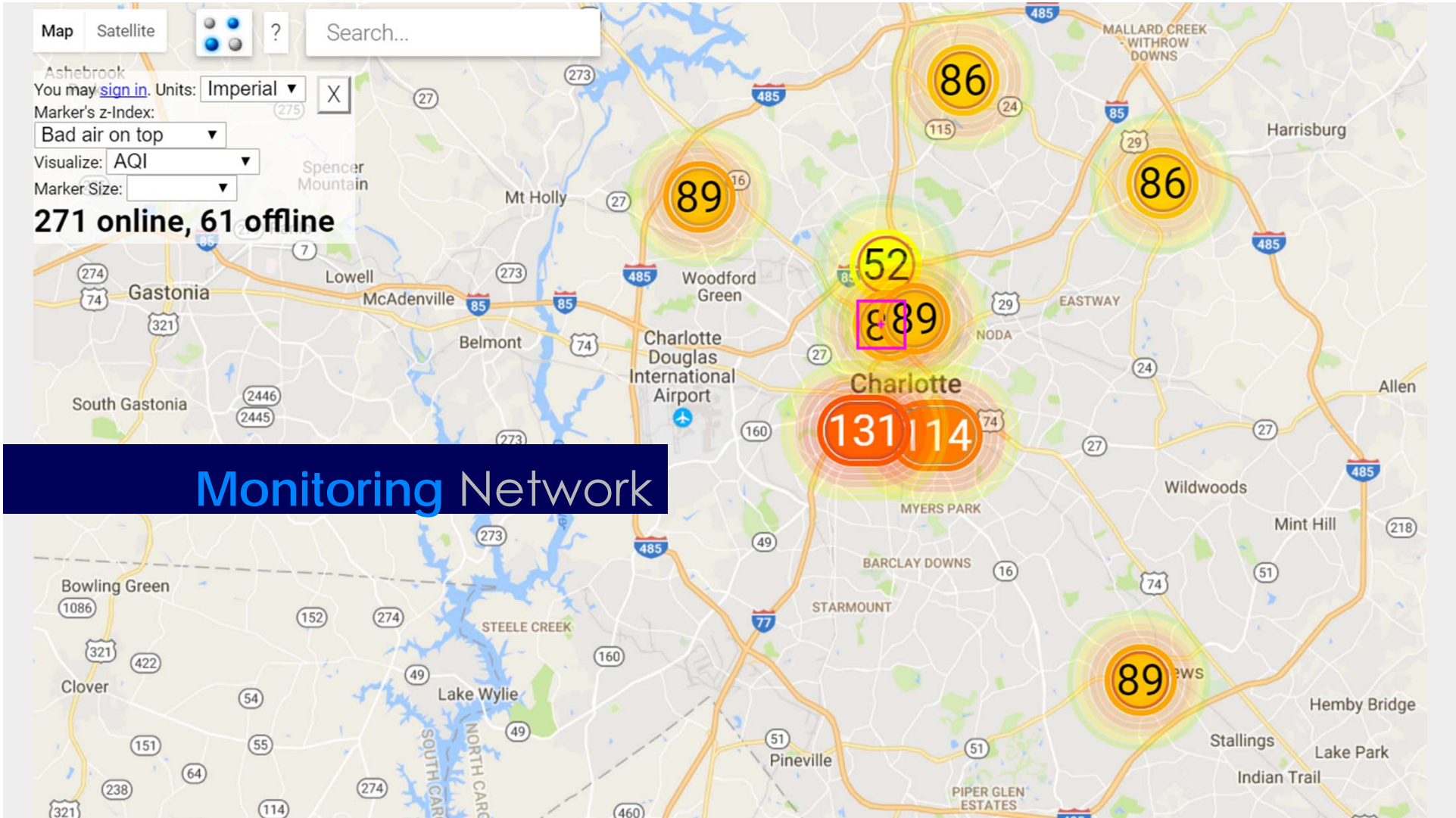
1) What is the air like where you live and go to school?

2) Can you see air pollution, like exhaust, smog, or smoke?

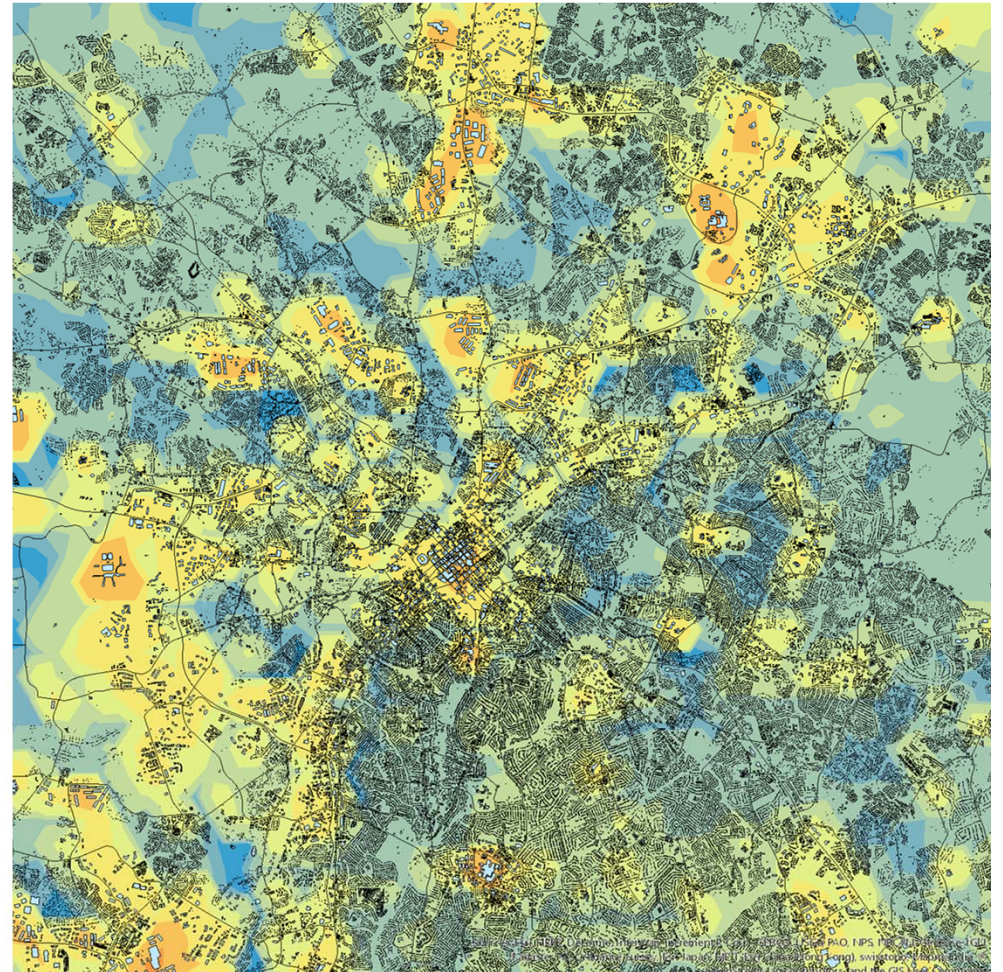
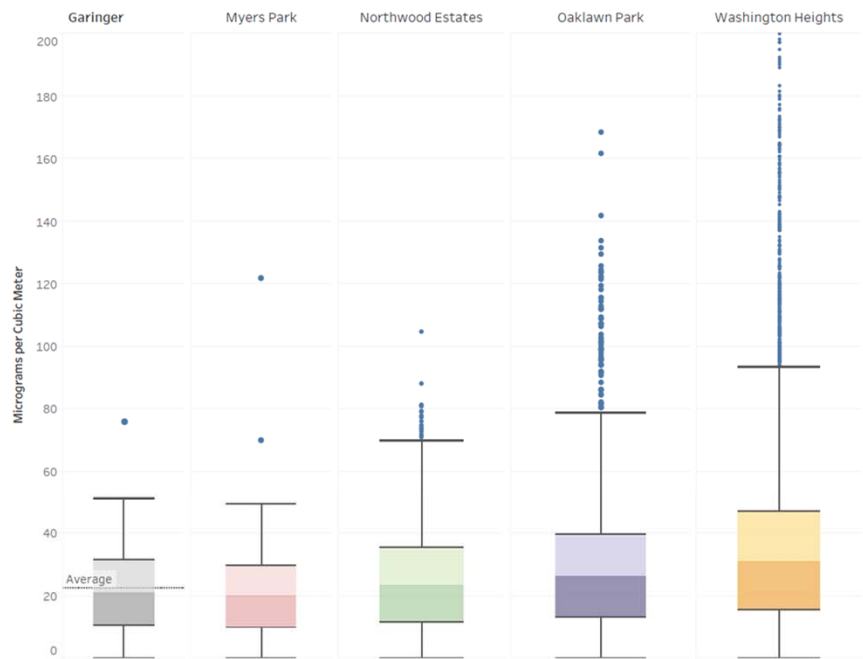
3) Are there busy roads, trains, or airports nearby?

# Monitoring Cannon School



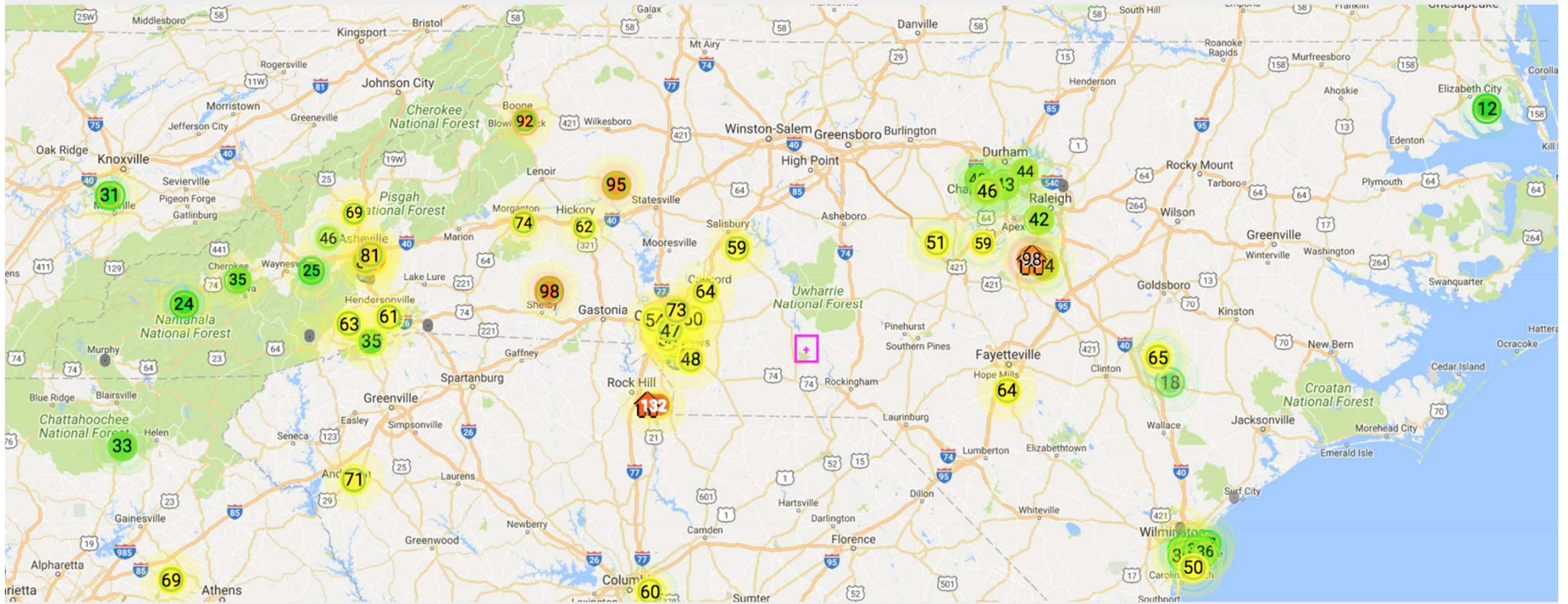


# High Resolution Modelling

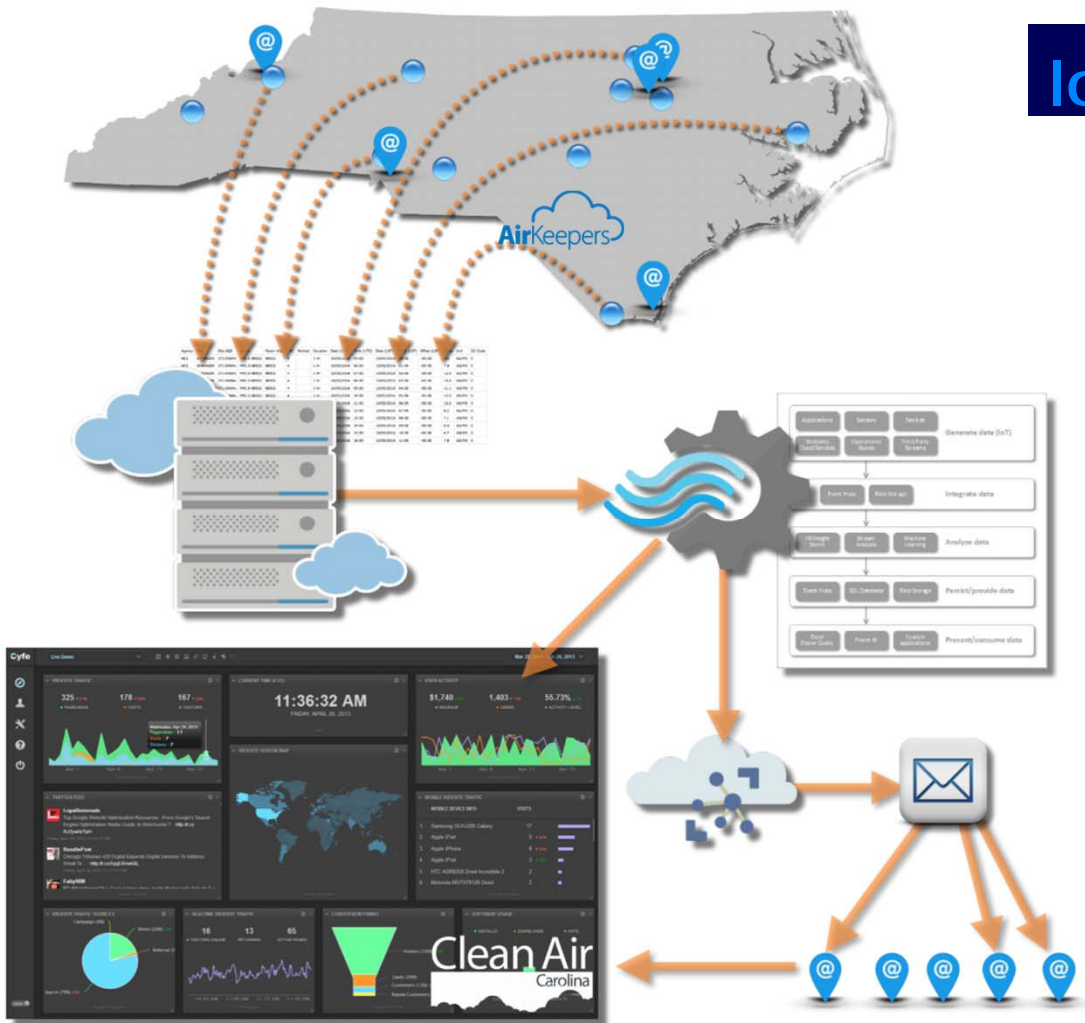




# Monitoring Network



# IoT Platform



Smoke Sense



HEALTHeWeather™

Questions?

**Air**Keepers

FIRST WARD PARK





# AirKeepers

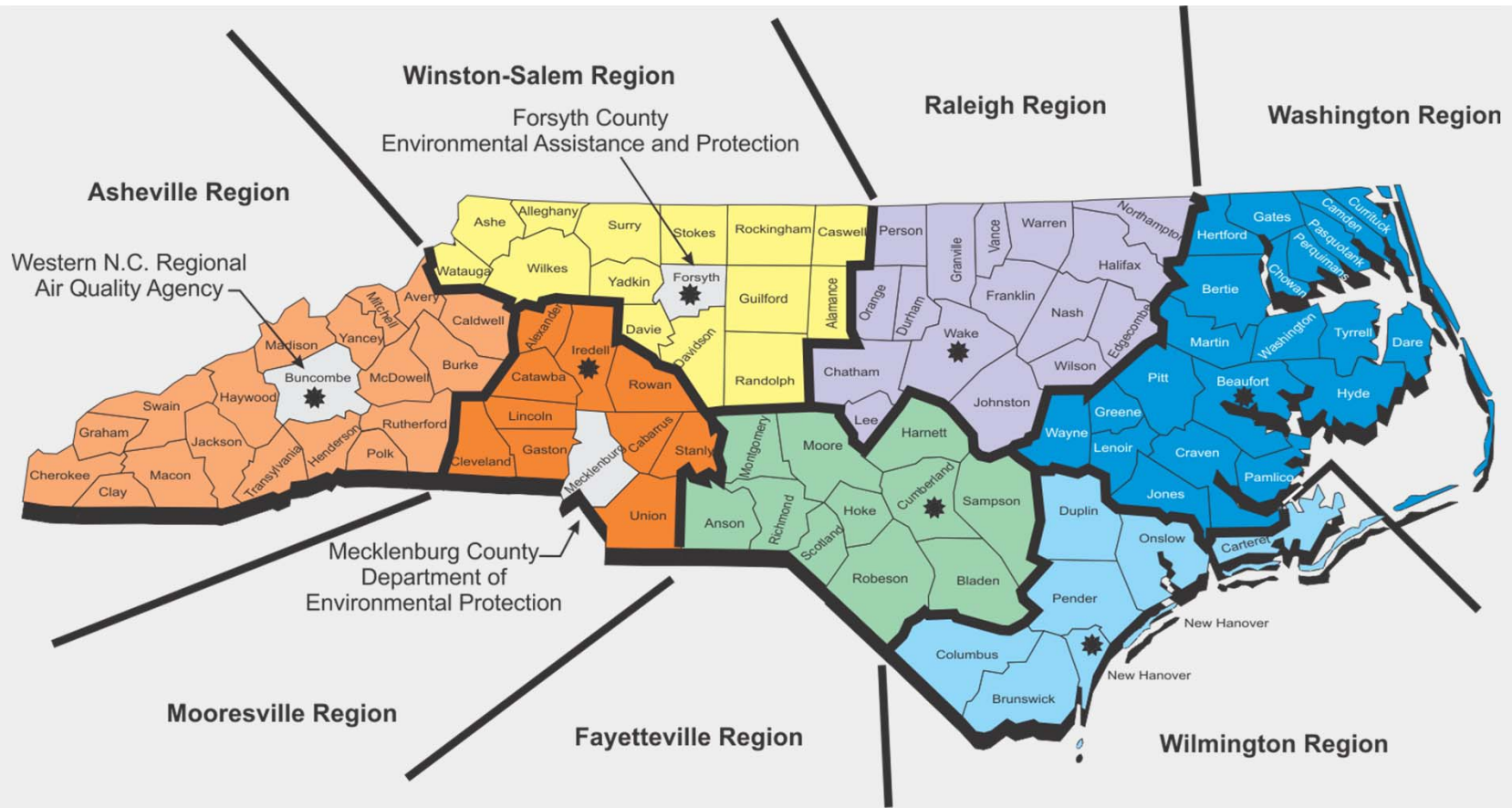
*Thank you!*

**Calvin A. Cupini**

Citizen Science Program Manager

[Calvin@CleanAirCarolina.org](mailto:Calvin@CleanAirCarolina.org)



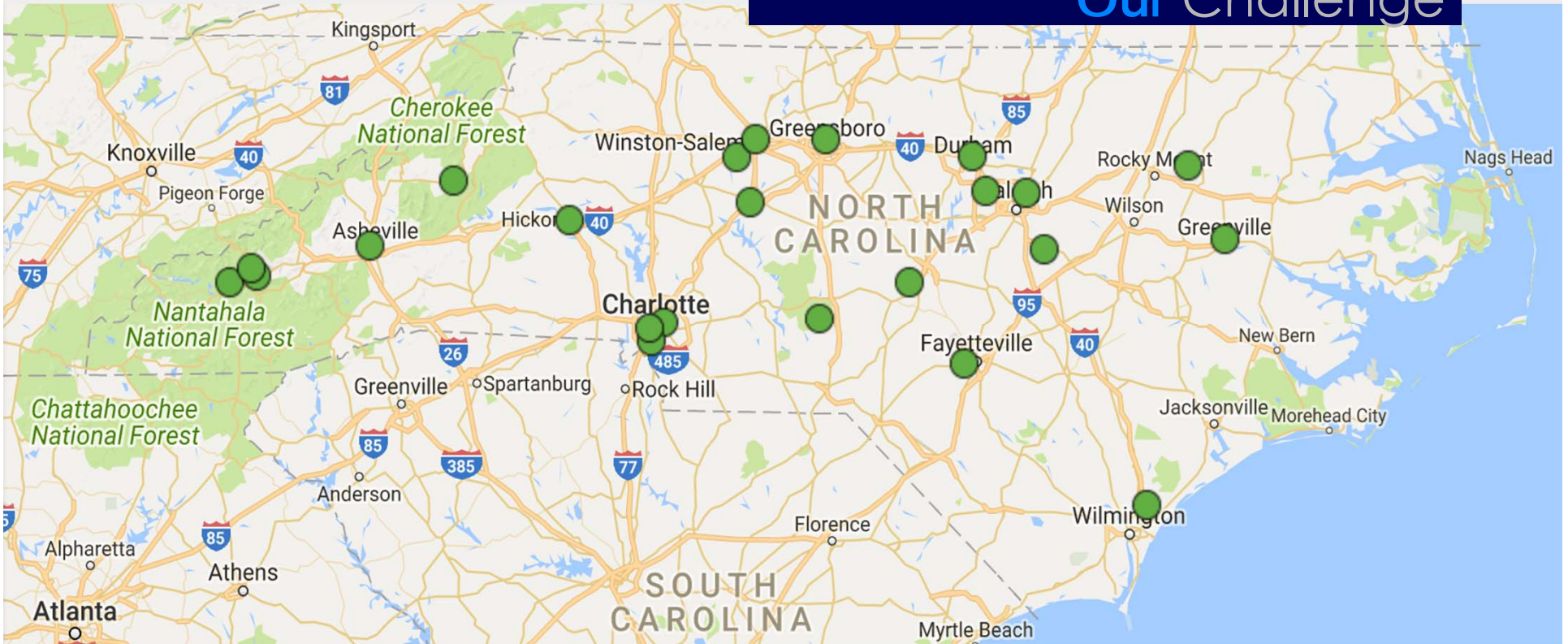


# Statewide Reach

# Atrium Health



## Our Challenge



## PM Reference Monitors

# Cannon School STEM





# WHAT IS PM2.5?

PM2.5 refers to dangerous particles of pollutants that are less than 2.5 microns in diameter. At 1/20th the width of a human hair, they lodge deep in lung tissue and are linked to many diseases, from cancer to asthma, and even autism.



**Pollen**  
50 microns

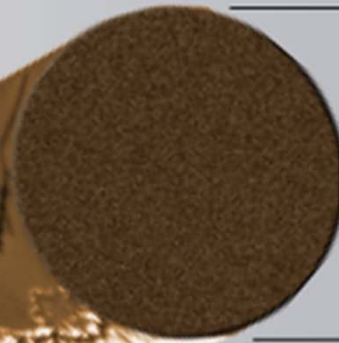
**Mold** ●  
8 microns



**Table salt**  
70 microns



**PM 2.5**   **PM 10**



**Human hair**  
100 microns in diameter

Source: [www.epa.gov](http://www.epa.gov)

## PM 2.5 and Your Health

- Fine particle pollution has long been linked to **heart disease** which is the leading cause of death in the US
- PM 2.5 can trigger **heart attacks and stroke**
- There is **no safe level of exposure**--even short-term exposure can impact lung function and increase emergency room visits & hospitalization for children with asthma
- Every 10 micrograms per cubic meter of PM2.5 **reduces life expectancy** by 5-10 months

