



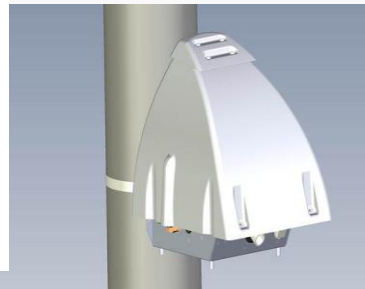
# **Air Sensors: Current Activities**

AAPCA Fall Meeting Topical Session: *Preparing for Personal Air Sensors: Communication, Context and Perspectives*

September 21, 2016

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# Proliferation of Sensors & Real-time Data

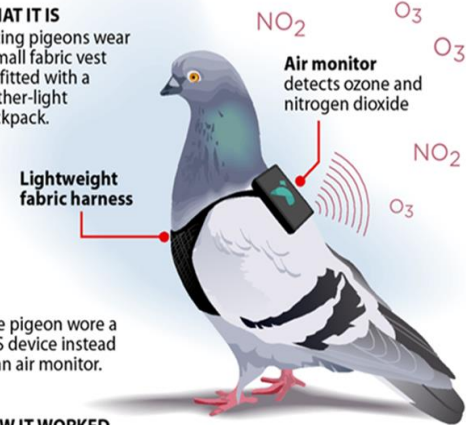


## 21st Century 'Canary in a Coal Mine'

The Pigeon Air Patrol — a joint project by tech companies Plume Labs and DigitasLBI — released pigeons outfitted with air-monitoring packs to record and report real-time air pollution levels in London. This three-day venture was used to spread awareness on London's smog problem.

### WHAT IT IS

Racing pigeons wear a small fabric vest outfitted with a feather-light backpack.



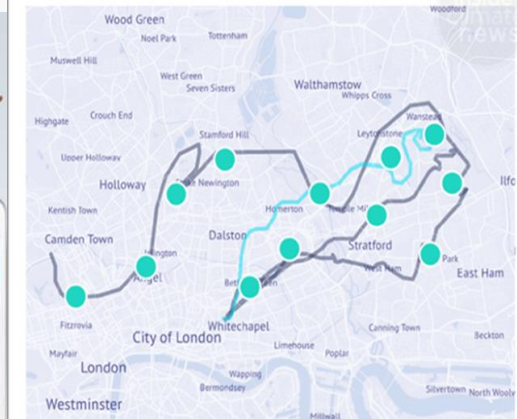
Lightweight fabric harness

Air monitor detects ozone and nitrogen dioxide

One pigeon wore a GPS device instead of an air monitor.

### HOW IT WORKED

Londoners Tweeted their location to a Pigeon Air team member and received real-time results (via Twitter) of air quality in their area.



SOURCE: DigitasLBI

PAUL HORN / InsideClimate News

# Proliferation of Sensors – Current Events



**Some recently launched projects include EPA involvement, others do not...**

## **1) First Array of Things Sensors Installed on Chicago Streets**

• <http://www.chicagotribune.com/bluesky/originals/ct-array-of-things-sensors-installation-bsi-20160829-story.html> (August 29, 2016)

## **2) Busiest U.S. Border Crossing Gets Community Air Monitoring Network** (August 26, 2016)

• <http://www.calepa.ca.gov/PressRoom/Releases/2016/BorderMonitor.htm>

## **3) Six Organizations Receive \$4.5 Million in EPA Grants to Conduct Low-Cost Air Monitoring Research Projects** (August 9, 2016)

• [https://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/recipients.display/rfa\\_id/587](https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/recipients.display/rfa_id/587)

## **4) EPA Offers up to \$80,000 to Communities to Develop Air Sensor Data Best Practices** (August 30, 2016)

• <http://www.challenge.gov/challenge/smart-city-air-challenge/>





## Current Technology

- Expensive
- Often snapshot
- Big footprint with dedicated power source
- May require expertise to use
- Often delays for lab analysis
- Established QA protocols
- Collected by gov, industry, researchers
- Data stored and explained on gov websites

## New Technology

- Low cost
- Often continuous
- Small footprint or mobile, battery or solar power
- Perhaps easy-to-use
- Real-time w/o lab analysis
- QA protocol gaps
- Collected by communities and individuals
- Data shared and accessed on non-gov sites

# Sensor Activities - Evaluations



- EPA and States are facing increased pressure to take action on non-regulatory data
- EPA is working across offices to evaluate emerging technologies:
  - ORD – Publication of sensor evaluation reports for O<sub>3</sub>, NO<sub>2</sub>, PM, and VOCs, the DISCOVER A-AQ project to test sensors collocated with reference instruments, fenceline sensor evaluations for VOCs, Village Green monitoring stations streaming real-time ozone and particulate matter data to the public, development of standard operating procedures for various handheld sensors, a citizen science toolbox to aid in the design of community based monitoring studies, Regional applied research efforts (RARE).
  - OAR – Tribal pilot study with the Leech Lake Band of Ojibwe to use three PM<sub>2.5</sub> sensors and compare results with onsite FEM instrumentation.
  - OECA – Purchase of infrared cameras for Regions 1, 2, 3, 4, 5, 6, 8, and 10 for use in leak detection and repair.

# Sensors – Moving Forward



## E-Enterprise Advanced Monitoring Scoping Team (EEAMT) Recommendations

- E-Enterprise Leadership endorsed five recommendations in April 2016
- Members: States (organized by ECOS), OAR, ORD, OECA, OW, OEI, and EPA Regions 1 & 2

### **Recommendations:**

#1: Feasibility study for a voluntary 3<sup>rd</sup> party certification program

#2: Technology screening and support network

- Recommendations 1 & 2 will build on lessons learned from sensor evaluations and pilot projects  
<https://www.epa.gov/air-research/air-sensor-toolbox-citizen-scientists>

#3: Interpretation of data from advanced monitoring approaches

- Finalize & expand pollutant list for prototype website that messages short term, real-time measurements  
<http://bit.ly/VillageGreenPilot>

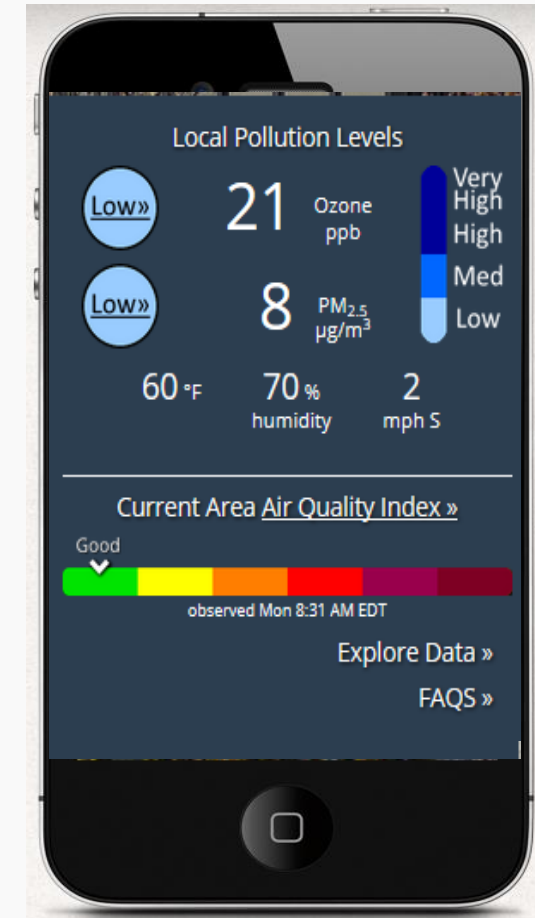
#4: Data standards & data quality tiers

#5: Lean technology evaluation parameters

# Sensor Scale Pilot Project



- On May 6<sup>th</sup>, EPA launched a new “sensor scale”
  - EPA developed the scale to help the public understand 1-minute data from Village Green stations
- Pilot appears on existing Village Green data webpage
  - <http://bit.ly/VillageGreenPilot>
- A fact sheet, FAQs, and other information available on the Air Sensors Toolbox
  - <https://www.epa.gov/air-research/air-sensor-toolbox-citizen-scientists>
- EPA is testing the effectiveness of the scale and messages during a spring-summer 2016 pilot project





# Previous Village Green Website



Village Green Project

Environmental Protection Agency [US] <https://www.airnow.gov/index.cfm?action=airnow.villagegreen>

Select a City ▼ Durham, NC Menu



**Most Recent Observations**  
Durham, NC


27	Ozone ppb	52.5 °F
0	PM <sub>2.5</sub> µg/m <sup>3</sup>	46% humidity
		3.1 mph W

observed Fri 9:06 AM EDT


[Explore Durham, NC](#)

### Welcome to the Village Green Project

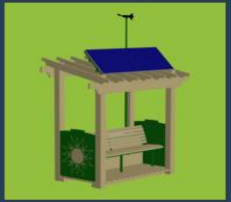
a research effort to discover new ways of measuring air quality and weather conditions in community environments.



Measuring and communicating on-the-spot air quality and weather conditions for research and awareness



Developing small and rugged data collection systems that can be powered by the wind and sun



Partnering with communities to pilot test the new technology in outdoor community spaces.

9:11 AM 4/8/2016



# Enhanced Village Green Website



24.104.117.6/welcome

Select a City Philadelphia, PA

### Local Pollution Levels

Low»	21	Ozone ppb	Very High
Low»	8	PM <sub>2.5</sub> µg/m <sup>3</sup>	High

60 °F 70 % humidity 2 mph S

### Current Area Air Quality Index »

Good

observed Mon 8:31 AM EDT

[Explore Data »](#)

[FAQS »](#)

## Welcome to the Village Green Project

a research effort to discover new ways of measuring air quality and weather conditions in community environments.

Measuring and communicating on-the-spot air quality and weather conditions for research and awareness

Developing small and rugged data collection systems that can be powered by the wind and sun


Partnering with communities to pilot test the new technology in outdoor community spaces.

[About Village Green »](#)

Data shown on these pages are preliminary and subject to change.


# Ozone Breakpoints and Messages



Pilot version <b>1-Minute Ozone Readings</b> <i>Not for regulatory purposes</i>	
<b>Low</b> <b>0-59 ppb</b>	Enjoy your outdoor activities.
<b>Medium</b> <b>60-89 ppb</b>	If medium readings continue, use the Air Quality Index to plan outdoor activities.
<b>High</b> <b>90-149 ppb</b>	If high readings continue, consider adjusting outdoor activities, especially if you are sensitive to ozone. Check the Air Quality Index to find out.
<b>Very High</b> <b>≥150 ppb</b>	If high readings continue, consider adjusting outdoor activities. Check the Air Quality Index to find out. Very high readings may mean the sensor is not working properly.
	Sensor may be offline. Check the Air Quality Index.

# PM<sub>2.5</sub> Breakpoints and Messages



Pilot version 1-minute particle pollution (PM <sub>2.5</sub> ) readings <i>Not for regulatory purposes</i>	
<b>Low</b> 0-29 ug/m <sup>3</sup>	Enjoy your outdoor activities.
<b>Medium</b> 30-69 ug/m <sup>3</sup>	If medium readings continue (for an hour or more), use the Air Quality Index to plan outdoor activities.
<b>High</b> 70 - 499 ug/m <sup>3</sup>	You may be near a source of particle pollution like dust, smoke or exhaust. Check the Air Quality Index to plan outdoor activities.
<b>Very High</b> ≥500 ug/m <sup>3</sup>	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.
	Sensor may be offline. Check the Air Quality Index.

# Ozone Sensor Breakpoints

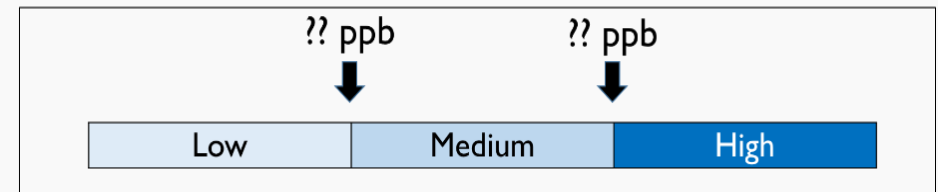


- Used available air quality data, together with judgments about the objectives for each sensor category
- Air quality analyses link 1-minute to 8-hour O<sub>3</sub> concentrations to inform sensor breakpoints without reinterpreting the health evidence
- ~7.6 million one minute ozone values from 18 sites (4 Village Green locations and 14 FRM)
- Numerous scenarios were analyzed to evaluate how 8-hour O<sub>3</sub> concentrations are distributed within various potential sensor categories

## AQI Categories (8-hr)



## Potential Sensor Categories (1-min)



# PM<sub>2.5</sub> Sensor Breakpoints



- For PM<sub>2.5</sub>, the available 1-minute data is more limited than for O<sub>3</sub>
  - **5 monitors provide 1-minute PM<sub>2.5</sub> data (DC, PA, KS, NC, NY)**
- PM<sub>2.5</sub> concentrations can exhibit sharp spatial and temporal gradients, with the potential for extremely high concentrations near sources
- PM<sub>2.5</sub> AQI categories are based on 24-hour concentrations; 24-hour PM<sub>2.5</sub> NAAQS is 35 µg/m<sup>3</sup>

## **Near-Source Concentrations**

1. Designated smoking areas:  
~ 70 to > 500 µg/m<sup>3</sup>
2. Near/on diesel buses:  
~ 75 to > 1,000 µg/m<sup>3</sup>
3. Near street paving operation:  
~ 80 µg/m<sup>3</sup>
4. Near candles/cooking  
~ 100 to > 1,000 µg/m<sup>3</sup>

# Analytical Approach for PM<sub>2.5</sub>



## Low breakpoint (30 $\mu\text{g}/\text{m}^3$ ):

- Considered relationship between 1-hour and 24-hour PM<sub>2.5</sub> concentrations
- Much more data available to identify relationships with 1-hour concentrations – almost 400 monitors covering most states
- One-hour PM<sub>2.5</sub> concentrations are better predictors of 24-hour concentrations

## Upper breakpoint (70 $\mu\text{g}/\text{m}^3$ ):

- Identification of PM<sub>2.5</sub> concentration ranges that have been measured near sources like bus terminals, smokers, cooking – high sensor readings should warn people that they may be near a PM source
- In response to high readings, people may be able to move away from sources and reduce their exposures





- Critical Topics Discussed
  - Understand the relationship between short term measurements and longer term standards based on science and health effects information
  - Create visualization tools that make continuous and discrete data more accessible and understandable
  - Develop a standardized, centralized repository of environmental metrics



# Discussion