Short-term Air Quality Data from Air Sensors: Communicating with the Public

CAAAC Meeting Presentation

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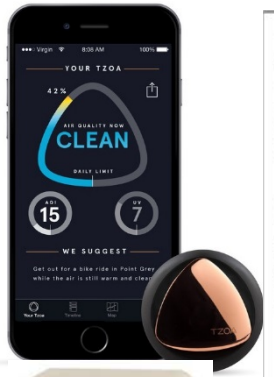
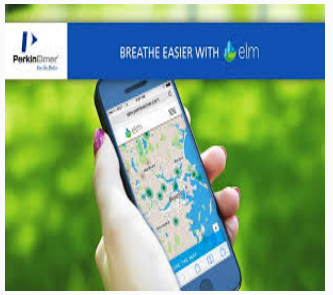
Proliferation of Sensors & Real-time Data



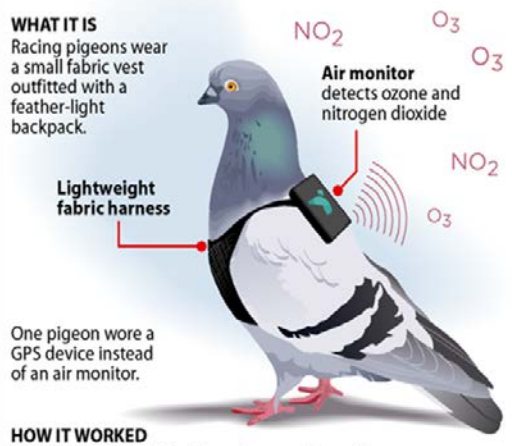


21st Century 'Canary in a Coal Mine'

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.



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

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 3rd 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

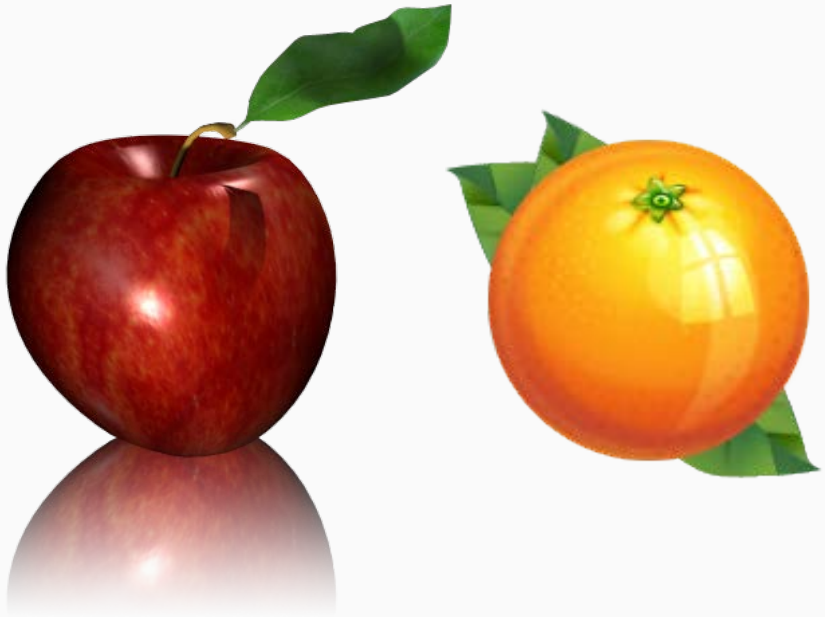
Introduction

- There is a great deal of growth in the availability, use, and quality of air quality sensors
- Sensor technology has great potential to empower people to understand local air quality but communicating real-time data is complicated
- Health studies do not support linking short term (e.g. 1-minute O_3 or $PM_{2.5}$) exposures to adverse health effects
- Many developers are incorrectly using whatever information is currently available, e.g., AQI

Sensor Reading vs. AQI

Sensor Reading ≠ Air Quality Index

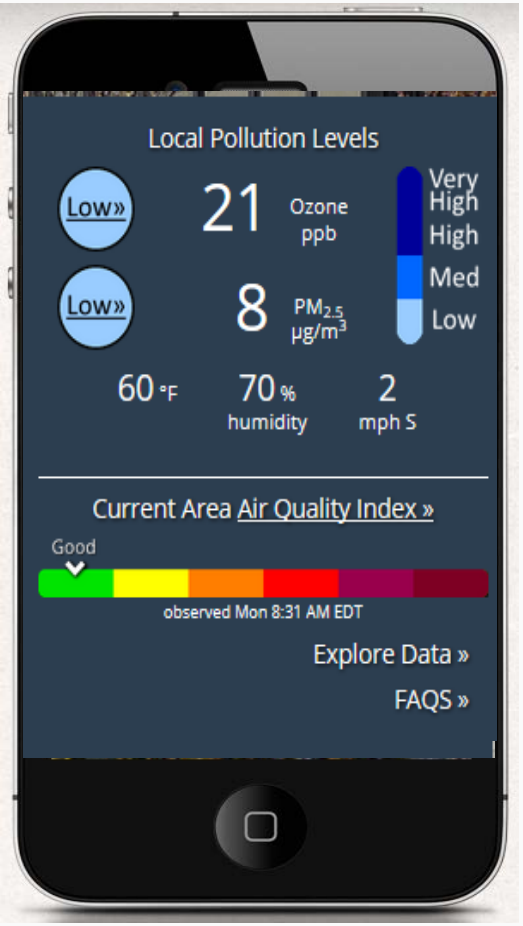
Sensor Reading
Concentration, particle count
Short term (e.g. 1 minute)
Data Quality Unknown



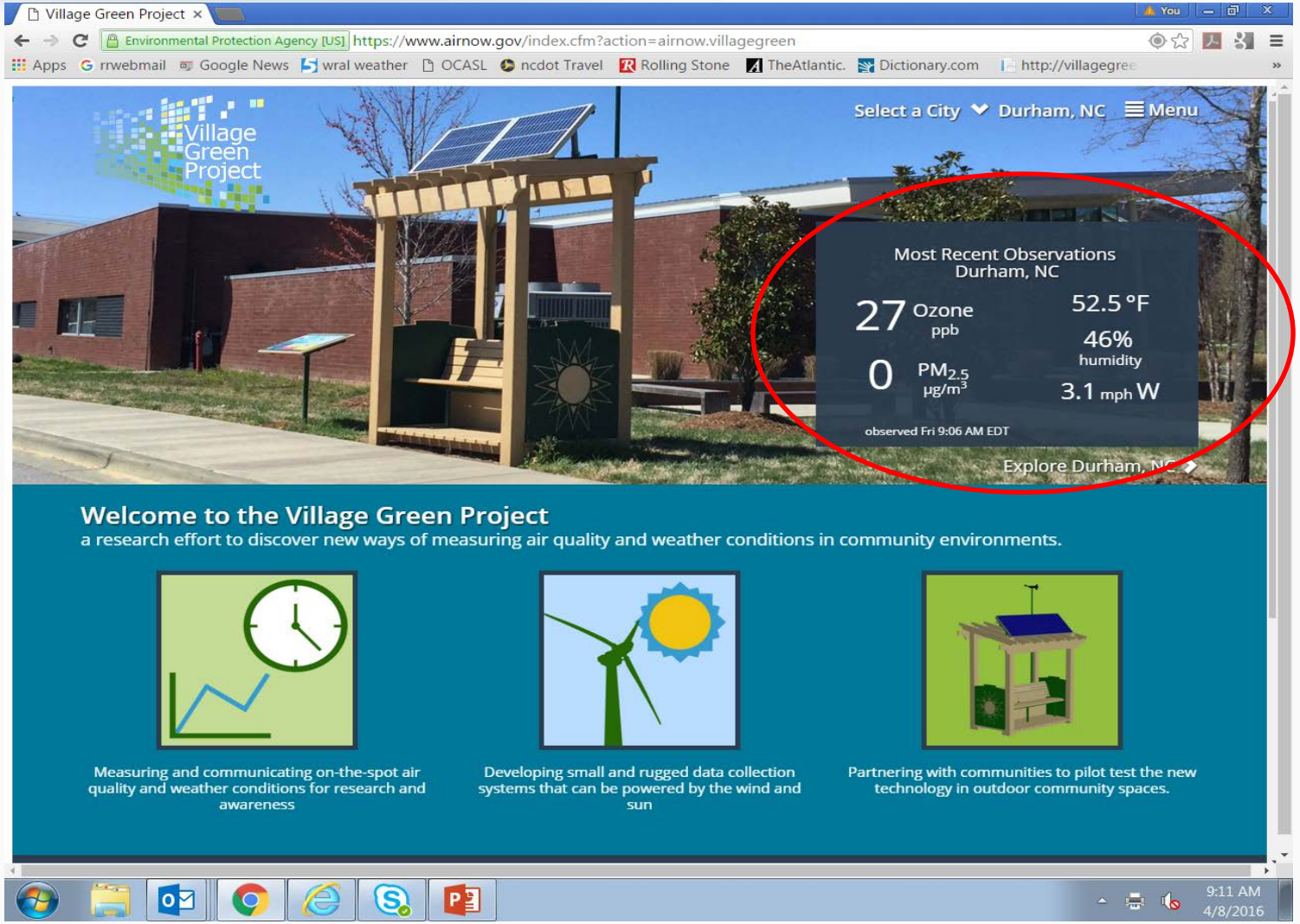
Air Quality Index
Index Color
Averaged (e.g. 8-hour, 24-hour)
Data Quality Assured

Sensor Scale Pilot Project

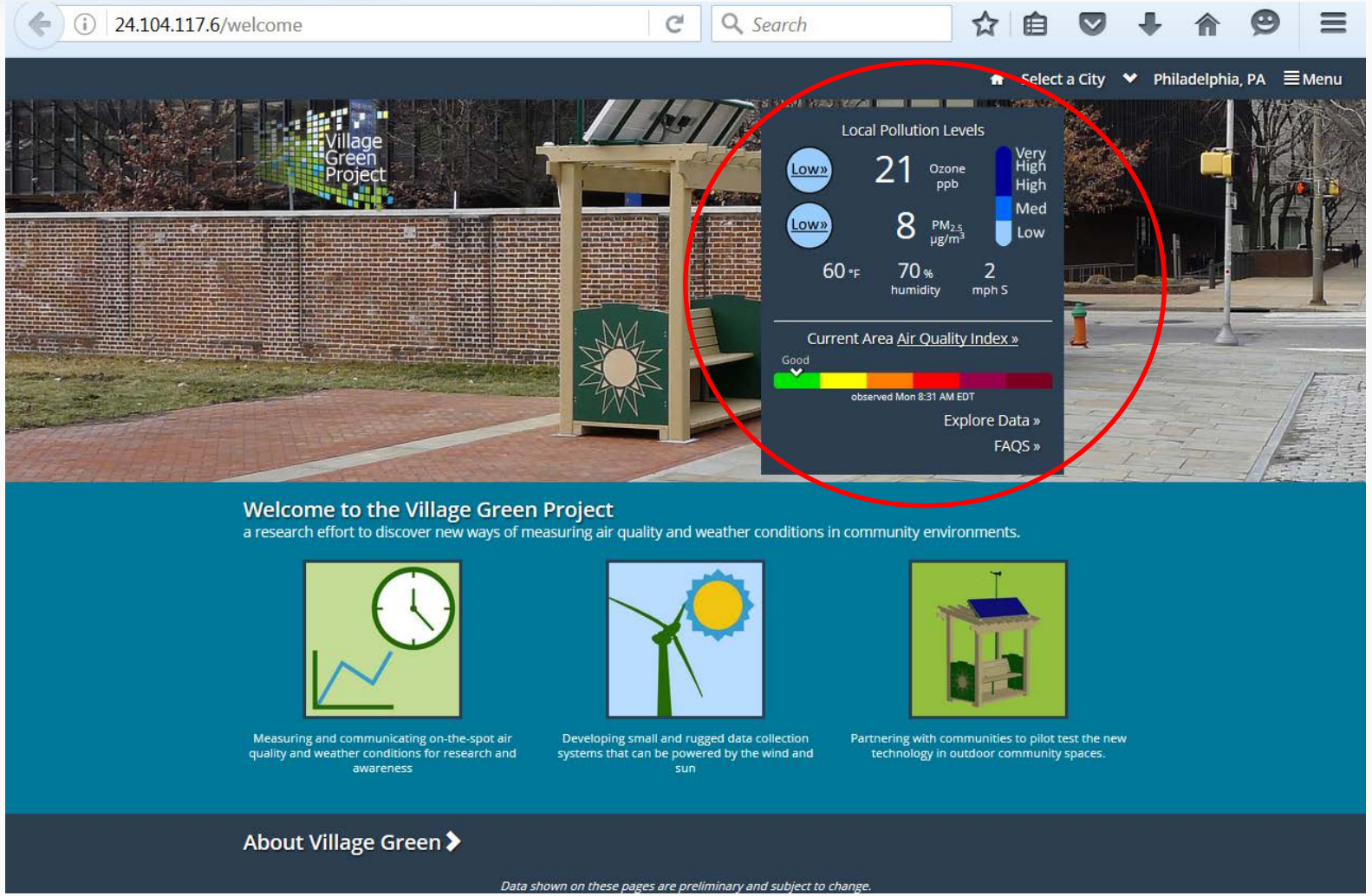
- On May 6th, EPA launched a new “sensor scale”
  - EPA developed the scale to help the public understand 1-minute data from Village Green stations
- Pilot appears on existing Village Green data webpage
  - http://bit.ly/VillageGreenPilot
- A fact sheet, FAQs, and other information available on the Air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



Previous Village Green Website



Enhanced Village Green Website



Ozone Breakpoints and Messages

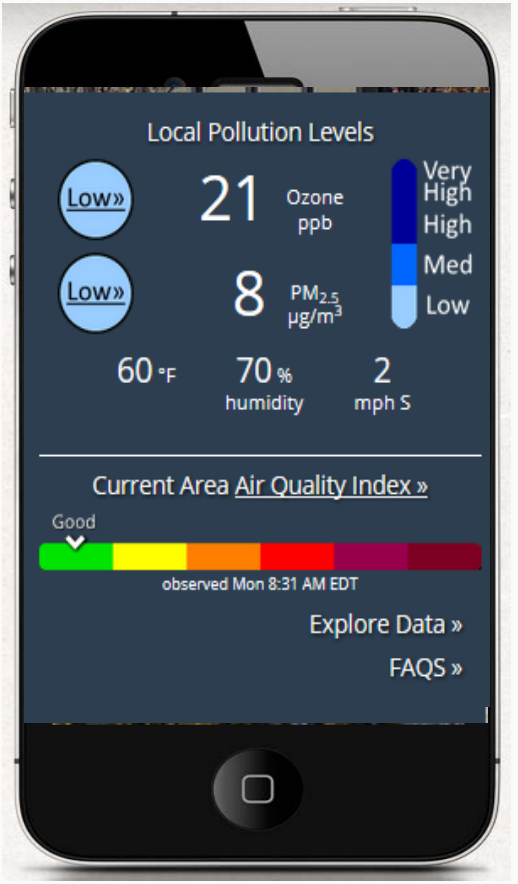
Pilot version **1-Minute Ozone Readings** ***Not for regulatory purposes***	
Low **0-59 ppb**	Enjoy your outdoor activities.
Medium **60-89 ppb**	If medium readings continue, use the Air Quality Index to plan outdoor activities.
High **90-149 ppb**	If high readings continue, consider adjusting outdoor activities, especially if you are sensitive to ozone. Check the Air Quality Index to find out.
Very High **≥150 ppb**	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.

$PM_{2.5}$ Breakpoints and Messages

Pilot version **1-minute particle pollution ($PM_{2.5}$) readings** ***Not for regulatory purposes***	
Low **0-29 ug/m3**	Enjoy your outdoor activities.
Medium **30-69 ug/m3**	If medium readings continue (for an hour or more), use the Air Quality Index to plan outdoor activities.
High **70 - 499 ug/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 ug/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.
	Sensor may be offline. Check the Air Quality Index.

Mobile Website View

- Optimized for smartphones
- Buttons are clickable to provide user:
  - Guidance on whether they should consider taking action
  - How to get further information
- Area Air Quality Index (AQI) is shown at bottom of page



Sensor Scale Pilot

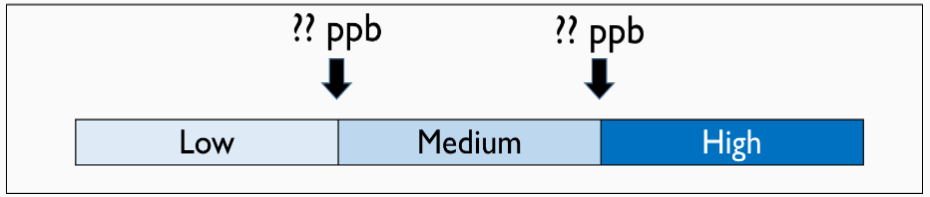
- EPA is testing the effectiveness of the scale and messages during a spring-summer 2016 pilot project
- This information is intended to provide users an additional tool for understanding air quality and exposures, and for planning activities. The sensor scale and breakpoints are not to be used for regulatory purposes.
- The scales and messages are based on analyses of U.S. air quality data, and on pollutant concentrations near sources in the U.S.; as such, they are appropriate only for use in the U.S.

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_3 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_3 concentrations are distributed within various potential sensor categories

AQI Categories (8-hr)

Potential Sensor Categories (1-min)



$PM_{2.5}$ Sensor Breakpoints

- For $PM_{2.5}$, the available 1-minute data is more limited than for O_3
  - **5 monitors provide 1-minute $PM_{2.5}$ data (DC, PA, KS, NC, NY)**
- $PM_{2.5}$ concentrations can exhibit sharp spatial and temporal gradients, with the potential for extremely high concentrations near sources
- $PM_{2.5}$ AQI categories are based on 24-hour concentrations; 24-hour $PM_{2.5}$ NAAQS is 35 $\mu g/m^3$

Near-Source Concentrations

1. Designated smoking areas:
   ~ 70 to > 500 $\mu g/m^3$
2. Near/on diesel buses:
   ~ 75 to > 1,000 $\mu g/m^3$
3. Near street paving operation:
   ~ 80 $\mu g/m^3$
4. Near candles/cooking
   ~ 100 to > 1,000 $\mu g/m^3$

Analytical Approach for $PM_{2.5}$

Low breakpoint (30 µg/m³):

- Considered relationship between 1-hour and 24-hour $PM_{2.5}$ concentrations
- Much more data available to identify relationships with 1-hour concentrations – almost 400 monitors covering most states
- One-hour $PM_{2.5}$ concentrations are better predictors of 24-hour concentrations

Upper breakpoint (70 µg/m³):

- Identification of $PM_{2.5}$ 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

Next Steps

- EPA is piloting “sensor scale” messaging
- Village Green website has a “contact us” link
- Based on feedback, EPA will update the scale and messages as appropriate. Our goal is make them available to sensor developers later this year.
  - Note: Earlier versions of the information shown in the tables and the mobile website have been focus tested, and we have solicited previously from other stakeholders – EPA plans to continue soliciting feedback

Acknowledgements

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APPENDIX

$PM_{2.5}$ Sensor Breakpoints

Lower breakpoint: Analyzed a wide range of potential breakpoints (12 to 45 µg/m^3); data supported breakpoint around 30 µg/m^3*

- With a lower breakpoint at around 30 µg/m^3:
  - Low sensor readings would correspond to the "good" and "moderate" AQI categories
  - Medium sensor readings (assuming they persist for an hour) would generally correspond to the "moderate" and "unhealthy for sensitive groups" AQI categories (consistent with O_3) – with a small percentage of days in the "unhealthy" category, depending on where the upper breakpoint is set

Upper breakpoint: Focused on the ranges of $PM_{2.5}$ concentrations that can occur near sources (e.g., diesel buses, designated smoking areas, candles, cooking, etc.)

- $PM_{2.5}$ concentrations varied widely near sources, from less than 100 µg/m^3 to several thousand µg/m^3
  (averaging periods from about 1 minute to 2 hours)
- To reflect the lower end of the range of $PM_{2.5}$ concentrations often found near sources, we identified an upper breakpoint of 70 µg/m^3 which would flag potential near-source concentrations