



EPA's Efforts on Discovery, Evaluation, and Application of Emerging Air Sensor Technologies

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Making Sense of Sensors Conference
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Sensors and Communities

Ultimately, air sensor technology has promise to reduce pollution exposure and improve public health through

- Improved knowledge on exposure to air pollution at a community and individual level
- Identification and investigation of emission sources within a community
- More extensive data supporting public health communication – e.g., sensors for Air Resource Advisors during wildland fires

Star Tribune, June 25, 2016
MINNEAPOLIS
Bicyclists strap on monitors to measure Twin Cities air quality





EPA/ORD Approach

EPA/ORD activities involve

- Air sensor market research and technology evaluation
- Development and application of custom sensor systems for specific research studies
- Development of sensor data analytics, visualization, and real-time quality assurance measures
- Outreach and training

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

The screenshot shows the EPA website's 'Air Sensor Toolbox for Citizen Scientists, Researchers and Developers' page. The page features the EPA logo, navigation links for 'Environmental Topics', 'Laws & Regulations', and 'About EPA', and a search bar. The main content area includes a headline 'Putting new ways to measure air quality into the hands of the public.' and a large image of a blue toolbox labeled 'Air Sensor Citizen Science Toolbox' with the tagline 'Measure · Learn · Share'. To the right, there are social media share icons and a 'CONTACT US' link. A sidebar on the right lists 'Announcements', 'Air Sensor Blogs', and 'Related Links' including 'Air Trends Report', 'AirNow - Current Air Quality', and 'Air Research'. A footer at the bottom states: 'This website provides information for citizen scientists and others on how to select and use low-cost, portable air sensor technology and understand results from monitoring activities. The information can help the public learn more about air quality in their communities.'



Custom Sensor Systems

Development and application of custom sensor systems

Village Green Project



Drop-in-place sensor pods



Mobile sensors



Fenceline monitoring



Aerial systems



Most common measures:
PM_{2.5}
Ozone
NO₂
VOCs
Black carbon



Wildland Fire Sensors Challenge





Village Green Project

Community-based research project designed to

- Demonstrate the capabilities of new real-time monitoring technology
- Provide first real-time streaming of air quality data by EPA
- Help residents and citizen scientists learn about local air quality

Key Features:

- Mid-cost pollutant sensors (PM, ozone, etc.)
- Meteorological sensors (temp, RH, WS, WD)
- Power supply (solar panels & battery)
- Microprocessor and cellular modem

Ongoing Work:

- Full design, operational specifications, and access to historical data - expected in 2018





Village Green Partners

City of Philadelphia and
National Park Service



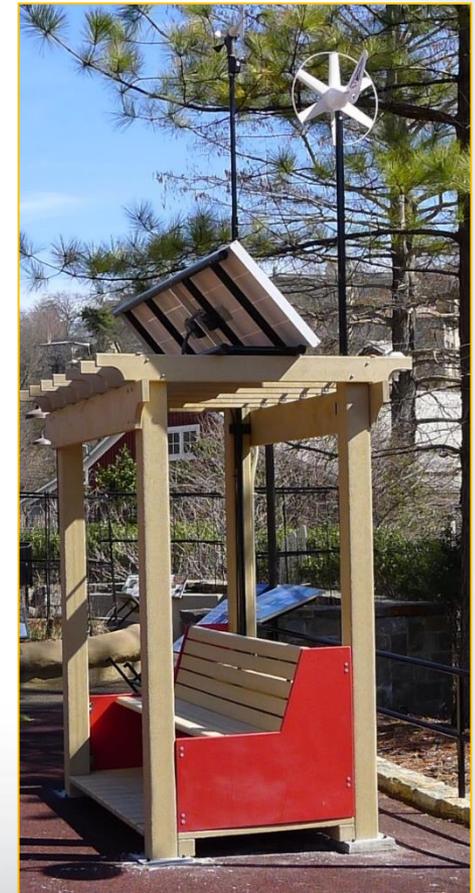
State of Oklahoma and
Myriad Botanical Gardens



State of Kansas,
Wyandotte County,
and School District



District Department
of the Environment
and Smithsonian

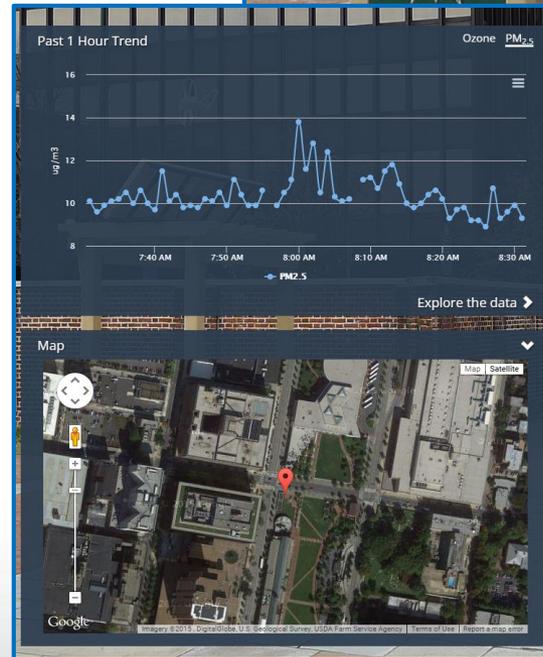




Village Green Data & Messaging

The data website allows users to

- Access real-time pollutant data in their community
- Explore historical data to understand the variability in pollutant concentrations
- Access the health-based Air Quality Index for their area
- Better understand the pollutant concentration based on the sensor scale categorization



Real-time data and interactive exploration available online at: airnow.gov/villagegreen

More information on the sensor scale categories and the development process is available at: www.epa.gov/air-sensor-toolbox/what-do-my-sensor-readings-mean-sensor-scale-pilot-project



AirMapper

The AirMapper collects real-time data about pollutants and the environment:

- Portable, small, and lightweight allowing it to be carried to mounted to a bicycle
- Allows citizen scientists and students to explore the community and learn about factors that influence air quality

Key Features:

- Low-cost pollutant sensors (PM, CO₂)
- Other environmental sensors (temp, RH, noise)
- Accelerometer and GPS
- Rechargeable battery power
- On-board data storage
- Touchscreen interface





Citizen Science Air Monitor

The CSAM is an evolving portable monitor collecting real-time data about pollutants and the environment:

- Numerous community applications through the country
- Allows citizen scientists to establish a small network of monitors to investigate community air quality issues

Key Features:

- Low-cost pollutant sensors
- Meteorological sensors (temp, RH, etc.)
- On-board data storage + cellular modem
- Power options including solar
- Portable and easy to use





Data Interpretation Tools

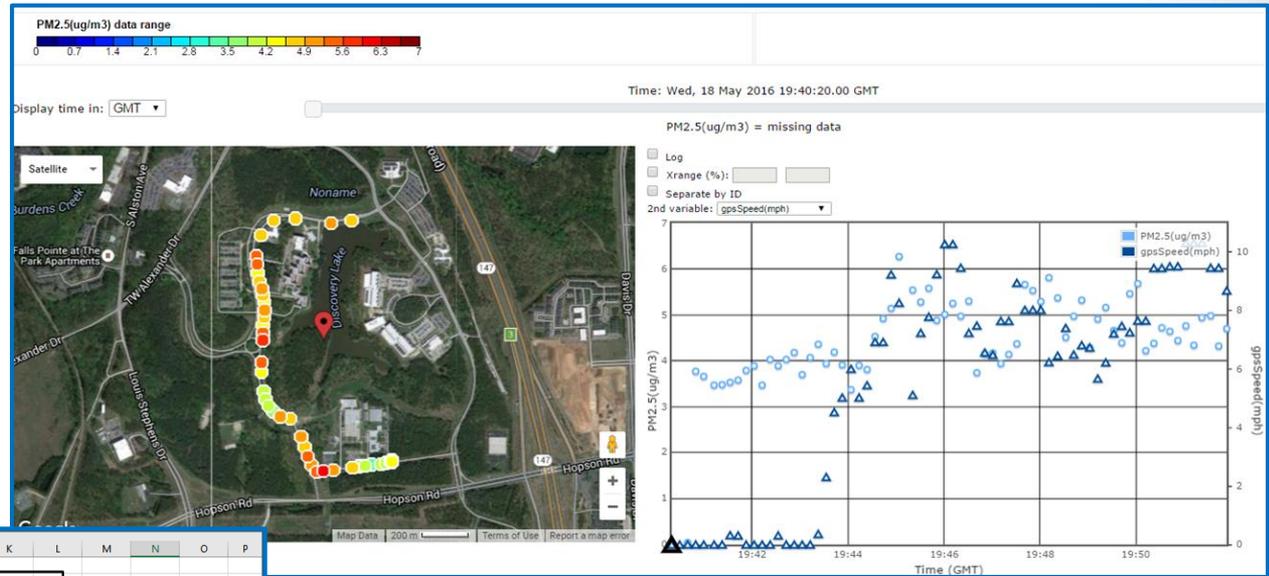
Development of a variety of tools to help users understand the quality of their sensor data and to visualize the results

Sensor Evaluation and Collocation Instruction Guide

How to Evaluate Low-Cost Sensors by Collocation with Federal Reference Method Monitors

National Exposure Research Laboratory
Office of Research and Development

RETIGO



Macro Analysis Tool

Macro Analysis Tool - MAT
Use this tool to process sensor data, reference data, or both!

This tool can

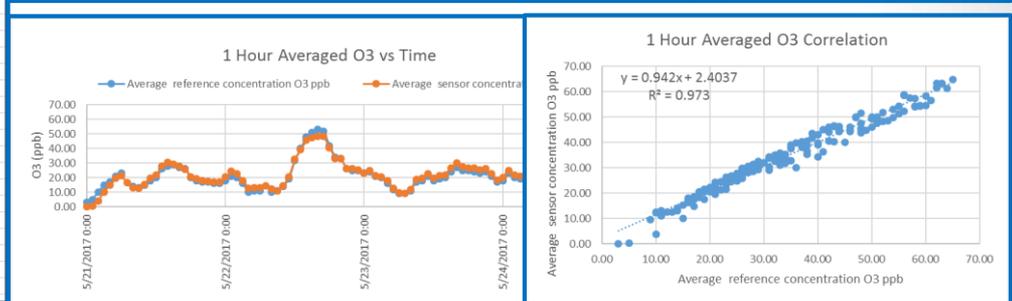
- time match the sensor and reference data streams.
- average selected data into longer time averages.
- plot a time series of selected data.
- plot sensor versus reference data and develop a regression equation.

This tool cannot

- process time stamps expressed as fractions.
- process input time intervals that vary.
- run reliably using Excel versions **XX** and Windows versions **XX**.

Control Panel

Instructions





Collocation Guide

Instructional guide for conducting a successful collocation evaluation of air sensors with regulatory grade instruments:

- Provided as a PowerPoint presentation for easy reading for a wide audience with visuals, examples, and links
- Helps users evaluate collocation data and to interpret the quality of the measurements for communication to others
- Public release to the Air Sensors Toolbox – expected late 2017

Topics Covered:

- Low-cost sensors vs reference
- Introduction to collocation
- Planning collocation
- Making measurements
- Data recovery and review
- Data comparison
- Using sensors



How to Evaluate Low-Cost Sensors by Collocation with Federal Reference Method Monitors

National Exposure Research Laboratory
Office of Research and Development





Macro Analysis Tool

Easy-to-use spreadsheet-based macro tool for performing data comparisons and interpreting the results:

- Tackles a big hurdle for citizen-led community air monitoring projects – working with the data
- Public release to the Air Sensors Toolbox – expected late 2017

The tool will

- Time match the sensor and reference data
- Average data into longer averaging times
- Plot a time series of selected data
- Plot sensor versus reference data and develop a regression equation

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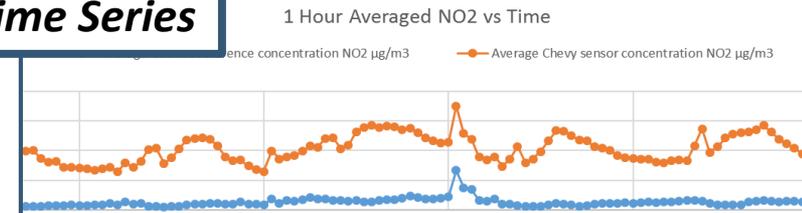
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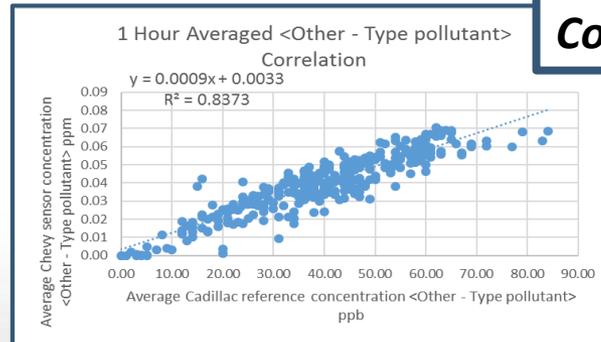
Control Panel

Instructions

Time Series



Correlation





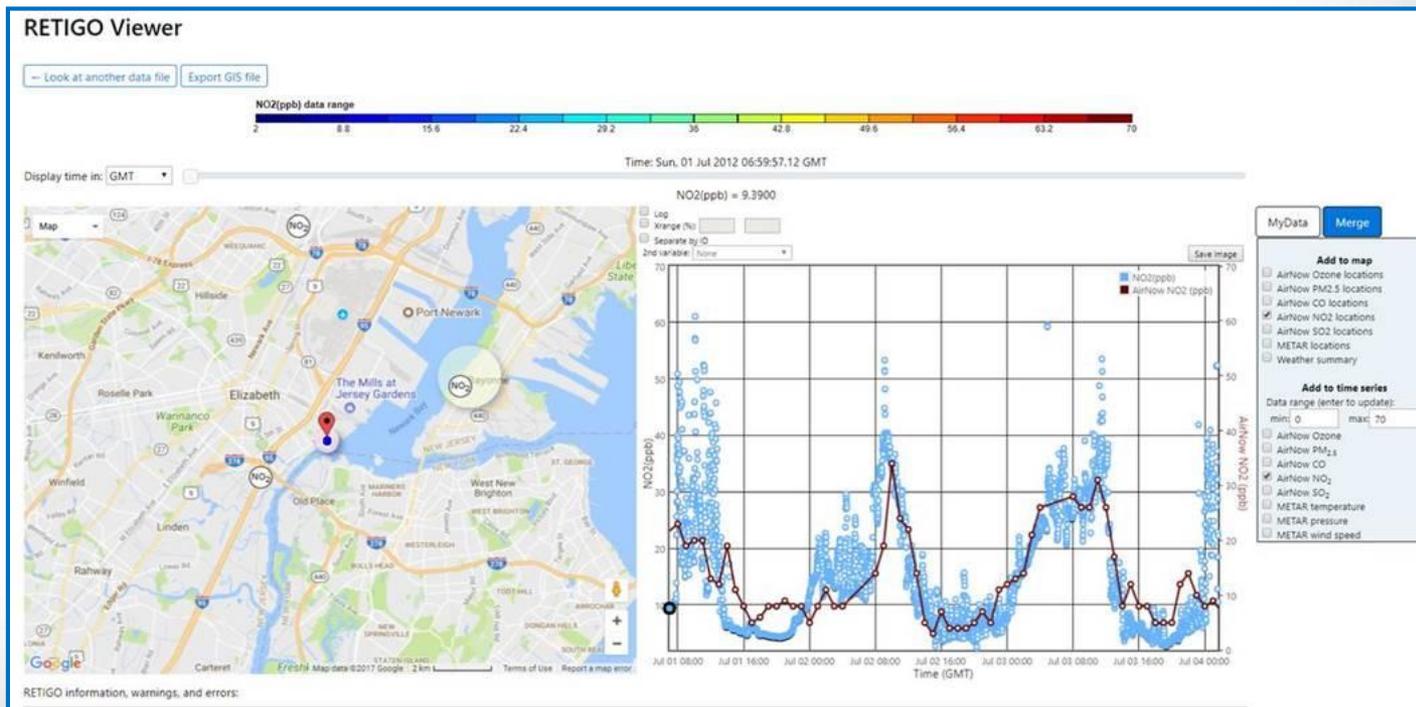
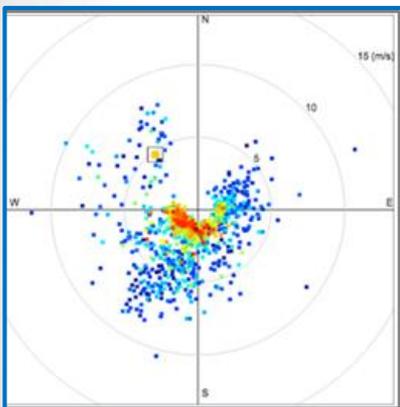
RETIGO

Real Time Geospatial Data Viewer (RETIGO) is a free, web-based tool that can be used to explore stationary or mobile environmental data:

- Adds data from nearby air quality and meteorological stations
- Added functionality in Version 3 – expected early 2018

Online at:

www.epa.gov/retigo





Acknowledgements

Contacts:

- Air Sensors Toolbox: www.epa.gov/air-sensor-toolbox
- Sensor Evaluation – Ron Williams, Andrea Clements, Teri Conner
- Village Green Project – Ron Williams, Sue Kimbrough
- Sensor Messaging – Kristen Benedict
- AirMapper – Sue Kimbrough, Ron Williams, Gayle Hagler
- CSAM – Ron Williams
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- RETIGO – Gayle Hagler, Heidi Paulsen