EPA's Air Sensor Toolbox for Citizen Scientists

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Abstract

The general public is increasingly interested in environmental data specific to their family or community. This is driven by many factors including concerns citizens have about known or perceived local pollution sources. Low-cost air pollution sensors and monitors have recently been introduced into the public domain, giving residents the opportunity to collect environmental data for their own use. This poster discusses challenges and opportunities associated with these new citizen science activities and describes emerging technologies available to support it. In addition, the poster introduces the Air Sensor Citizen Science Toolbox, including Community Air Monitoring Training, sensor evaluation reports, and the RETIGO tool.

Citizen Science: Challenges and Opportunities

Citizen Scientists are using increasingly more reliable lower cost air pollution monitors to collect environmental measurements data to better understand individual health, community exposures, conduct research, and for other purposes. However, most citizens do not have the technical training to operate environmental monitors or interpret the results and most of the lower cost environmental monitors have not been evaluated for their performance characteristics.

A Typical Low Cost Monitor:
- Inexpensive ($100 to $2000) to purchase
- Highly portable and easy to operate (often mobile)
- Requires little or no training to start collecting data
- Inexpensive to operate (replace or recharge batteries)
- Lifetime of service not expected to exceed 1-2 years

Common parameters measured by sensors:
- Particles: optical measurement (not mass measurement)
- Ozone: metal oxide and electrochemical sensors
- Oxides of nitrogen (NO, NO_2): metal oxide and electrochemical sensors
- Carbon monoxide: metal oxide and electrochemical sensors
- Total volatile organic compounds (VOCs): photoionization detector (PID)
- Carbon dioxide: non-dispersive infrared sensors (NDIR)

Pollutants for which low-cost (<2K), ambient-level of sensitivity is lacking:
- Particle mass measurement
- Particle components (e.g., black carbon, organic carbon, nitrate)
- Sulfur dioxide
- Speciated organics

Example devices on the market include turnkey sensors as well as original equipment manufacturer (OEM) components used in maker projects:

Notes: 1. Cairpol nitrogen dioxide/ozone sensor; 2. School application of nitrogen dioxide sensor during DISCOVER-AQ study; 3. Citizen Science Air Monitor (CSAM) demonstration; 4. AirBeam particle sensor developed by HabitatMap's AirCasting project; 5. Dylos particle counter; 6. MetOne particle counter; 7. Shinyei particle sensor; 8. Air Quality Eggs; 9. Community group operating Dylos particle counters on bicycles; 10. AQMesh multipollutant sensor system.

Community Air Monitoring Training

30 in-person attendees, 800+ via webinar

July 9, 2015: A Glimpse into EPA's Air Sensor Toolbox
Goals:
- To share tools, best practices, and resources from EPA's Air Sensor Toolbox for Citizen Scientists
- To educate interested groups and individuals on how to conduct successful air monitoring projects.

Presentations included:
- Air quality basics, air pollution monitoring, sensor technology, performance goals.
- How to start a citizen science program / obtain funding.
- Citizen science study design.
- Data measurement, management, quality, uncertainty.

Air Sensor Toolbox

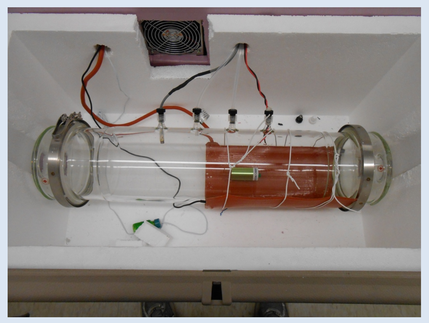
The Air Sensor Toolbox for Citizen Scientists provides guidance and instructions to citizens to allow them to effectively collect, analyze, interpret, and communicate air quality data. This includes a list of devices with known performance characteristics, sampling methodologies, generalized calibration/validation approaches, measurement method suggestions, and data interpretation guidelines. The ultimate goal of the Toolbox is environmental awareness of local pollution levels through citizen-based environmental monitoring.

Air Sensor Toolbox Website:
http://www.epa.gov/heasd/airsensortoolbox/

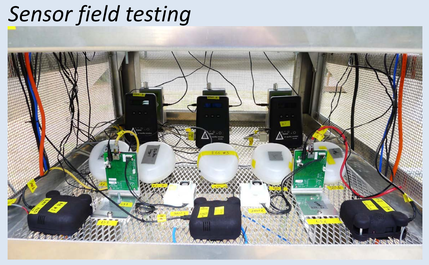
The Air Sensor Toolbox provides:
1. Guidance on how to identify pollutants of interest, appropriate sensors
2. Easily understandable operating procedures for highly portable sensor units
3. Quality assurance guidelines
4. Guidance and deployment recommendations based on pollutants and sources
5. Basic ideas for data analysis, interpretation, and communication
6. Citizen Science Funding Resource Guide
7. Fact sheets, news articles and blogs

Example reports

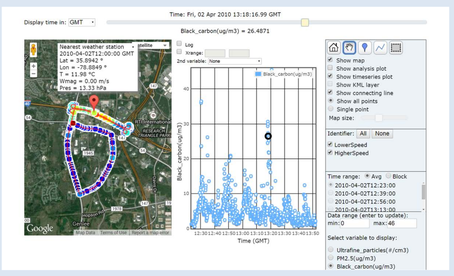
Sensor laboratory testing



Sensor field testing



RETIGO data visualization tool



Data visualization tool: Real-Time Geospatial Data Viewer (RETIGO)
Website: www.epa.gov/retigo

RETIGO Target attributes
- Non-hardware specific – generic and flexible data input format.
- Comfortable to use for an individual with only intermediate-level experience in Excel.
- Provides interactive data visualization for geospatial air monitoring time series.
- Supports inclusion of complementary web-available data.

Next-Generation Air Measurement Research

Ongoing and new research projects evaluating/applying emerging air monitoring technologies

Region 1: CAIRSENSE, Village Green Project
Region 2: Citizen Science Air Monitor (CSAM), RETIGO
Region 3: VOC sensors (SPOD), Village Green Project
Region 4: Lead on RM (CAIRSENSE) and RESES (CitySpace) projects
Region 5: RARE (Village Green Project, AirMapper)
Region 6: RARE (Village Green Project), CitySpace
Region 7: CAIRSENSE, CitySpace, Village Green Project
Region 8: CAIRSENSE
Region 9: RARE (ozone sensors)
Region 10: RESES (PM sensors at bus stops)