science in ACTION
INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE

Community-led air sensor evaluation:
Tools for citizen scientists

Background

As air sensor technology advances, new smaller and lower-cost air quality monitors have emerged, creating exciting opportunities for a range of uses beyond traditional regulatory monitoring.

These low-cost, portable, and easy to use sensors make it possible for citizens to collect air quality data in their own communities. Citizens can compare their results with existing state or local regulatory monitoring data, obtain personal exposure information, or learn about local air quality in their homes, neighborhoods, communities, or regions.

Low-cost sensors versus regulatory monitors

The [Clean Air Act](#) requires states to use regulatory monitors to measure common ambient air pollutants and these monitors must meet specific federal standards. The instruments and methods used at regulatory monitoring stations are called [Federal Reference Methods (FRM) or Federal Equivalent Methods (FEM).](#) These instruments are considered the

EPA and partners from the Eastern Band of Cherokee Indians review the assembly of a weather shelter for low-cost sensors.

"gold standard" in air quality monitoring, and can be used to evaluate the performance of other sensors that might be lower cost and less reliable.

While low-cost sensors can measure many of the same air pollutants that costlier regulatory monitors measure, they aren't required to meet the same rigorous standards of accuracy and reliability. Collocation of low-cost and regulatory monitors is one method to determine if data from the low-cost monitors is comparable to the federal standards.

New tools for citizen scientists

EPA has developed a guide and analysis tool for citizen scientists to evaluate the performance of low-cost sensors and interpret the data they collect to help citizen scientists interested in learning about local air quality.

Instruction Guide

The first tool is an instruction guide on conducting a successful collocation evaluation of low-cost air sensors. Collocation refers to the process of operating a regulatory grade reference monitor (FRM/FEM) and non-

reference monitor (low-cost sensor) side-by-side in real-world conditions for a defined evaluation period. Collocating low-cost sensors with regulatory monitors can help citizen scientists evaluate their sensors' performances and the accuracy of their data.

The instruction guide contains links to web-based supporting materials and introduces users to the second product–-a Macro Analysis Tool.

Macro Analysis Tool

EPA created the user-friendly, Excel-based Macro Analysis Tool to help citizen scientists compare data from low-cost sensors to data from regulatory monitors, and interpret their results. The tool allows users to input data from low-cost and regulatory monitors for comparison, even if measurements weren't recorded at precisely the same time, or were collected at different time intervals (e.g., 1-minute vs. 5-minute intervals).

This tool addresses one of the major hurdles in citizen-led community air monitoring projects, which is working with and understanding the data.

How were these tools developed and who should use them?

The tools were developed as part of a community-led air sensor evaluation project initiated during fall 2016 in support of EPA's emerging technologies research

program. During the year-long project, EPA partnered with one community group (Clean Air Carolina) and one tribal nation (Eastern Band of Cherokee Indians) to conduct a sensor performance evaluation using their choice of low-cost sensors. Both project partner groups used the tools and gave feedback on how to better tailor them to a citizen scientist audience.

While EPA developed each of these tools to be suitable for citizen scientists and communities, they are also useful to the broader air sensor user community, both experts and non-experts. Furthermore, the Macro Analysis Tool can be used to compare datasets beyond the specific collocation application it was designed for, such as comparing data from one low-cost sensor to another.

These tools are EPA's latest efforts to assist users in understanding and effectively using low-cost sensors.

Where can I find these tools?

Both tools, and other helpful resources including a guidebook, sensor evaluation reports, training and links to other resources, are available through [EPA's Air Sensor Toolbox](). Download the Instruction Guide and Macro Analysis Tool at: [www.epa.gov/air-research/instruction-guide-and-macro-analysis-tool-community-led-air-monitoring]().

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