

EPA Tools & Resources Webinar Q&A

Enhanced Air Sensor Guidebook

1. Do you have suggestions regarding portable air sensors, for indoors and outdoors?

As a federal agency, EPA cannot endorse or recommend specific products or companies. But, we do offer resources to help those interested select air sensor technologies to match their local needs: (1) *The Enhanced Air Sensor Guidebook* (<https://www.epa.gov/air-sensor-toolbox/how-use-air-sensors-air-sensor-guidebook>), and (2) Six Questions to Ask Before You Buy a Lower-Cost Air Sensors (<https://www.epa.gov/air-sensor-toolbox/selecting-lower-cost-air-sensor-monitors>). The six-questions guide is included in *The Enhanced Air Sensor Guidebook* (see Section 3.4), as well as on EPA's Air Sensor Toolbox website in both English and Spanish.

2. Is there a recommended way to evaluate popular air quality sensors for performance?

EPA published recommended testing protocols to evaluate the performance of air sensors measuring fine particulate matter and ozone. These recommendations are meant for non-regulatory supplemental and informational monitoring applications in ambient, outdoor, fixed site environments only. EPA also plans to publish similar protocols for sensors measuring particles with diameters of 10 microns or less (PM₁₀), nitrogen dioxide, carbon monoxide, and sulfur dioxide.

Please visit the Sensor Performance Targets and Test Protocols page on the Air Sensor Toolbox website for more information: <https://www.epa.gov/air-sensor-toolbox/air-sensor-performance-targets-and-testing-protocols>.

3. What is your experience with the AirNow Sensor Data?

Air sensors have several limitations including:

- Sensors may occasionally report questionable data;
- Sensors have a bias, which means they regularly report a higher or lower amount of pollution than is in the air; and
- Most sensors are not located or operated by air monitoring experts.

Despite these limitations, air sensors can provide valuable information about air quality especially in areas located between where regulatory monitors are placed, and at times when air quality conditions are changing rapidly.

Before deciding to display air sensor data alongside data from more traditional monitors on the AirNow Fire and Smoke Map, EPA's Office of Research and Development engaged in research to better understand the quality of the sensor data and determine the quality assurance and data correction steps needed to ensure the sensors could provide comparable data. Learn more about that effort and methodology by reading these two open

access journal articles:

1. Barkjohn, K. K., Gantt, B., and Clements, A. L.: Development and application of a United States-wide correction for PM2.5 data collected with the PurpleAir sensor, *Atmos. Meas. Tech.*, 14, 4617–4637, <https://doi.org/10.5194/amt-14-4617-2021>, 2021.
2. Barkjohn, K.K.; Holder, A.L.; Frederick, S.G.; Clements, A.L. Correction and Accuracy of PurpleAir PM2.5 Measurements for Extreme Wildfire Smoke. *Sensors* 2022, 22, 9669. <https://doi.org/10.3390/s22249669>

Quality control steps and the scientific correction equation are applied to the sensor data before it is displayed on the AirNow Fire and Smoke Map. These steps reduce the bias in the sensor data and make it more comparable to data from monitors operated by experts. Users have found the sensor data to be an informative addition giving them a better understanding of local air quality and rapid changes in air quality from the movement of smoke.

Learn more by clicking the FAQ button in the upper right of the map at <https://fire.airnow.gov/> and dive deeper by visiting the [user guide and question and answer documents](#) for the map.

4. Is the siting information included in the Guidebook, or is there a different link?

Yes, guidance on the siting of sensors is discussed in the *Enhanced Air Sensor Guidebook* in Section 3.5. That section links to additional resources including a page on the Air Sensor Toolbox which illustrates some examples: <https://www.epa.gov/air-sensor-toolbox/guide-siting-and-installing-air-sensors>.

5. Do you work directly with or advise grassroots groups who are planning a multiple site air monitoring project?

EPA is frequently contacted by groups planning small- and large-scale air monitoring projects using air sensors. As our schedules permit, we provide general guidance and technical information based on our research experiences. This service is offered to anyone. EPA also conducts projects with select groups; this is typically arranged through the EPA's regional offices. These collaborations typically address specific needs of the EPA Regions and their external partners and vary in scope and partner involvement.

6. What about sensor standards? How do we make sure the data we are gathering are accurate and repeatable? Collocations are time consuming and can be difficult for the public to access. Any comments?

EPA has recommended performance targets (testable performance metrics) for fine particulate matter and ozone sensors. More information can be found on the Sensor

Performance Targets and Test Protocols webpage: <https://www.epa.gov/air-sensor-toolbox/air-sensor-performance-targets-and-testing-protocols>.

To ensure sensor data is accurate and repeatable, collocation is recommended. Section 3.6 of *The Enhanced Air Sensor Guidebook* provides detailed information on how to conduct collocation and how to use the collocation results to correct sensor data to make it more comparable to reference monitor data.

Additionally, EPA developed a *Collocation Instruction Guide* and *Macro Analysis Tool* to help analyze collocation data. Those resources can be found here: <https://www.epa.gov/air-sensor-toolbox/air-sensor-collocation-macro-analysis-tool>

7. Does EPA evaluate specific sensor technology and out-of-the-box products that are being commercially produced?

EPA evaluates select sensor technologies and posts the evaluation results on the Air Sensor Toolbox website. Evaluations can be found here: <https://www.epa.gov/air-sensor-toolbox/evaluation-emerging-air-sensor-performance>

8. Does the Enhanced Air Sensor Guidebook include guidance about radon monitors?

Radon is primarily a concern for indoor air environments. Although the Guidebook discusses some indoor air considerations, it is focused on outdoor air pollution so you will not find substantial discussion of radon.

We recommend visiting <https://www.epa.gov/radon> for more information on this pollutant.

9. When you say air sensor data is non-regulatory, does that mean it cannot be used in enforcement against certain companies or local governments?

Data from new air sensor instruments should not be used in a regulatory context at this time unless those instruments meet all applicable regulatory requirements.

For compliance with the National Ambient Air Quality Standards (NAAQS), monitoring instruments, including sensors, must meet the applicable requirements in the Code of Federal Regulations (CFR) – Part of Title 40, Protection of Environment, or other state environmental regulations (see, e.g., 40 CFR Parts 50, 53, and 58).

For more information, please see the 6/22/2020 memo from EPA's Office of Air and Radiation found here: https://www.epa.gov/sites/default/files/2020-07/documents/air_sensors_memo_june_22.2020.pdf

10. Are there any criteria about the sensor metrics used in evaluation? Such as, how good is good enough in terms of accuracy or precision?

EPA published recommended sensor performance metrics (precision, bias, linearity, error) and corresponding target values for fine particulate matter and ozone sensors used in non-regulatory supplemental and informational monitoring applications (NSIM) for ambient, outdoor, fixed site environments. Sensor users can use this information to gage how well a sensor performs. More information can be found on the Sensor Performance Targets and Test Protocols webpage: <https://www.epa.gov/air-sensor-toolbox/air-sensor-performance-targets-and-testing-protocols>

11. Who approves the reliability of the sensors in general?

Currently, there is no entity that approves the reliability of sensors. Sensor users must determine which sensors are reliable enough for their intended application. Many organizations evaluate the performance of different sensor types and publish the results. The resource links listed at the end of Section 4.2 of the *Enhanced Air Sensor Guidebook* point to many of these organizations. Sensor users should keep in mind that evaluation approaches and the performance metrics reported can vary from organization to organization.

12. We are grassroots groups trying to uncover air pollution levels next to or at fence line of pollution source facilities or mobile sources. We want to bring these data to permit processes about new sources of pollution as part of cumulative impacts. The sensors you provide info for are “not for regulatory use” — so this does not fulfill our needs. What should we do?

We recognize the interest in using sensors to uncover air pollution problems. While sensors are not appropriate for regulatory use, they may inform the collection of additional measurements using regulatory-grade monitors.

Chapter 3 of *The Enhanced Air Sensor Guidebook* details the steps involved in planning a monitoring study. Depending on the purpose of data collection, a Quality Assurance Project Plan (QAPP) might be needed to provide confidence in the data collected. The checklists provided in Appendix B can help you effectively plan a study and be prepared to answer questions from others if you decide to share your plans, data, and results to encourage action.

13. Will there be guidance to community users on how to choose the specific sensors that best address their monitoring needs?

We recommend that community users read Chapter 3 of the *Enhanced Air Sensor Guidebook*. Choosing the right sensor for your monitoring needs often depends on the questions the community is trying to answer, the pollutants that need to be measured, the features required in a sensor device, and the data quality required.

More specifically, Section 3.4 of the *Enhanced Air Sensor Guidebook* focuses on Selecting an Air Sensor. Section 4.4 discusses how performance evaluation results can be used to estimate sensor data quality so that users can use this information to make informed purchasing decisions.

14. Where's the best place to find out about sensor-related workshops?

Workshops offered by the EPA are typically announced on our websites and through our listservs. To subscribe to the Air Sensors Listserv, visit the [Air Sensor Toolbox website](#), scroll down to below the banner and look for the Air Sensor Toolbox logo on the right. Within that box you can register to “get air sensor news by email.” After registering, you will be presented with the option to register for other listservs.

This is a direct link to information about the 2023 Air Sensor Quality Assurance Workshop: <https://www.epa.gov/amtic/2023-air-sensors-quality-assurance-workshop>

Lastly, the Air Sensors International Conference also holds virtual webinars and conferences and is a great place to connect with other sensor users. You can find out more about those offerings on their website: <https://asic.agrc.ucdavis.edu/>

15. Where's the best place to find out about EPA's air sensor research?

The Air Sensor Toolbox website (<https://www.epa.gov/air-sensor-toolbox>) is EPA's portal for sharing air sensor related information and resources. The site offers users information on sensor performance, evaluation, and use, data interpretation guidance, information about EPA air sensor research, and a large variety of resources and links.

Learn about EPA's latest research developments and announcements via social media, Twitter: @EPAresearch; and Facebook: U.S. EPA Research

16. What are the limitations and potential sources of error when using air sensors as described in the *Enhanced Air Sensor Guidebook*, and how can these be addressed to ensure accurate and reliable monitoring of air pollution in communities?

Section 2.3 of the *Enhanced Air Sensor Guidebook* describes some of the key differences between various types of monitoring equipment, including air sensors. Section 3.4.1 discusses some of the limitations associated with air sensors. Processes like collocation (Section 3.6.1), data correction (Section 3.6.2), and quality assurance and control (Section 3.7) can help to address some sources of error such as sensor bias. However, not all limitations can be addressed, and a different measurement method may be needed.