WILDFIRE SMOKE FACT SHEET

Using Air Quality Sensors for Smoke: What to Consider

Air sensors, also called portable, low- or lower-cost air quality sensors, or sometimes "monitors," have made it easier for people to monitor air quality where they spend time. Air sensor costs range from under $100 to several hundred dollars. Because they provide localized readings, air sensors can help you make decisions about personal activities, but they are not intended to replace the highly accurate readings taken by monitors typically used by government agencies.

Learning how to use an air sensor can help you get the most useful information from your device during a wildfire smoke event. This fact sheet focuses on using sensors to measure fine particulate matter ($PM_{2.5}$), the most common pollutant in wildfire smoke. Many of the recommendations in the fact sheet also apply to sensors for other pollutants like nitrogen oxides, carbon monoxide, and ozone.

How Air Sensors Can Help You

During wildfire smoke events, air sensors can provide useful, real-time information about $PM_{2.5}$ levels outdoors and indoors. Data from sensors can help you:

- make decisions about where to go to avoid smoke exposure.
- identify better times to go outside (ideally when smoke levels are relatively low).
- understand what actions, like air filtration, most effectively reduce your smoke exposure indoors.

How to Choose an Air Sensor

Look for a sensor that measures $PM_{2.5}$. Here are some things to consider before purchasing a sensor to measure smoke:

How will you access the data from your sensor?

Some sensors:

- connect to the internet via WiFi or cellular networks and allow you to view or download your data on a website or mobile device app.
- store data on a removable memory card that you can download and analyze on a computer.
- display graphics, colors, or numbers to indicate real-time pollutant levels directly on the device or related app.

What type of sensor best fits your needs?

For example:

- A sensor with a display provides information about current $PM_{2.5}$ levels quickly.
- One that connects to a website or app will allow you to view your $PM_{2.5}$ levels remotely or compare it to other areas.

How will you power the sensor?

Some sensors:

- plug into a wall outlet.
- charge using small solar panels.
- provide battery backup.

Where to Place an Air Sensor

Before you place an air sensor, consider your objectives: *What do I want to learn about $PM_{2.5}$ from this sensor?*

- Using sensors outdoors can help you decide whether to hold outdoor sports practice or engage in other outdoor activities.
- Using a sensor in the room where you will use an air cleaner can help you decide when to turn on your air cleaner.

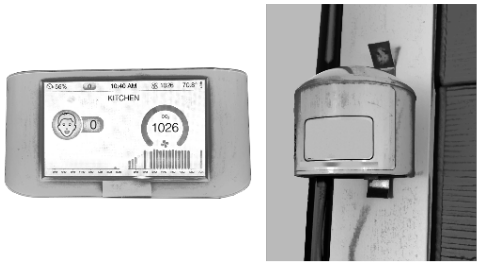

Figure 1: Indoor and outdoor sensors

These objectives will help you understand where to place the sensor, and which areas to avoid.

- Try to place the sensor 3-6 feet off the ground (at breathing height) and in a location that does not restrict airflow to the sensor.
- Avoid placing the sensor near exterior doors, windows, stoves, and heating and cooling vents, which can negatively impact sensor readings.

In addition, consider logistics as you select your location, including:

- providing power for the sensor;
- accessing the sensor data;
- connecting the sensor to an existing communications network;
- placing it where it will not be unplugged or damaged; and
- getting permission to monitor at the site, if not on your property.

See the box below for links to more detailed information about siting sensors.

What will you use the data for?

Some monitoring applications may require higher quality data and more accurate sensors. For information on sensor accuracy and related topics, see:

- EPA: https://www.epa.gov/air-sensor-toolbox/evaluation-emerging-air-sensor-performance
- South Coast Air Quality Management District: http://www.aqmd.gov/aq-spec
- Lawrence Berkeley National Laboratory (indoor air quality monitors): https://indoor.lbl.gov/air-quality-sensors

See the Understanding Sensor Data fact sheet to learn more.

Note: As of 2023, there are no widely accepted standards for air sensor performance, but some standards are being developed: https://www.epa.gov/air-sensor-toolbox/air-sensor-performance-targets-and-testing-protocols.

For more information:

- EPA's Air Sensor Toolbox: https://www.epa.gov/air-sensor-toolbox
- EPA's Guide to Siting and Installing Air Sensors: https://www.epa.gov/air-sensor-toolbox/guide-siting-and-installing-air-sensors
- Other Wildfire Guide Fact Sheets: https://www.airnow.gov/wildfire-guide-factsheets/
- AirNow Fire and Smoke Map: https://fire.airnow.gov/

EPA United States Environmental Protection Agency
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Using Air Quality Sensors for Smoke: Understanding Sensor Data

During smoke events, air quality sensors can provide localized information about outdoor and indoor air quality. Air sensors may help you make decisions about where to spend time or when to go outside when wildfire smoke is affecting your area. They may also help you understand how to reduce your smoke exposure indoors. This fact sheet focuses on the use of sensors to measure fine particulate matter ($PM_{2.5}$), because it is the most common pollutant in wildfire smoke. See the What to Consider fact sheet for information about choosing and placing sensors.

How You Can Use $PM_{2.5}$ Sensor Data

These simple approaches can help you understand your $PM_{2.5}$ sensor data:

- **Examine trends over time –** Sensor data can help you see when $PM_{2.5}$ levels are starting to get better or worse in real-time. For example, you can:
  - see how much $PM_{2.5}$ levels drop when you use a portable air cleaner or run your central air system with a higher-efficiency filter.
  - see how activities in your home can contribute to increased $PM_{2.5}$ levels (e.g., burning candles, cooking).
- **Compare $PM_{2.5}$ levels in different locations –** Sensor data can help you compare $PM_{2.5}$ levels in different locations. For example, you can:
  - see whether $PM_{2.5}$ levels are lower indoors or outdoors.
  - compare $PM_{2.5}$ levels in different outdoor locations.
  - identify which room in your house has the lowest $PM_{2.5}$ levels.

If your sensor data shows that $PM_{2.5}$ levels are trending higher at your location, take steps to reduce your exposure. Learn more in our other Wildfire Guide Factsheets.

Understanding Sensor Data Quality

$PM_{2.5}$ sensors have a higher level of uncertainty and may not give the same readings as the highly accurate $PM_{2.5}$ monitors typically used by government agencies. They can also be affected by unrelated interferences such as fog, relative humidity, and temperature.

> **Trust your senses**. If you are experiencing health effects from smoke, take action to reduce your exposure regardless of what a sensor is reading.

$PM_{2.5}$ sensors are good for measuring smoke particles nearby, but they do not measure visible smoke high in the sky, visible large ash on surfaces, or gases.

Checking the Quality of Your Sensor Data

For outdoor sensors, comparing your sensor's data to data from other sensors or government agency monitors nearby can indicate how well your sensor is working. While they may not report the same values due to highly localized sources, different data corrections, or error, they should show similar trends over time.

Recognizing Problems with Sensor Data

Air sensors sometimes fail, and you may not notice the failure right away. Routinely review your data to help identify these common problems with $PM_{2.5}$ sensors:

- **Suspicious data.** Values that don't change, sudden frequent jumps in the data, or suddenly very erratic data may indicate a problem.
- **Consistently very low values:** If the sensor reports very low values, you may not be able to tell whether this is accurate or a sensor malfunction. You can do a simple test to see if the sensor is responding, such as safely lighting a match nearby.
- **Large differences in duplicate measurements:** Some sensor products report data from two sensors in the same unit. You can compare the data to make sure they both respond similarly.
- **Declining performance over time.** Sensor readings may become less accurate when sensors have been in operation for a long time, or during high $PM_{2.5}$ levels.

If you notice a problem with the data from your air sensor, consult the manufacturer's recommendations for troubleshooting or replacing the device.

Correcting $PM_{2.5}$ Sensor Data

Uncorrected sensor data can be useful for detecting trends or comparing $PM_{2.5}$ levels in different locations.

Correction equations, including equations specifically for smoke, may be available for some sensors. Applying these equations can improve the accuracy of the sensor data. For example, AirNow applies an EPA correction equation before showing sensor data on the Fire and Smoke Map.

Note: Air sensors typically report pollutant levels every few seconds or minutes. Use caution if comparing these very short-term sensor readings directly to the National Ambient Air Quality Standards (NAAQS) or the U.S. Air Quality Index for $PM_{2.5}$, which are based on 24-hour averages. For the official data used to determine compliance with the $PM_{2.5}$ NAAQS, visit http://www.epa.gov/air-trends/air-quality-design-values.

For more information:

- EPA's Air Sensor Toolbox: https://www.epa.gov/air-sensor-toolbox
- EPA's A Guide to Siting and Installing Air Sensors: https://www.epa.gov/air-sensor-toolbox/guide-siting-and-installing-air-sensors
- EPA's National Ambient Air Quality Standards (NAAQS): https://www.epa.gov/criteria-air-pollutants/naaqs-table
- AirNow Fire and Smoke Map: https://fire.airnow.gov/
- Other Wildfire Guide Factsheets: https://www.airnow.gov/wildfire-guide-factsheets/

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