

Resources and Tips on Air Sensor Data Analysis

For communities & organizations looking to understand the basics of air quality data analysis and how to effectively communicate results

This guide highlights important steps to improve how you evaluate, share, and use data gathered from your monitoring project. While there are many pieces involved in planning and conducting air monitoring projects using air sensors, the focus of this document is data analysis. Other key concepts including Data Management and Data Quality are briefly mentioned, but readers are encouraged to find more details in accompanying guides.

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Introduction

Establish Project Goals & Understand Your Sensor Technology

For successful monitoring projects, you should plan early for how your data will be used, what questions you're looking to answer, and how you'll communicate the results. The exploration of your data should start early and continue throughout the lifecycle of the project. Your team will first want to develop a monitoring plan, establish monitoring goals, and select an air sensor that matches your purpose for collecting data. For detailed information on developing a plan and selecting an air sensor, see **Chapter 3** in **EPA's Enhanced Air Sensor Guidebook**, **pages 39-84**.

After your team develops a monitoring plan and properly places one or more air sensors, it is time to collect data. The analysis process starts while data is being collected, so it is important to periodically examine your sensors to ensure they are measuring quality data. Visit the accompanying guides on Data Management and Data Quality for an expansion on how to select a data management system (DMS) that suits your team's skillset and how to develop quality assurance procedures.

In this resource guide, find four outlined steps to help you effectively analyze sensor data, with pointers to resources that expand on methods and techniques for successful data evaluation, interpretation, visualization, and communication.



Four Steps to Analyze Data & Communicate Results

1 Select an Analysis Tool

There are many analysis tools and data management platforms that are available to help you organize and share sensor data. First, refer to the accompanying Data Management Guide for details on how to select a data management system (DMS). The primary functions of a DMS are to streamline the intake, storing, processing, quality control, and sharing of data. Next, use the resources below to identify analysis tools that best suit your skillset.

Resources

- Examples of analysis tools include Excel spreadsheets, <u>EPA's RETIGO tool</u>, RStudio & the <u>OpenAir package</u>, RStudio & the <u>AirSensor package</u>, the <u>AirSensor DataViewer Tool</u> (web-based application), and ArcGIS.
- For a brief discussion on the capabilities of each tool or platform mentioned above, refer to pages 4-12 & 4-13 in South Coast AQMD's guide,
 <u>"Community in Action: A Comprehensive Educational Toolkit on Air Quality Sensors</u>."
- Further discussion and links to data management tools can be found in EPA's Enhanced Air Sensor Guidebook, pages 84-89.

2. Validate Your Sensor Data

Data validation is an important step towards boosting confidence in your results. The purpose of validating data is to detect values that may not correctly represent the actual conditions at your sampling site. During the planning phase of your project, it is important to establish validation procedures and criteria that will be adhered to throughout the project's lifecycle. Refer to the accompanying guides (Data Management & Data Quality) for an expansion on quality control data checks, quality assurance procedures, and how to develop a Quality Assurance Project Plan before collecting data.

You will want to look early and often at the data being collected and consider having a digital logbook to take notes on weather, air quality events, and other unusual conditions that might affect your site during sampling.

Note the validation steps below and explore <u>South Coast AQMD's "Community in</u> <u>Action" guide</u> for an expanded discussion of these data validation steps (pages 4-14 through 4-17).

Data Validation Steps

- O Visually check your data focusing on diurnal and spatial patterns.
- Consider using metrics like data completeness, expected data ranges, or regression statistics from comparisons to other sensors or nearby reference instruments to see how well your sensor adheres to these metrics.
- Explore accuracy and precision, where accuracy is the general agreement of a sensor's measurement with the true concentration, and precision is how well a sensor reproduces a measurement.
- Implement Quality Assurance/Quality Control (QA/QC) procedures. See Table 3-2 in EPA's Enhanced Air Sensor Guidebook (pages 81-82) for common QC checks designed to catch issues early and help ensure a quality data set.

Also, check out the data processing steps outlined in section 3.8.1 Analyze and Interpret Data of <u>EPA's Enhanced Air Sensor Guidebook</u>, page 90.

3. Analyze and Visualize Your Data

Visualizing data is crucial in helping you interpret results. You are now the explorer, examining your data, looking for patterns through a wide range of approaches. See **Figure 3-16**, reproduced from <u>EPA's Enhanced Air Sensor Guidebook</u>, for common ways of visualizing data, including time series graphs, scatter plots, calendar plots, maps, and charts of wind direction or pollution concentrations. Explore the following resources to learn how and when to use each visualization option.



2 round

Time Series Plots show changes in one or more parameters with time. Useful in comparing trends (pollutants, temperature, multiple sites, etc.).

Scatter Plots show the relationship between two parameters. Color coding the dots can indicate a different variable (humidity, temperature, etc.).



Calendar Plots give a big picture look at quality over a month or longer period. Dates can be colored to indicate higher or lower concentrations.



Maps show the spatial patterns of data across a region. Plotting other data such as traffic count or locations of emissions sources can help explain changes in the data.



Wind and Pollution Roses show the frequency of wind direction and can be colored to show pollutant concentrations or wind speed. Useful in showing where higher pollutant concentrations come from.

Figure 3-16. Common Visualization Methods for Air Quality Data.

Resources for Visualizing Data

- For suggested approaches to analyzing your data and potential research questions to investigate, refer to pages 4-18 through 4-22 in <u>South Coast</u> <u>AQMD's "Community in Action" guide</u>.
- O Check out <u>South Coast AQMD's Data Analysis Guide</u> for additional questions to consider as you look for trends or variations in the data.
- See page 91 of <u>EPA's Enhanced Air Sensor Guidebook</u> to view a list of questions you should ask yourself when visualizing data.
- Visit Step 4 of <u>Citizenscience.gov's Toolkit</u> to briefly explore how data analysis can help you record facts, identify patterns, and check for error.

4. Share and Communicate Results

You are eager to share the results of your project with a wider audience including members of your community, government officials, local regulators, industry, or others. First, consider the goals of your individual air monitoring project and the story your data can tell. Find example questions below and reflect on the goals your team laid out in its monitoring plan.

- Why are you collecting data at the site(s) you've established?
- O What are the concerns of your community?
- O What information will decision-makers need to use your data?
- Are you seeing patterns in the data over time?
- Are there impacts from potential pollution sources?
- Which days in the past month or year had the worst air quality?

Whether you present your results as a written report, a presentation, on a website, or in conversation, you should be able to describe the following components of your air monitoring project:

- 1. A clear purpose or objective.
- 2. The monitoring setup and QC checks you had in place.
- 3. Your analysis and data processing steps.
- 4. Visualizations of the data.

Additional Resources

- Visit pages 92-94 of EPA's Enhanced Air Sensor Guidebook for an expansion on these four components.
- O Refer to Step 4 of <u>Citizenscience.gov's Toolkit</u> to learn more about the importance of communicating & sharing your data in a format that is accessible and easy to use by both technical and non-technical members of your community.

When More Data Are Needed

Is your analysis generating more questions for your community? You may identify a need to collect additional data following your interpretation of the results. Visit **pages 42-43** of EPA's Enhanced Air Sensor Guidebook_for details on refining your project objective. See **Figure 3-2** reproduced below showing how several attempts may be neccessary to develop a project question that is detailed and specific.



Figure 3-2. Example of adding details to your question or objective.

Next Steps:

If your data is sufficient, as detailed by the accompanying Data Quality Guide, see **page 5-8** in <u>South Coast AQMD's "Community in Action" guide</u> for outlined next steps in taking action locally, engaging with local regulatory agencies, and maintaining momentum on your monitoring project. Refer to **pages 5-10 through 5-13 of this guide** for effective communication guidelines and a list of product formats for sharing results.

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Disclaimer: This guide is a resource for community air monitoring and does not necessarily reflect U.S. EPA policies.

Resources

EPA's Enhanced Air Sensor Guidebook

Link: https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=CEMM&dirEntryId=356426

Relevant Sections:

- Chapter 3, pages 39-97
 - 3.2 Question: Determining a Purpose for Monitoring
 - 3.8 Evaluate: Analyzing, Interpreting, Communicating, and Acting on Results
- Appendix A: Resources
 - A.3.6 Collect: Data Collection, Quality Assurance/Quality Control, and Data Management, pages A-15 – A-16
- Appendix B: Questions to Consider When Planning for and Collecting Air Sensor Data, and Sharing Your Results
 - B.1 Planning, page B-1
 - B.6 Evaluating Data, page B-3

South Coast Air Quality Management District's Community in Action: A Comprehensive Educational Toolkit on Air Quality Sensors

Link: <u>http://www.aqmd.gov/docs/default-source/aq-spec/star-grant/community-in-action-a-</u> comprehensive-guidebook-on-air-guality-sensors.pdf?sfvrsn=10

Relevant Sections:

- Understanding Your Data: Chapter 4, pages 12-25
- Communicating Results: Chapter 5, pages 10-13
- Appendix C. Information About the PurpleAir Sensor, C-10 C-19
- Appendix D. Data Analysis Guide, D-1 D-7
- Appendix L. User Guide for AirSensor DataViewer, L-1 L-12

South Coast Air Quality Management District's Low-Cost Sensor Data Analysis Guide

Link: <u>http://www.aqmd.gov/docs/default-source/aq-spec/star-grant/air-quality-sensor-data-analysis-guide.pdf?sfvrsn=6</u>

Citizenscience.gov's Toolkit

Link: https://www.citizenscience.gov/toolkit/howto/step4/#

Relevant Section: "Step 4 - Manage Your Data."