Community Air Monitoring Fundamentals

Webinar 2:
Introduction to Air Monitoring and Measurements

TD Enviro
Eastern Research Group, Inc. (ERG)
US EPA Office of Air Quality Planning and Standards

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Your Speakers

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Overview of Webinar Series

Fundamentals:

Webinar #1: Introduction to Air Quality Concepts and Regulations

Webinar #2: Introduction to Air Monitoring and Measurements

Building an Air Monitoring Network:

Webinar #3: Objectives and Data Management

Webinar #4: Selecting Equipment, QAPPs, and Siting a Monitoring Device

Webinar #5: Installation, Operation, Data Analysis, and Communication

Webinar 2 Agenda

1 Recap of Webinar 1

2 Air Monitoring

3 Measurement Devices

4 Important Concepts for Making Measurements

5 Data and Quality Assurance Concepts

6 Examples of Using Measurements

7 Recap

8 What's Next

9 Q&A

Recap of Webinar 1

- Air Quality Concepts
- Sources and Emissions
- Pollutants
- Why We Care
- Air Quality Regulations
- Air Monitoring Regulations

Air Monitoring

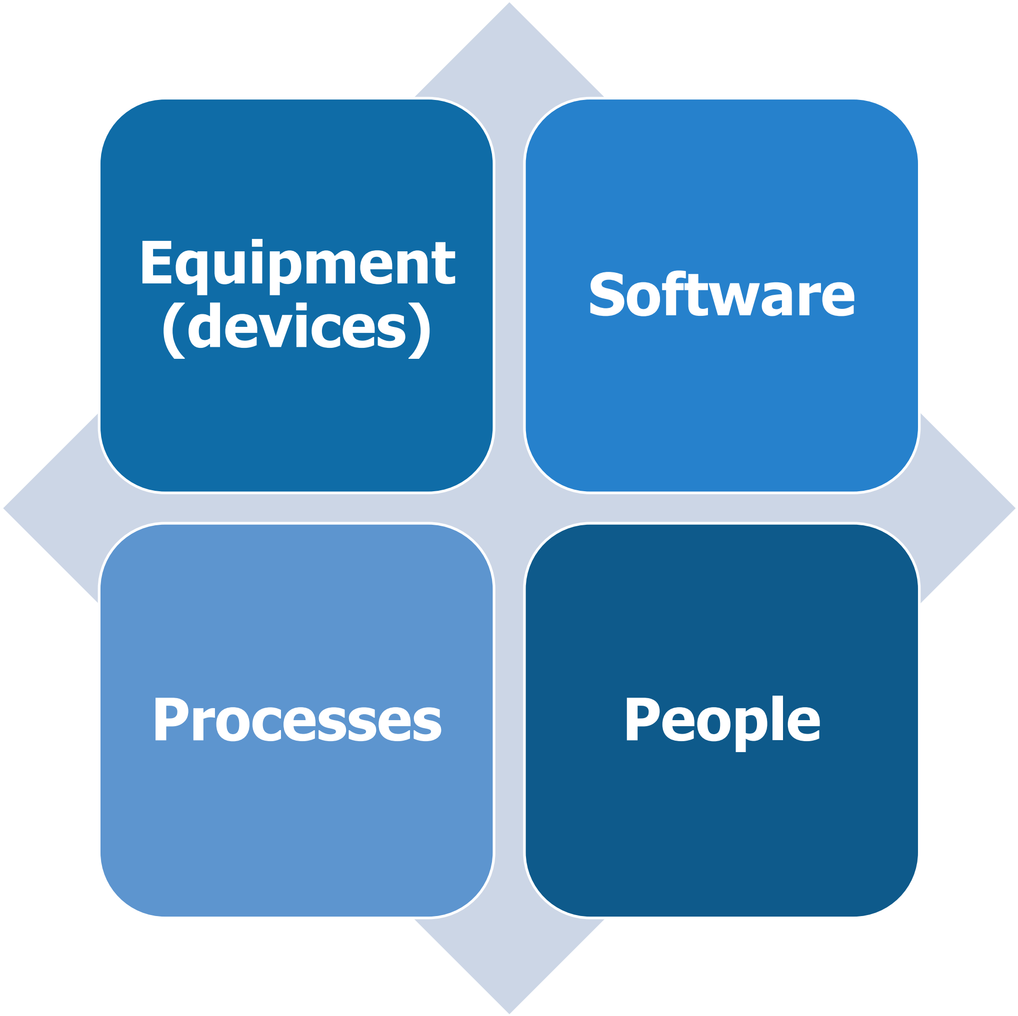
DEFINITION

Air Monitoring:

Detection of pollutant levels by measuring the quantity and types of certain pollutants in the outdoor air.

Source: SCAQMD

What is Air Monitoring?



Why is Air Monitoring Important?

Air monitoring is a critical part of the nation's air quality management infrastructure. It has many purposes including:

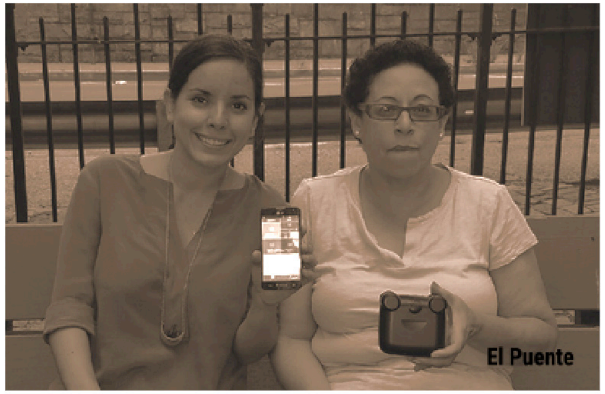
- Supporting research on the health effects of air pollution
- Estimating health-related exposure risks
- Evaluating source-receptor relationships
- Characterizing air quality and trends
- Developing and evaluating emission control strategies
- Providing data for input to run and evaluate models
- Developing and determining compliance with the National Ambient Air Quality Standards (NAAQS)
- Air enforcement targeting
- Measuring overall progress
- Providing data for public air quality alerts and air quality forecasting

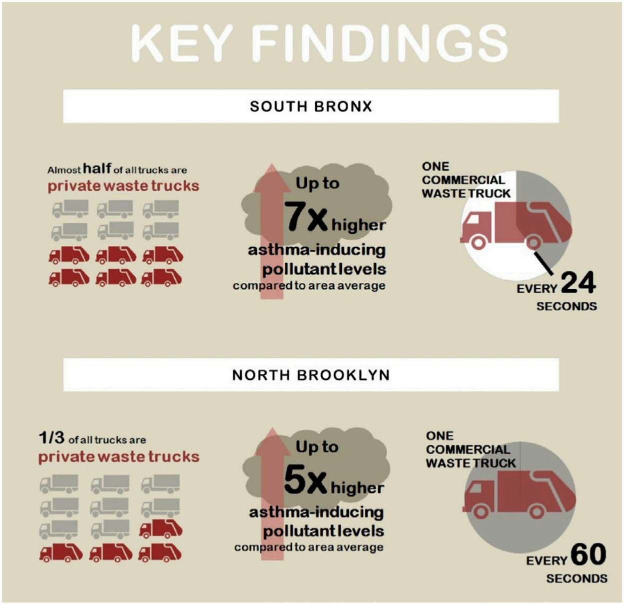
Example Use of Air Monitoring Data

Transform Don’t Trash NYC Coalition, 2016

- Investigate and document impacts of commercial waste system routes through low-income communities and communities of color in South Bronx, North Brooklyn
- Air quality impacts of garbage diesel truck traffic
- $PM_{2.5}$ data collected by community members and private waste workers
- Findings supported extensive advocacy and negotiations on commercial waste industry reform

Data + advocacy supported policy implementation





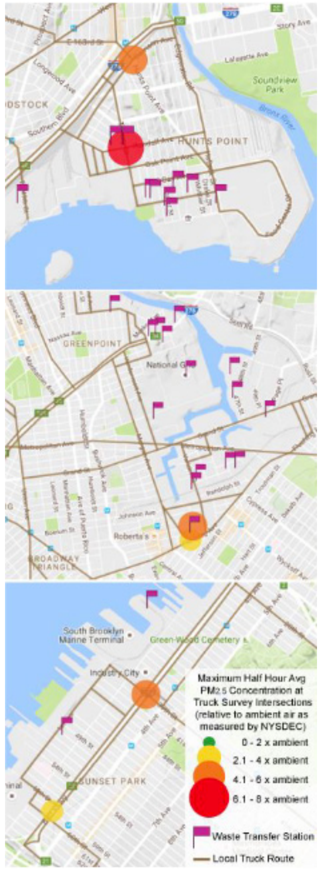
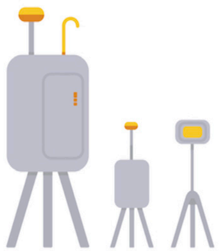


Image Sources: Transform Don’t Trash

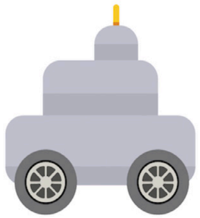
Measurement Devices

Measurements – Locations



Fixed

- Stationary
- Long-term
- Easier to interpret
- Useful for trends



Mobile

- Moveable
- Short-term
- Harder to interpret
- Can include handheld

Satellite

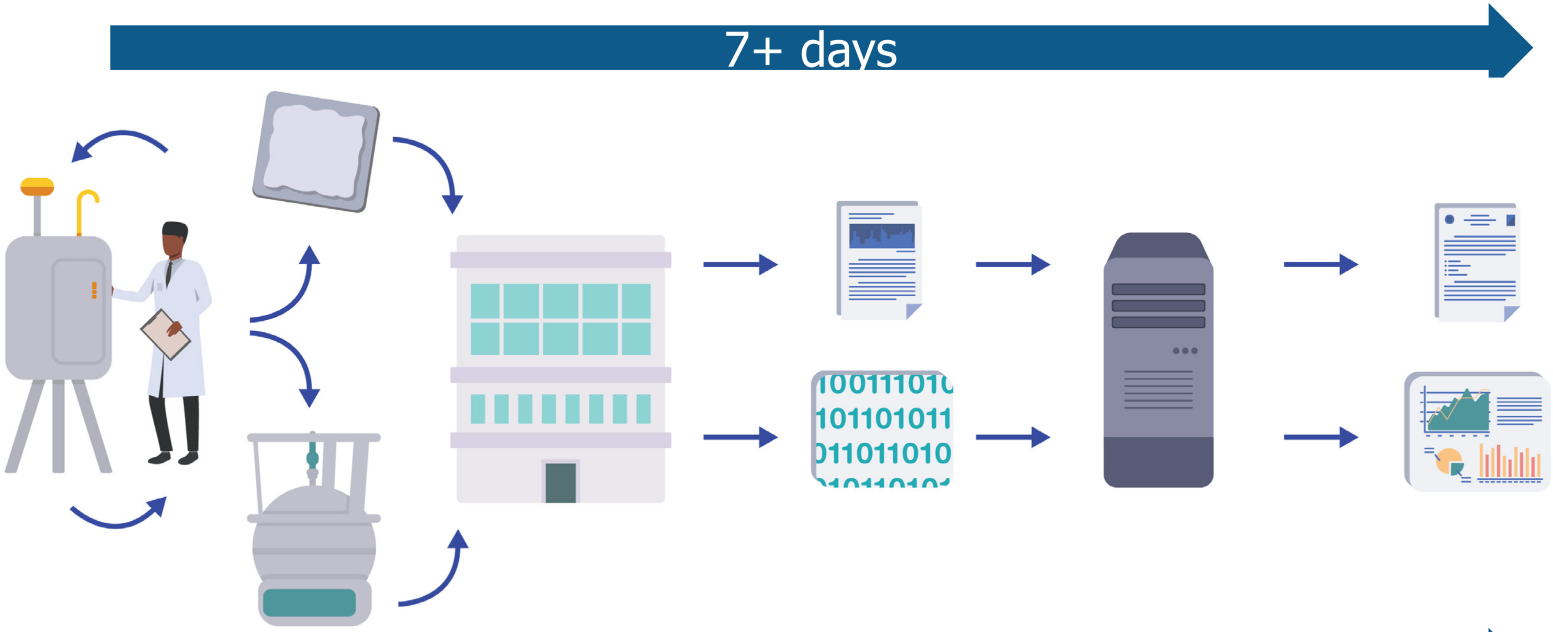
- Remote
- Some limitations
  - Timeliness
  - Resolution
- Harder to interpret

Source: Georgetown Climate Center

Measurements – Methods

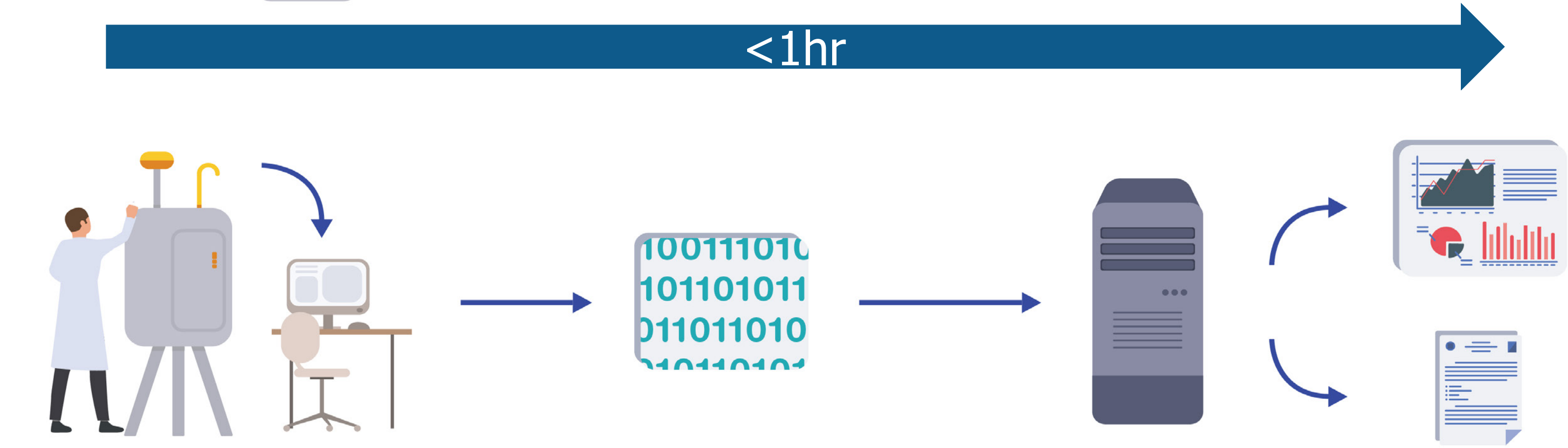
Integrated (Sampler)

Collects samples on a filter or in a canister over a period of time



Continuous

Detects pollutant concentrations on a frequent basis



Source: Georgetown Climate Center

Continuous measurement devices

We focus on continuous measurement devices in this webinar series.

Four types:

1) Reference/regulatory monitors
2) Air sensors
3) Research devices
4) Remote sensors

1) Reference/Regulatory Monitors

- Used to determine compliance with the NAAQS and enforcement for air targeting
- Designated as either Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors
- Must meet strict operating, performance, and quality assurance requirements
- Highly accurate
- Very reliable
- Fixed location (typically)
- Sensitive
- Long lifespan (with periodic maintenance)
- Expensive

Interior of a monitoring shelter in New Hampshire

Air monitoring station at Springfield, MA that measures SO_2, NO, NO_2, NO_x, $PM_{2.5}$, $PM_{2.5}$ filter (6 day), and black carbon

2) Air Sensors

- Lower in cost, more portable, and generally easier to operate
- Can measure some air pollutants, but not all
- Less reliable
- Fixed location (typically)
- Not as sensitive
- Indicative measurements

EPA researchers test air sensors at the Air Innovation Research Site at laboratories in Research Triangle Park, NC.

3) Research Devices

- A wide range of technologies ranging from lower-cost air sensor technologies to mid-range prototype instruments to high-end laboratory-type instruments modified for use in the field.
- Often built or designed for specific applications, like research projects.
- Operated by experts to achieve the performance needs for their application.

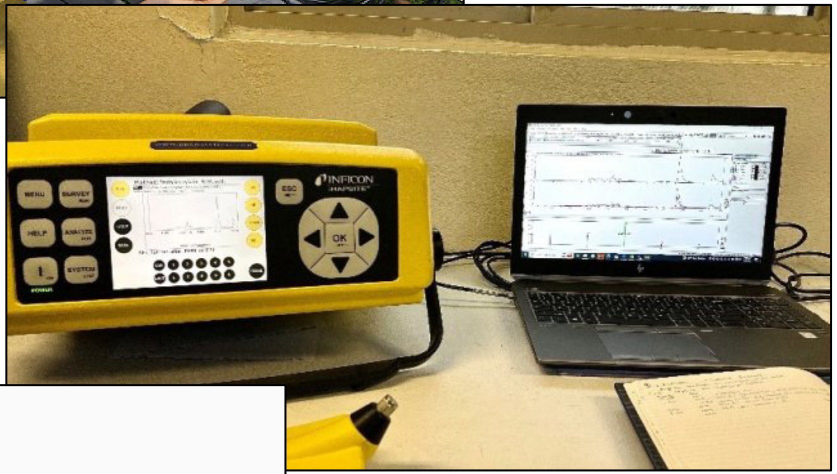


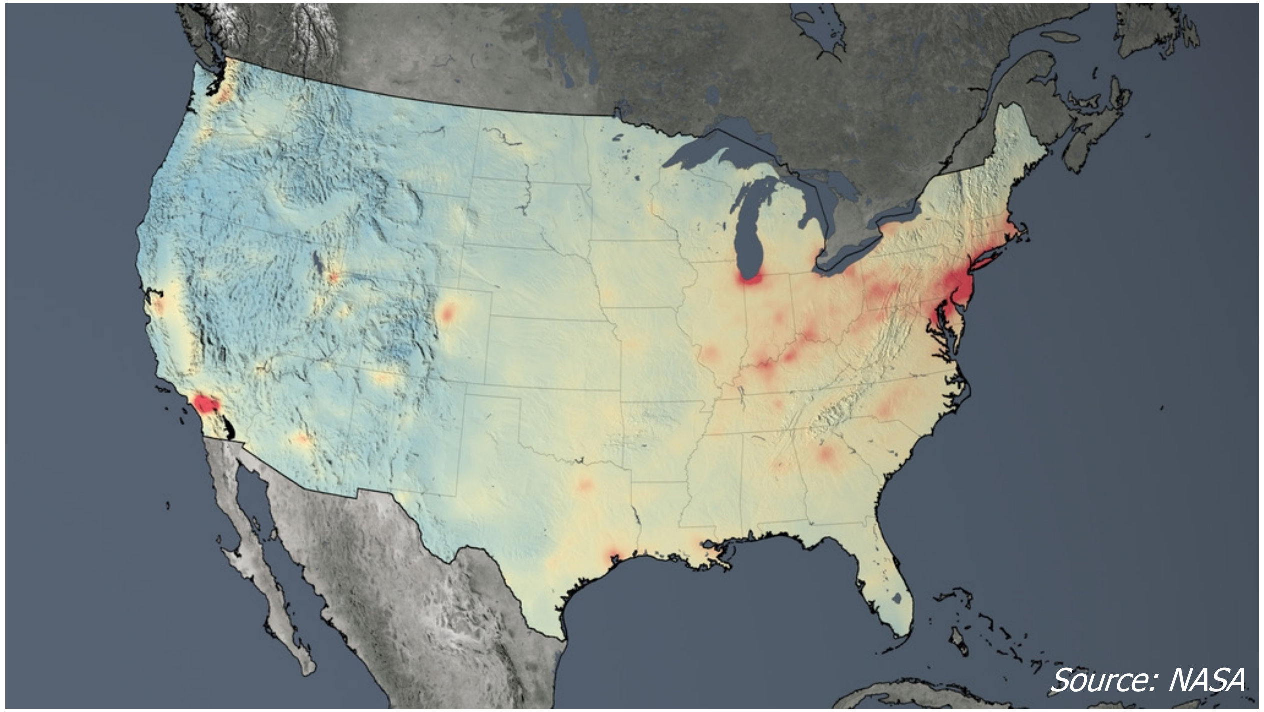
Image Sources: EPA

4) Remote Sensors/Sensing

Method for measuring pollutants at a distance without physical contact

Useful for detecting PM, gaseous criteria pollutants, and some VOCs

- Ground-based: fence line
- Space-based: satellites


Source: NASA

How do you use air monitoring devices?

Guest Speaker

Katie Praedel, Wisconsin Department of Natural Resources

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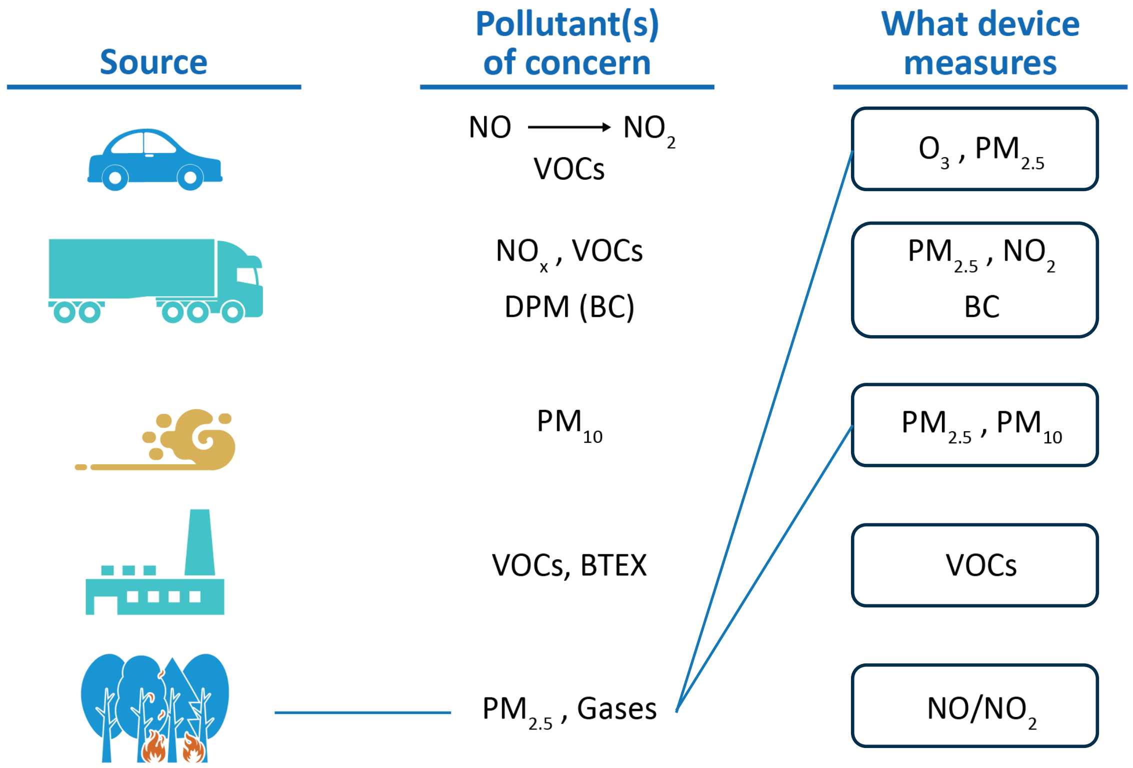
Five Important Concepts for Making Measurements

1: Your pollutant or source of interest needs to match your monitoring technology

1. What does the source emit?
2. What's the pollutant(s) of most concern?
3. What device(s) can detect that pollutant?



1 (cont.): Your pollutant or source of interest needs to match your monitoring technology

Two examples:

- If you want to look at wildfire smoke impacts, you shouldn't measure NO_2, you should measure $PM_{2.5}$.
- If you want to understand truck pollution, $PM_{2.5}$ data will not be very helpful. Black carbon instruments would be a better choice.

2a: Concentration Units

Concentration is the amount of a pollutant in a standard volume of air.

Parts-per-million (ppm)

- CO

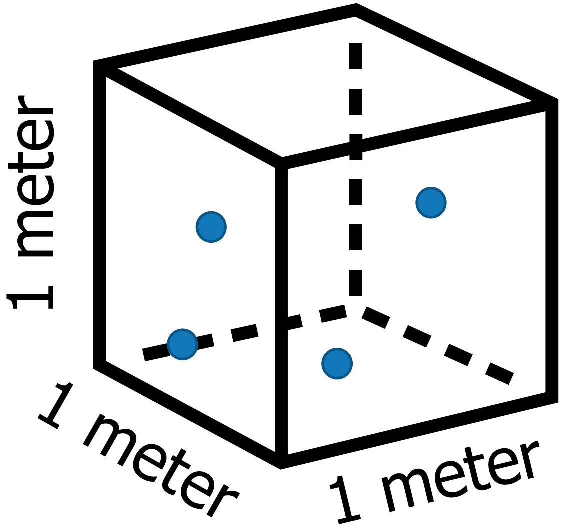
Parts-per-billion (ppb)

- Ozone
- SO_2
- NO_2

Micrograms per cubic meter (µg/m³)

- PM
- Black Carbon (soot)

A single drop of ink in a 60-gallon bathtub would be about 70 ppb



2b: Concentration & the Air Quality Index (AQI)

The AQI is the EPA's index for reporting the level of air pollution and associated health concerns. Think of it as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern.

AQI Category	Index Values	2015 Ozone Standard Breakpoints (ppb, rolling 8-hour average)	2024 $PM_{2.5}$ Standard Breakpoints ($\mu g/m^3$, 24-hour average)
Good	0–50	0–54	0.0–9.00
Moderate	51–100	55–70	9.1–35.4
Unhealthy for Sensitive Groups	101–150	71–85	35.5–55.4
Unhealthy	151–200	86–105	55.5–150.4
Very Unhealthy	201–300	106–200	150.5–250.4
Hazardous	301–500	201–600	250.5–500

3: Measurement Range

The lowest and highest pollutant concentrations that a device can measure.

A device will be most useful when it measures a target pollutant over the full range of concentrations commonly found in the air.

Pollutant (Abbreviation)	Typical Hourly Outdoor Concentration Range to Expect within the U.S.
Black Carbon (BC)	0 to 15 µg/m³
Carbon Monoxide (CO)	0 to 0.3 ppm
Lead (Pb)	0 to 0.1 µg/m³
Nitrogen Dioxide (NO_2)	0 to 50 ppb
Ozone (O_3)	0 to 125 ppb
Particulate Matter ($PM_{2.5}$)	0 to 40 µg/m³ (100 to 1,000 µg/m³ near wildfires)
Particulate Matter (PM_{10})	0 to 100 µg/m³ (500 to 1,000⁺ µg/m³ in dust storms)
Sulfur Dioxide (SO_2)	0 to 100 ppb (100 to 5,000 ppb near active volcanoes)
Ultrafine Particles (UFP)	3,000 to 200,000 particles/cubic centimeter (cm³)
Volatile Organic Compounds (VOCs)	5 to 100 µg/m³

Source: EPA

4: How long you Measure

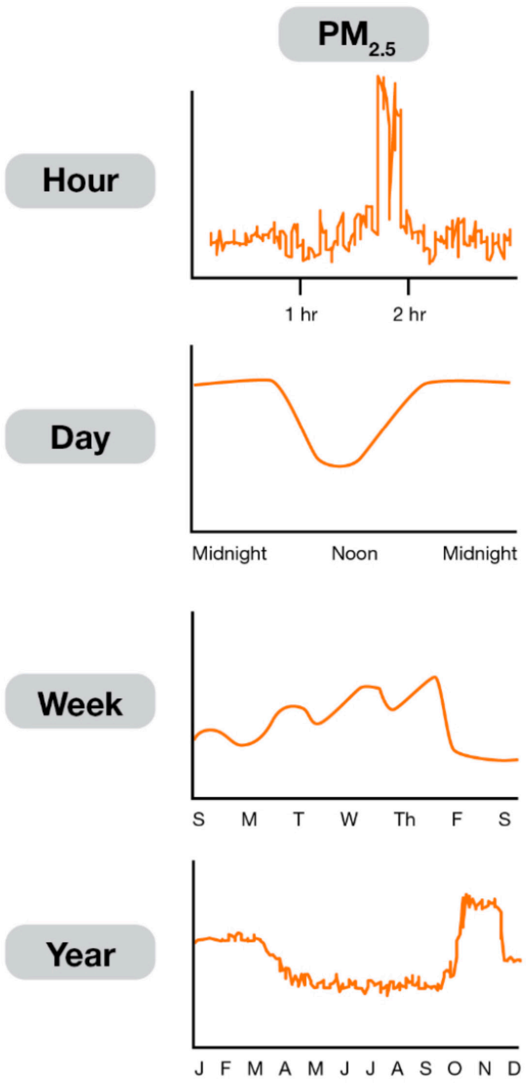
What you detect is also determined by how long you measure. There are two important time concepts.

Measurement Period:

- Length of your study or time that you collect data
- Typically, one year or longer, shorter for specific events (wildfire, accidents, etc.)
- It must be long enough to capture air quality variations across different seasons, weather conditions, and emission patterns

Measurement Duration/Interval:

- The time that a device samples the air and creates a data value
- Typically, 1 minute to 1 hour to 24 hours, but can be longer



Source: EPA

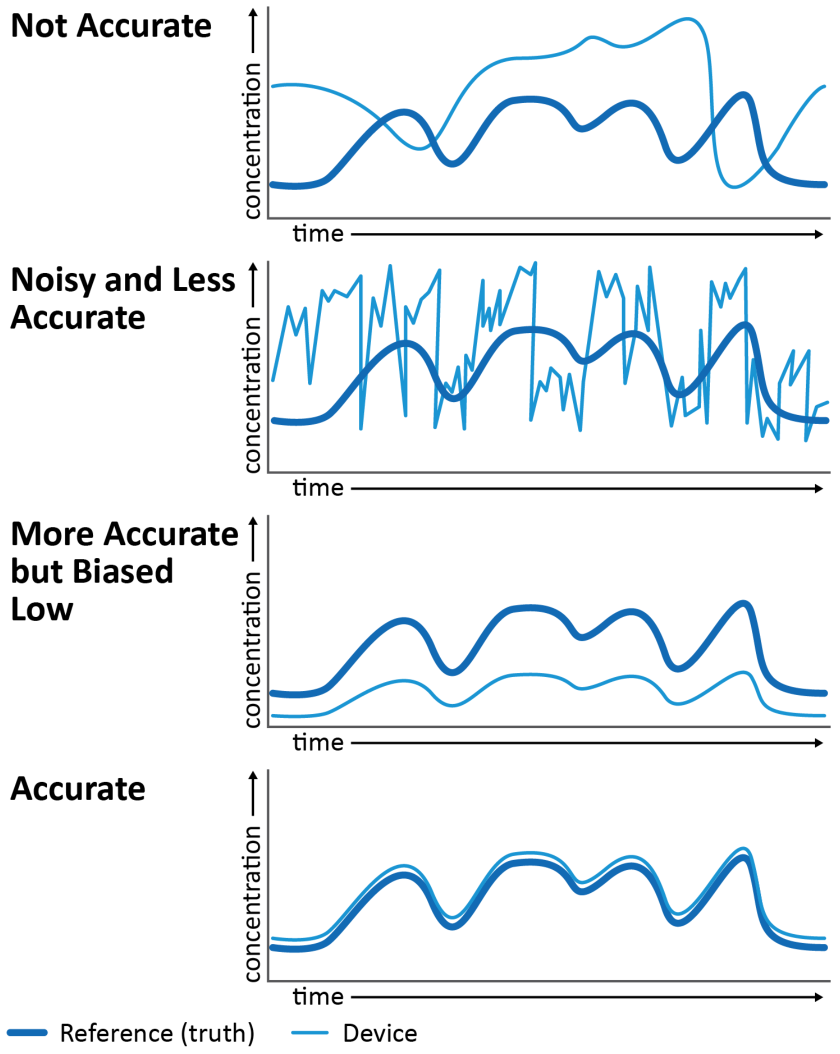
5a: Accuracy

The agreement between the device's pollutant concentration measurement and the concentration measured by the reference instrument

How do you accomplish this?

1. Conduct an intercomparison
2. Quantify the agreement
3. Periodically re-check the device

Have the manufacturer prove it's accurate



5b: Accuracy: Quantitative & Qualitative Measurements

Quantitative measurements can be expressed using numbers. For example, a pollutant concentration expressed in parts per billion (ppb).

Example : You would like to setup a network of sensors for long-term deployment in a community to supplement an existing regulatory monitoring network.

Qualitative measurements are descriptive, based on concepts, and often expressed in words. For example, pollutant concentrations described as "higher" or "lower".

Example : You would like to use one sensor to measure an air pollutant in your backyard to determine when air quality is best for outdoor activities.

Data and Quality Assurance Concepts

1: Handling and Processing

Raw instrument/sensor signal

- Quality control checks
- Data correction (public or proprietary)
- Data aggregation

- Reported pollutant concentration/AQI
- Data analysis and sharing

Source: EPA

2: Averaging

Aggregation makes data easier to interpret/view.

It also enables you to compare your data to other indicators (e.g., standards) like:

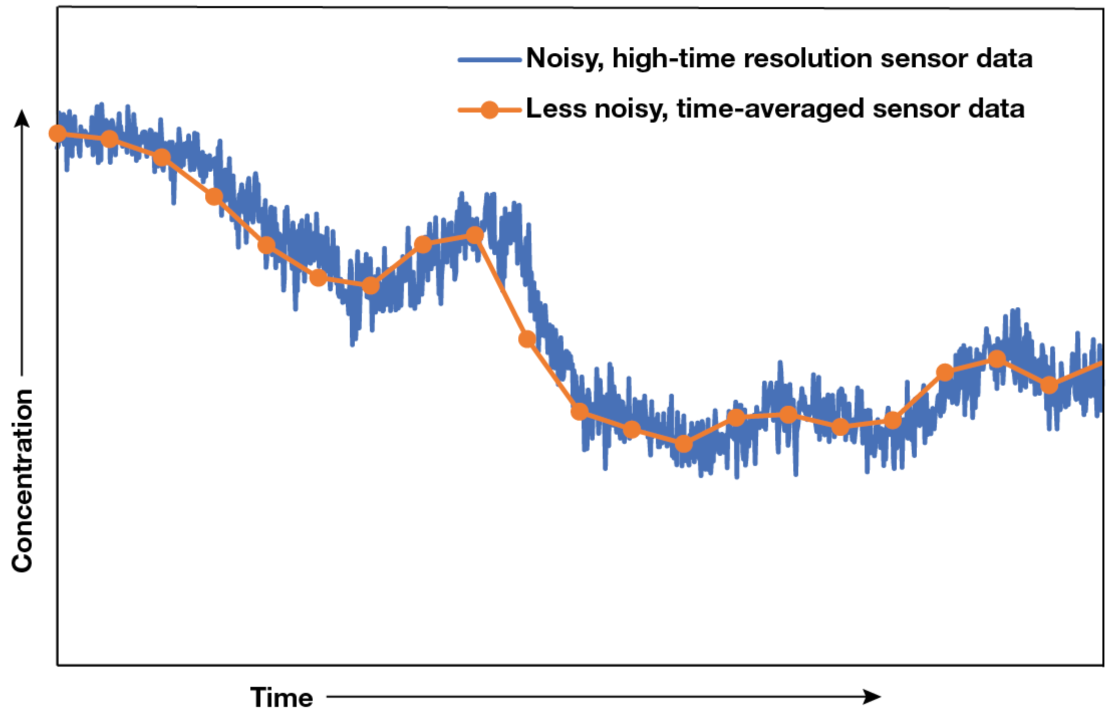
- Air Quality Index (AQI)
- National Ambient Air Quality Standards (NAAQS)

Typical averaging methods:

- Hourly
- 8-hour
- Daily (24 hours)
- Annual

Typical counting methods:

- Count of days above a value
- Count of Air Quality Index hours/days



Source: EPA

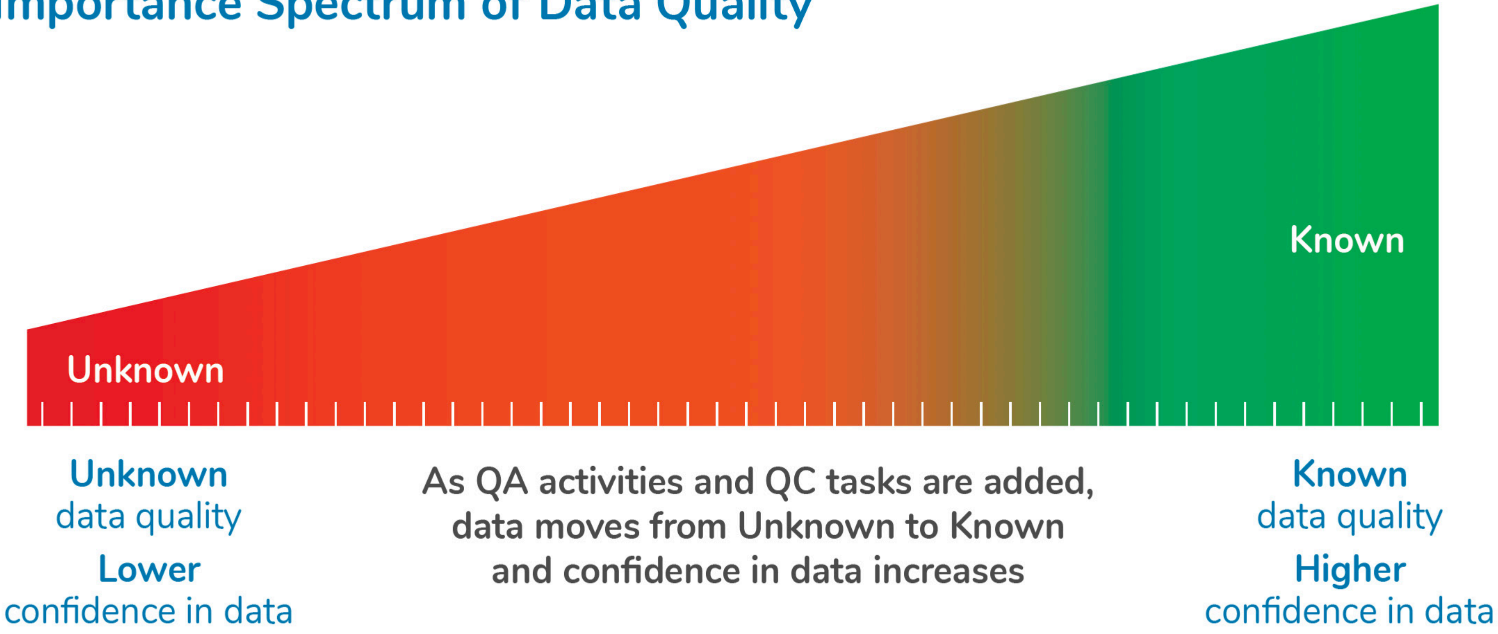
3: Data Quality

Quality Assurance and Quality Control (QA/QC) activities ensure you are collecting high-quality data that can reliably be used to meet project goals.

QA/QC steps include:

- Planning
- Documenting activities
- Performing regular maintenance
- Checking and reviewing data
- Comparing data to standards
- Validating data
- Reporting data
- …and more

Importance Spectrum of Data Quality



Source: Bay Air Center

4: Quality Assurance Project Plans (QAPPs)

A QAPP is for everyone!

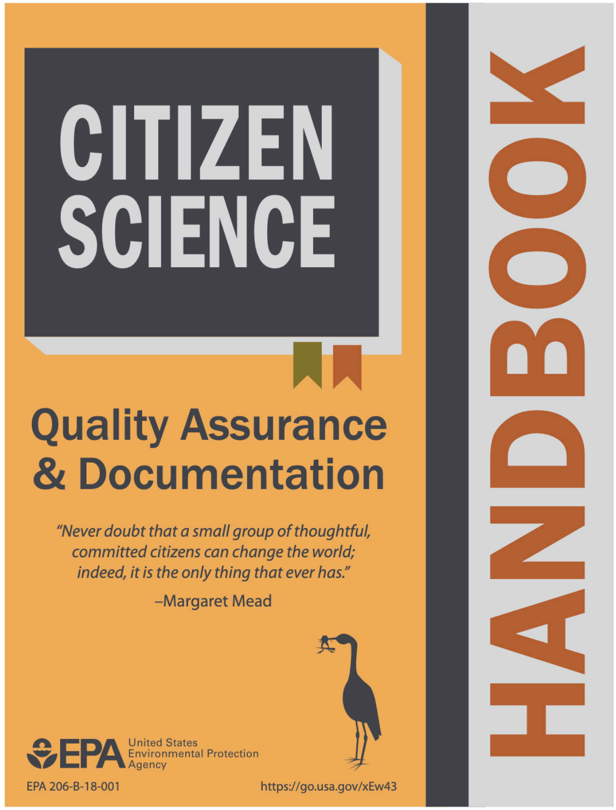
A written document that explains how organizations ensure that collected data can be used for its intended purpose.

Describes QA/QC across:

- Monitoring purpose and project organization
- Setup, data collection, and data evaluation

Creating a QAPP supports your project and team members!

- Roles and responsibilities are clear
- A plan for collecting quality data is agreed upon
- Potential problems are identified at an early stage
- Processes are documented to assist with future data interpretation and presentation



Source: EPA

Poll: How familiar are you with QA/QC?

Multiple choice, single option

- Unfamiliar – never done any
- Somewhat familiar - I've done a little but am still new to QA/QC
- Familiar - I've done some QA/QC
- Very familiar – I've done a lot of QA/QC

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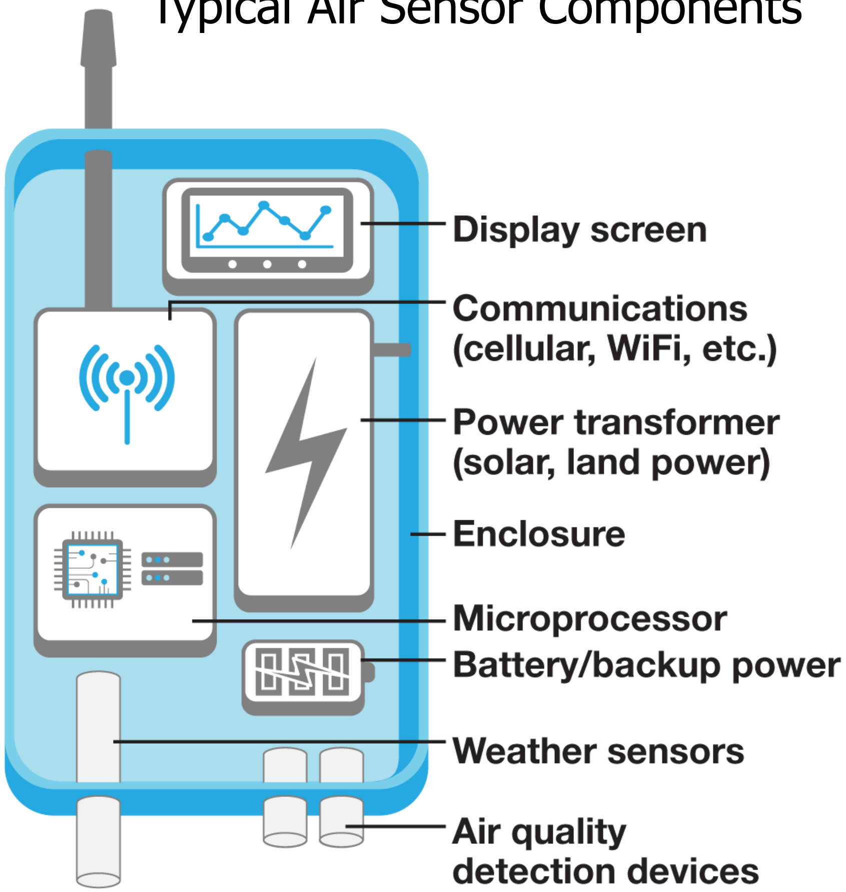
Purchasing Equipment

Review a device's feature *before* purchasing to ensure it meets your needs and produces data that's suitable for your application

- Pollutants of interest
- Accuracy
- Detects high and low concentrations
- Reliable
- Ease of use (operational needs, data displays, etc.)
- Power
- Data transmission
- Transparent data processing
- Data handling and access
- Cost (including extra equipment for repairs/replacements)

Typical Air Sensor Components



Source: EPA

Operating Monitoring Equipment

Routine preventative maintenance ensures proper functionality and reliable data collection and is necessary for both short- and long-te operations.

Operational activities can include:

- Regularly scheduled internal/external cleaning (e.g., dust build u
- Examining site conditions
- Replacing filters
- Replacing device components as they age
- Regular review of data

Benefits:

- Reduces errors in data collection
- Extends the device's operating life
- Saves money spent on replacement of parts and repair services

Request and review the manufacturer's user manual!

Source: Georgetown Climate Center

Examples of Using Measurements

Guest Speaker

Marilyn Wurth, NY DEC

Interactive End-of-Session Feedback

What’s the most useful thing you learned today?

Recap

- Air monitoring
- Measurement devices
- Five important concepts for making measurements
- Data and quality assurance concepts
- Examples of using measurements

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What’s up next

Webinar 3

Building an Air Monitoring Network: Objectives and Data Management

Developing air monitoring objectives, understanding data management options and needs