

# Is that smoke affecting me?

## Using crowdsourced public data to explore air quality during smoke events

Olivia S. Ryder<sup>1</sup>, Steve G. Brown<sup>1</sup>, Andrea L. Clements<sup>2</sup>, Rachelle M. Duvall<sup>2</sup>, Rachel A. Smoak<sup>3</sup>, Christi Dubois<sup>4</sup>, Sarah Waldo<sup>4</sup>, India J. Young<sup>4</sup>

<sup>1</sup>Sonoma Technology; Petaluma, CA

<sup>2</sup>U.S. EPA Office of Research and Development; RTP, NC

<sup>3</sup>Student Volunteer and NSF Intern assigned to U.S. EPA Office of Research and Development; RTP, NC

<sup>4</sup>U.S. EPA Region 10; Seattle, WA



Air sensors can help make invisible air pollution visible! This hands-on, interactive lesson plan is designed to give users an introduction to air sensors, common sources of particulate matter (PM), and the health effects of breathing in PM. Users will also learn about factors that can influence fine PM (PM<sub>2.5</sub>) concentration levels, and the difference between air quality measurements from a regulatory PM monitor and an air sensor. Using the AirNow Fire and Smoke Map, users will learn how to view PM levels around their community – or anywhere! After viewing the PM values in the community, users will investigate data trends and learn ways to reduce personal exposure to PM during smoke events. Finally, users will brainstorm some ways in which they can help to reduce their own personal PM exposure and improve air quality in their community.

This lesson plan includes:

- Lesson Plan aligned with Next Generation Science Standards (NGSS)
- Extension Activity
- Introductory Presentation Slides

- Supplemental Presentation Slides - *Fire and Smoke Map images during a wildfire and example activities for different age groups*
- Data Collection Worksheet
- Worksheet Answer Key

Additional resources are also available to support this lesson plan. These resources can be found on the Educational Resources page on the Air Sensor Toolbox website located at: <https://www.epa.gov/air-sensor-toolbox/educational-resources-related-air-sensor-technology>. Quick start guides detailing how to install and operate a sensor to supplement the Fire and Smoke map is also available on the webpage (e.g., PurpleAir Quick Start Guide). Additional resources give users more background information on air quality and sensors including:

1. Air Quality 101: A Background on Air Pollution (Presentation Slides)  
Available at: [https://cfpub.epa.gov/si/si\\_public\\_record\\_Report.cfm?Lab=CEMM&dirEntryId=349514](https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=CEMM&dirEntryId=349514)
2. Advanced Topics in Using Sensors to Measure Air Quality (Presentation Slides)  
Available at: [https://cfpub.epa.gov/si/si\\_public\\_record\\_report.cfm?Lab=CEMM&dirEntryId=350602](https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=CEMM&dirEntryId=350602)

These materials are meant to be accessible and adaptable. Users may carry out these suggested activities as a starting point to design and conduct experiments of their own. These materials target a 6<sup>th</sup> grade level, however they may be adapted as necessary for younger or older audiences. If you create adapted materials that you wish to share with others, you may contact [clements.andrea@epa.gov](mailto:clements.andrea@epa.gov).

These materials were originally developed to support the Air Sensor Loan Pilot Programs in EPA Region 10. We would specifically like to recognize the following individuals who have worked to establish and facilitate the loan programs and contributed to developing the concept for the lesson plan and review of the materials created.

#### Institute for Tribal Environmental Professionals (ITEP)

- Mansel A. Nelson and Josie Kamkoff

#### Heritage University

- Jessica L. Black (Center for Indigenous Health, Culture & the Environment)
- Dalia Wolftail, Darren Olney, Agnes Meninick, and Lillie Wesley (Science Department)

#### Nez Perce Tribe Air Quality Program

- Johna Boulafentis and Mary Fauci

#### Sonoma Technology

- Bryant West

We request that users cite this work as follows: O.S. Ryder, S.G. Brown, A.L. Clements, R.M. Duvall, R.A. Smoak, C. Dubois, S. Waldo, I.J. Young, “Is that Smoke Affecting Me? Using Crowdsourced Public Data to Explore Air Quality During Smoke Events”, Air Sensor Loan Program in Tribal Communities, Funded by U.S. EPA, 2022

*Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.*

O.S. Ryder, S.G. Brown, A.L. Clements, R.M. Duvall, R.A. Smoak, C. Duboiski, S. Waldo, I.J. Young, "Is that Smoke Affecting Me? Using Crowdsourced Public Data to Explore Air Quality During Smoke Events", Air Sensor Loan Program in Tribal Communities, Funded by U.S. EPA, 2022

# Is that smoke affecting me?

## Using crowdsourced public data to explore air quality during smoke events.



## Table of Contents

Lesson Overview.....	3
Alignment with Next Generation Science Standards .....	3
About This Lesson.....	5
Learning Objectives.....	5
Documents Associated with This Lesson .....	6
Materials Needed for This Lesson .....	6
Time Requirement.....	6
Age Range.....	7
Disclaimer About Technology .....	7
Note About PurpleAir Sensors and Data Privacy.....	7
Introduction .....	8
What Is Particulate Matter? .....	8
What Are the Health Impacts of PM?.....	9
What Role Does Particle Size Play? .....	9
Acute vs. Chronic Exposure to PM .....	11
Where Does Particulate Matter Come from? .....	11
Human-Made Sources .....	12
Natural Sources .....	14
What Factors Influence PM <sub>2.5</sub> Levels? .....	15
How is PM Measured?.....	16
Regulatory Monitors.....	16
Air Sensors.....	17
PurpleAir Sensors: A Type of Air Sensor.....	17
What is the Air Quality Index? .....	18
AirNow Fire and Smoke Map .....	20
The PurpleAir Map.....	23
Map Activity.....	26
Part 1: Investigating Your Regional Air Quality.....	26
Part 2: Air Quality in Your Community .....	30
Part 3: Linking Observation to Measurement: Wildfires and Visibility .....	31
How Does PM Impact What We See Outside?.....	32
How to Reduce Your Personal Exposure to PM and Steps to Take to Improve Air Quality .....	34
Air Quality – Inside vs. Outside .....	36

## Lesson Overview

---

### Alignment with Next Generation Science Standards

Middle School Standards	
MS-LS2	Ecosystems: Interactions, Energy, and Dynamics
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-ESS2	Earth's Systems
MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
MS-ESS3	Earth and Human Activity
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ETS1	Engineering Design
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

High School Standards	
HS-LS2	Ecosystems: Interactions, Energy, and Dynamics
HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-ESS3	Earth and Human Activity
HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts on human activities on natural systems.
HS-ETS1	<b>Engineering Design</b>
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

## About This Lesson

In this activity, you will learn about common particulate matter (PM) sources and the health impacts of PM exposure. You will also learn about factors that can influence fine PM (PM<sub>2.5</sub>) concentration levels, and the difference between air quality measurements from a regulatory PM monitor and an air sensor. Using the AirNow Fire and Smoke Map, you will learn how to view PM levels around your community – or anywhere! After viewing the PM values in your community, you will investigate data trends and learn ways to reduce your exposure to PM during smoke events. Finally, you will brainstorm some ways in which you can help to reduce your own personal PM exposure and improve air quality in your community.

Before starting the activity, review the following background materials and resources:

1. **Review the AQ101 Presentation.** This presentation provides background information on PM, including: What is PM? Where does it come from? Why should you care about PM?
2. **Read the introductory material or attend an instructor-led presentation on the introductory material.** The introductory material for this activity (*Is that smoke affecting me?*) will teach you about PM and common sources of outdoor PM.
3. **Review the Quick Start Guide or attend an instructor-led presentation on the Quick Start Guide.** The Quick Start Guide will teach you how to use the PurpleAir sensor.
4. **Review the AirNow Fire and Smoke Map** (<https://fire.airnow.gov/>) and **PurpleAir Sensor Map** ([purpleair.com/map](https://purpleair.com/map)).
5. **Review the EPA Air Sensor Toolbox page.**

## Learning Objectives

In this activity, participants will use crowdsourced particulate matter (PM) measurements in their community to explore air quality. Participants will learn about:

- Sources of particle pollution.
- The health impacts related to PM exposure.
- What the Air Quality Index (AQI) is and what it can tell you.
- The difference between regulatory monitor and air sensor measurements.
- How to navigate and use the AirNow Fire and Smoke Map.
- How to navigate the PurpleAir Sensor Map.
- How to mitigate personal exposure to PM during smoke episodes.
- How to actively reduce everyday personal contributions to PM.

## Documents Associated with This Lesson

- This document (“**Is that smoke affecting me?**”) contains introductory information on the activity, background information, step-by-step instructions, and questions to help you to make sense of your results.
- The “**Is that smoke affecting me? Data Collection Worksheet**” provides an organized place to write answers to the questions asked in this activity and take notes.
  - If you are performing this activity under the guidance of an instructor, the **Data Collection Worksheet** will help you in group discussions. You may also need to turn it in (ask your instructor for more information).
  - If you are performing this activity individually, you can use the **Data Collection Worksheet** to organize your observations and notes, but you will not need to turn it in to anyone.
- The “**Is that smoke affecting me? Instructor Answer Key**” provides answers to the questions in the activity.
- The “**Is that smoke affecting me? Supplemental slide deck**” provides additional visuals you can use to help understand the effects of wildfire on air quality and sample additional activities for younger and more advanced learners.

## Materials Needed for This Lesson


- PurpleAir sensor (optional)
- A computer with access to the internet
- Data Collection Worksheet or paper for taking notes and recording your answers

## Time Requirement

The main activity can be tailored to fit into any given time period by adjusting the length of time spent exploring the map. Under instructor guidance, at least 45 minutes is recommended, while at least 60 minutes is advised for people guiding themselves through the activity. The extension activity will take additional time – at least 45 minutes is recommended.



## Age Range

The material in this lesson is geared towards participants ranging from **middle school-aged students (about a 6<sup>th</sup> grade level) through adults**. However, where available, options for younger students aged 4-8 are noted with this symbol . Additional sample activities for younger and older students are also available in the supplemental side deck.

## Disclaimer About Technology

While we are outlining activities for specific air sensors, this activity can be used for other air sensors with publicly available data.<sup>1</sup>

## Note About PurpleAir Sensors and Data Privacy

For PurpleAir sensor data to appear on the AirNow Fire and Smoke Map (used in this activity), the sensor will need to be connected to Wi-Fi and registered in “public” mode. This mode will make all data available for anyone to view and can empower everyone with knowledge about their local air quality. The activities within this lesson plan will be easiest to accomplish when data are public and you are able to utilize the Fire and Smoke Map. The **Quick Start Guide** instructions show how to set a PurpleAir sensor to “public” mode. This operating mode is recommended if possible and safe to do so.

If you prefer, you could run the PurpleAir sensor in “private” mode. In this mode, you can view your data using the PurpleAir website map ([purpleair.com/map](https://purpleair.com/map)) after signing in, and the data will only be visible to those who have a password that you create. These data will not flow to the AirNow Fire and Smoke Map. Although comparing data among PurpleAir sensors will be possible, this mode will make comparison to the permanent monitors used for regulatory applications more difficult. For more information about registering sensors in “private” mode, see the PurpleAir **Quick Start Guide**.

Lastly, SD card-enabled PurpleAir sensors can also be operated without registering the device and without a Wi-Fi connection. In this case, data will be saved directly to the SD card. Although this mode allows for the greatest data privacy, it is more difficult to download data and compare them with other data sources. The PurpleAir **Quick Start Guide** discusses how to access the data from the SD card.

---

<sup>1</sup> Note: EPA makes no endorsement of PurpleAir or any other air sensor technology.

# Introduction

---

In this activity, you will use a computer to navigate to the online AirNow Fire and Smoke Map where you can view particulate matter (PM) levels in your community and overall region. Before you get started you will learn about two different classes of PM ( $PM_{2.5}$  and  $PM_{10}$ ), where they commonly come from, and the health impacts of PM. You will learn about the difference between air pollution measurements from regulatory monitors and more readily available air sensors. In your investigation, you will identify air sensors that are reporting high and low PM values and investigate possible causes. Next, you will learn how to identify trends and interesting features in the data. Finally, using what you learned from this activity, you will think of ways to limit your personal PM exposure in your daily life and ways to reduce your contribution to indoor and outdoor PM levels.

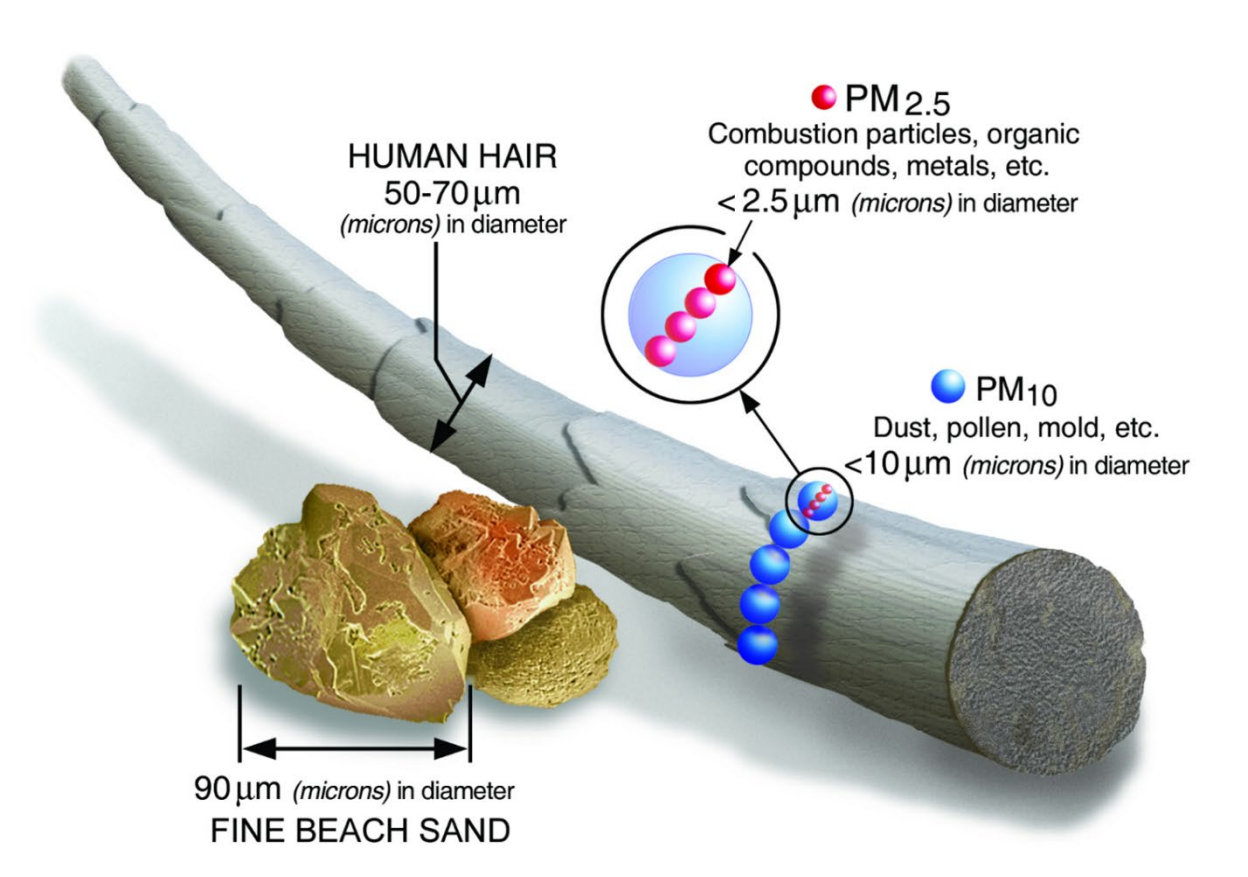
## What Is PM?

PM is a mixture of very small solid particles and liquid droplets that are suspended in the air. They can be made up of soil, soot, dust, pollen, metals, and much more. Scientists often group PM into different classes based on their size. It is important to distinguish between the different classes because both classes can cause different health effects. Two common classes are  $PM_{10}$  and  $PM_{2.5}$ .

**$PM_{10}$**  – This class includes particles that are smaller than 10 micrometers in diameter. Some of these particles are large enough to be seen by the naked eye, such as dust and pollen. You may have experienced these types of  $PM_{10}$  particles, especially on a windy day, and they may have led to coughing or eye irritation.

**$PM_{2.5}$**  – Also called fine PM, this class includes particles that are smaller than 2.5 micrometers in diameter. These particles are too small to be seen by eye but can be seen under a microscope.

You may not often think in terms of micrometers, so it might be hard to imagine how small these particles are. To give you a better idea of the size of particles found in the air, see **Figure 1**. A human hair is approximately 50-70 micrometers ( $\mu m$ ) in diameter. You can see that  $PM_{10}$  particles could fit many times into the diameter of a human hair. You can fit even more  $PM_{2.5}$  particles into the diameter of a human hair, as they are much smaller than  $PM_{10}$ !



**Figure 1.** A schematic showing the size of a PM<sub>2.5</sub> particle and a PM<sub>10</sub> particle in comparison to a grain of sand and a human hair. Image credit: U.S. EPA

## What Are the Health Impacts of PM?

Many health studies have shown a strong link between breathing in PM and harmful health effects. The health risks can include but are not limited to heart attacks, cardiac arrhythmias, asthma attacks, and bronchitis. When people are exposed to PM, it can lead to increased absences from school or work, hospital admissions, emergency room visits, and restricted activity days.

### *What Role Does Particle Size Play?*

The size of the particles (PM<sub>2.5</sub> or PM<sub>10</sub>) makes a difference to their health effects!

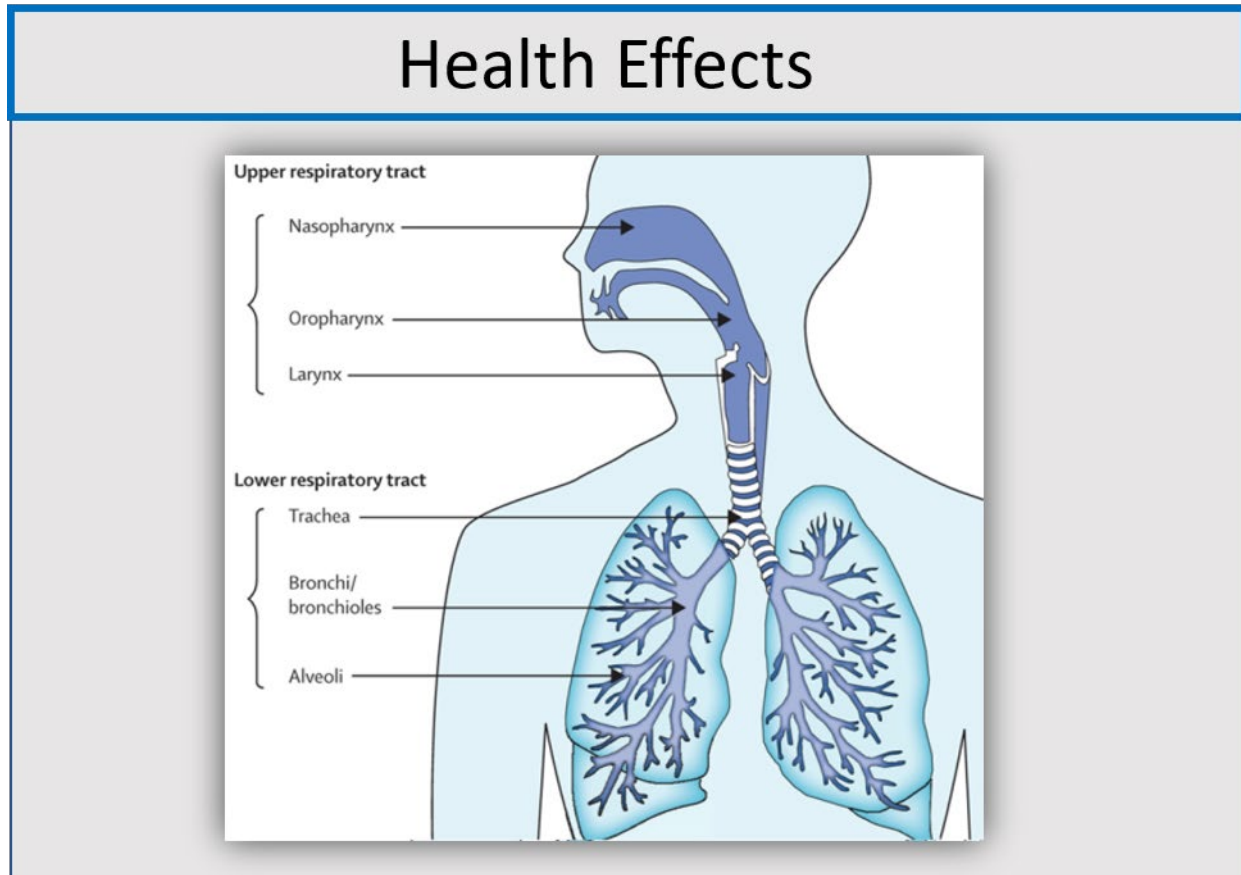
PM<sub>2.5</sub> can travel deep into your lungs (lower respiratory tract) and bloodstream, which can cause:

- **Breathing problems**, such as coughing, throat irritation, difficulty breathing, asthma, bronchitis, and many other ailments. Some of these problems are short-term, and others may become chronic with prolonged exposure.

- **Heart problems**, such as heart attacks or an irregular heartbeat.

PM<sub>10</sub> does not travel as deep into the lungs because the body is better at filtering them out. Generally, they affect the upper respiratory tract. These particles are most associated with causing eye, nose, and throat irritation.

Figure 2 shows the areas of the respiratory system that can be affected by breathing in PM.



**Figure 2.** The areas of the respiratory system that can be affected by breathing in PM.

The PurpleAir sensors that you will be using can measure PM<sub>10</sub>, PM<sub>2.5</sub>, and PM<sub>1</sub> (particles smaller than 1 micrometer in diameter). Because of the important health effects of PM<sub>2.5</sub>, you will focus on monitoring PM<sub>2.5</sub> in this activity.

## Acute vs. Chronic Exposure to PM

A person can have an acute or chronic exposure to PM depending on how often and how long they are exposed to it. **Acute** exposure happens when a person has brief contact with PM. This might last between one and several hours.

**Chronic** exposure happens when a person has a repeated or prolonged exposure to PM. For example, chronic exposure might happen if someone is exposed to PM repeatedly on a daily, weekly, or monthly basis, every summer, or consistently over their lifetime.

Acute exposure to PM<sub>2.5</sub> can lead to changes in blood pressure, stroke, cardiovascular mortality, and exacerbation of heart failure. Acute exposure might happen if there is a one-off event, such as a wildfire or other burning event.

Chronic exposure to PM<sub>2.5</sub> is associated with cardiovascular disease, mortality and the reduction of a person's life expectancy. Several large studies have shown an association between chronic exposure to air pollution (particularly PM<sub>2.5</sub>) and mortality. Chronic exposure might happen if someone lives or works near a PM source or if they are exposed to a source on a regular basis.

- For more information on how PM can affect your health, you can check out: <https://www.epa.gov/particle-pollution-and-your-patients-health/course-outlinekey-points>
- Particle Pollution and Your Health (PDF), How Smoke from Fires Can Affect Your Health: <https://www.airnow.gov/air-quality-and-health/how-smoke-from-fires-can-affect-your-health>
- Research on Health Effects from Air Pollution: <https://www.epa.gov/air-research/research-health-effects-air-pollution>



**Figure 3.** A member of the community wearing a mask on a hazy day.

## Where Does Particulate Matter Come from?

There are many sources of PM in the environment, produced by both human activities and natural sources. Below are some examples of human and natural sources that you may find in your community. Specifically noted is whether the sources produce PM<sub>2.5</sub>, PM<sub>10</sub>, or both. Remember to pay close attention to PM<sub>2.5</sub> sources as those are the focus of this activity.

This activity focuses on PM<sub>2.5</sub> due to its important health effects.

## *Human-Made Sources*

Some common human-made PM sources include emissions from wildfires started intentionally or accidentally by human activity, burning wood (including in woodstoves), and agricultural burning to clear land of plant waste. These burning activities all produce particles that are mostly in the PM<sub>2.5</sub> size range, which, as you learned above, are the particles with the greater health concerns.

Agricultural activities that involve creating dust, such as plowing fields or harvesting crops, also produce PM, but most of these particles are in the PM<sub>10</sub> size range. As noted above, PM<sub>10</sub> can cause irritation to your eyes, nose, and throat, but do not travel as deeply into the lungs as PM<sub>2.5</sub> do.

Diesel engines, which are often found in trucks, buses, and heavy construction or agricultural equipment, also produce PM<sub>2.5</sub>. Industrial facilities may emit PM, although the size of the particles a facility emits depends on what the facility does or what product it produces. **Figure 4** shows a summary of common human-made sources of PM.



## Sources of Particles: Human-Made



### Wildfires

Wildfires produce large amounts of mainly  $PM_{2.5}$  sized particles.



### Woodstoves

You may have seen smoke coming from a wood boiler or wood stove. Burning wood emits  $PM_{2.5}$  into the air.



### Agricultural Burning

Agricultural burning may be part of a management plan to clear land or for orchard or tree farm pruning. These activities release  $PM_{2.5}$  into the air.



### Industrial Facilities

Industrial facilities may also release PM into the atmosphere. Whether this is  $PM_{2.5}$  or  $PM_{10}$  will depend on the type of industry and processes that take place at the facility.

An example of an industrial facility you may have seen in your community is a sawmill.



### Residential Burning

Residential burning includes disposal of leaves, yard waste, and garbage by burning them. Burn barrels are also a problem in rural areas.

These activities release  $PM_{2.5}$  into the air.

If the items being burned contain plastic, that will lead to the release of harmful cancer-causing pollutants as well.



### Agricultural Activities

Agricultural activities such as burning, plowing, and harvesting can emit PM.

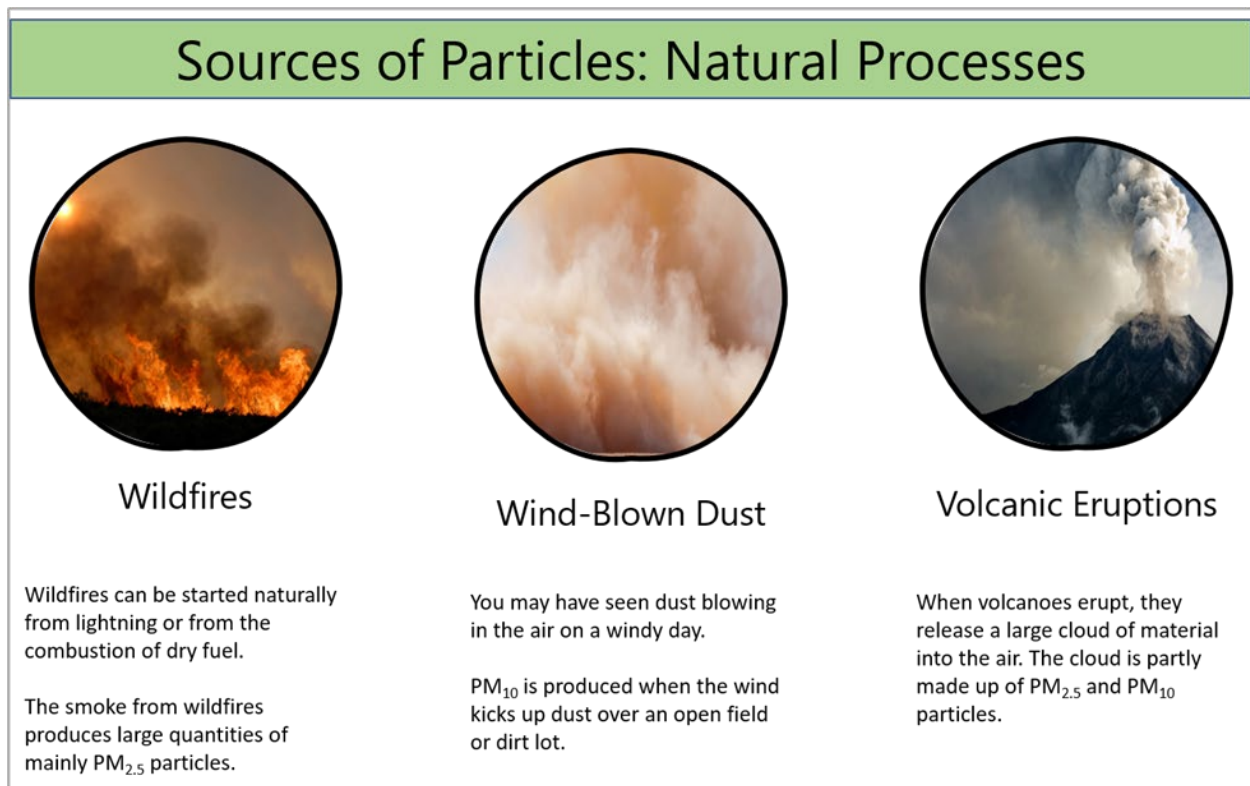
When the soil is plowed or tilled,  $PM_{10}$  particles in the form of dust can be released into the air.

Machinery that is used by farmers to harvest crops is typically diesel-powered, which releases  $PM_{2.5}$  into the air.

**Figure 4.** Common sources of PM from human activities.

## Natural Sources

A common natural source of  $PM_{2.5}$  is wildfires, which may be started by lightning strikes or other geological processes. Other natural sources of  $PM_{10}$  include dust blown by the wind and volcanic eruptions that emit ash (among other pollutants) into the air. **Figure 5** summarizes common natural sources that generate PM.



**Figure 5.** Common sources of PM from natural processes.

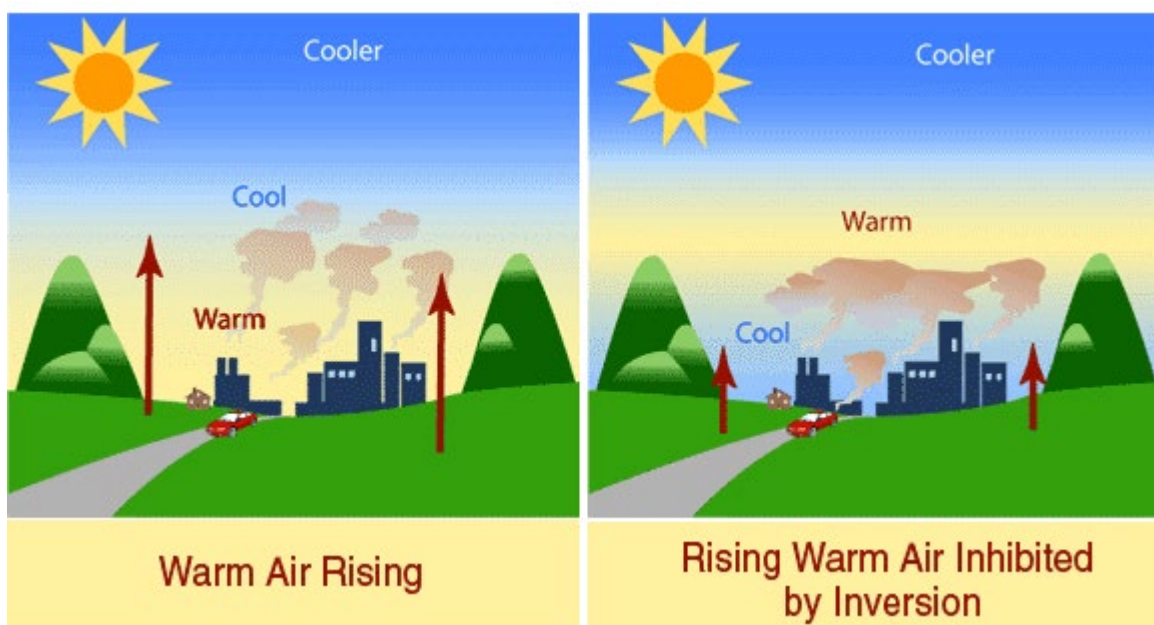


## What Factors Influence PM<sub>2.5</sub> Levels?

A variety of weather conditions and other factors can influence PM<sub>2.5</sub> levels. For instance, wind can transport particles a long distance. Oftentimes, PM<sub>2.5</sub> can be found hundreds or even thousands of miles away from its original source. Rain can clear particles out of the air, and topography (how hilly or flat land is) can make certain places more susceptible to higher PM levels. For example, as shown in **Figure 6**, communities located in valleys can be more susceptible to temperature inversions that trap air pollution. A temperature inversion occurs when a layer of cooler air is trapped close to the ground by a layer of warmer air above it. When the air cannot rise, it traps pollutants at the surface. In locations where wood is burned for heat in the winter, PM levels can be especially high during temperature inversion events.

For more information about particle pollution and temperature inversions, check out:

<https://www.epa.gov/pmcourse/what-particle-pollution>.



**Figure 6.** Illustration of a temperature inversion. Inversions happen when a layer of cooler air is trapped close to the ground by warmer air above, as shown in the image on the right. When the air cannot rise, it traps pollutants at the surface. This happens more commonly at nighttime when clear skies allow air near the ground to cool faster than the air above. Image credit:

<https://www.epa.gov/pmcourse/what-particle-pollution>

## How is PM Measured?

### *Regulatory Monitors*

Tribal, state, and local air quality agencies are responsible for monitoring air quality levels within their region. These agencies use both permanent year-round and temporary regulatory monitors to monitor the PM<sub>2.5</sub> levels.

**Figure 7** shows an example of a regulatory monitoring site.

Permanent monitors are placed in specific and carefully chosen locations to provide data at one site over many years. Temporary monitors are typically placed in areas where higher pollution levels are expected over a fixed period of time, such as near a wildfire or construction site.



**Figure 7.** A photo of a regulatory monitoring station.  
Image credit: U.S. EPA

Regulatory monitors provide high quality measurements. Maintenance, as well as quality assurance and quality control checks, are regularly performed to make sure the instruments are working correctly. At a regulatory monitoring site, the monitoring instruments are kept inside a small building or trailer with temperature and humidity control to ensure the instruments operate properly and to prevent them from getting damaged or broken. Because these monitors are used to collect data for specific goals, and where they are located is driven by the population size, the number of regulatory sites vary from state to state. It is possible that the nearest regulatory monitor may be located many miles away from your community.

## Air Sensors

Another class of technologies known commonly as “air sensors” also exist and have become popular in recent years. There are many different types of air sensors available, but overall, they tend to be smaller, more portable, more affordable, and easier to use than regulatory instruments. Members of the general public can purchase an air sensor and start making their own measurements relatively easily.

However, there are some important factors to keep in mind. Sensors are not as accurate as regulatory monitors, can have shorter lifespans, and the data quality can vary greatly depending on the type of sensor and how it is used. For example, measurements vary in different weather and depending on the type and size of particles you are monitoring. Despite these limitations, air sensors are a great way for the public to measure PM levels in their own communities.

### *PurpleAir Sensors: A Type of Air Sensor*

Air sensors can empower communities by helping them build awareness about local air quality. PurpleAir is the type of air sensor that is the focus of this lesson. A photo of a PurpleAir sensor is shown in **Figure 8**. This sensor measures PM<sub>1</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub>. It can be mounted in your backyard, school, library, or work, and can help inform you about the PM levels around your community, neighborhood, or street. Some individuals have even installed PurpleAir sensors inside of their homes. Doing this gives individuals a better picture of the air quality inside and outside, which can help inform daily activities such as opening windows and spending time outside. Some schools have also installed networks of PurpleAir sensors on campuses to monitor PM levels and inform student safety (e.g., limiting outdoor activities during high PM days, or recirculating air within a school when PM levels are high).

As mentioned before, air sensors are not as accurate as regulatory monitors, and the data quality can vary. PurpleAir sensors are no different. Scientists have compared data from PurpleAir sensors to more accurate regulatory monitors in numerous research studies. Through these studies they found that PurpleAir sensors typically compare very well with one another. This practice makes comparing the reported concentrations from two different sensors very easy. Scientists also track PM trends,

## Terminology

...

In this activity, the term **air sensor** is used. In other places, you may see the same sensors referred to as “**small sensors**” or “**low-cost air quality sensors.**”



**Figure 8.** A PurpleAir sensor, side and bottom view

such as higher and lower PM<sub>2.5</sub> concentrations. PurpleAir sensors tend to overestimate PM<sub>2.5</sub> concentrations, which means data may need to be mathematically corrected before PurpleAir data can be compared with nearby regulatory monitoring measurements. Scientists also found that, occasionally, the 2-minute data reported by the sensor can be noisy (the data shows lots of random and meaningless fast changes), which may be a result of issues with the sensor or a passing bug or spider. Closely examining the data and removing questionable data point or averaging data to longer time averages, like 1-hour averages, can minimize the effects of this noise. Lastly, particle size influences the sensor's performance. While the sensor performs reasonably well when measuring PM<sub>2.5</sub>, it sometimes fails to effectively measure larger particles like dust. Thus, PM<sub>10</sub> measurements are less accurate, and a large dust event may be misread. If you are experiencing a dust episode, you should check the PM<sub>10</sub> data from the nearest regulatory monitor by visiting <https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors>.

## What is the Air Quality Index?

Just as the weather changes with time, air quality can change daily or even hourly. U.S. EPA developed the Air Quality Index (commonly abbreviated as "AQI") so people can better understand how healthy or unhealthy the air is outdoors. U.S. EPA has a scale for five major air pollutants, also known as criteria pollutants, that are regulated by the Clean Air Act to protect human health. PM (including PM<sub>2.5</sub> and PM<sub>10</sub>) is one of these pollutants. For more information on the criteria air pollutants, see <https://www.epa.gov/criteria-air-pollutants>.

The AQI scale is broken down into six different categories, which are shown in **Table 1**. For each of the categories, there is a distinct color, level of concern, and range of AQI values. These categories tell people how clean or polluted the outdoor air is and the associated health effects that may be of concern. For example, if you see green you know that the air quality is "Good," whereas if you see red you know that the air quality is "Unhealthy." The higher the AQI number, the worse the air quality is outside. It is important to note that the daily AQI value is determined for each of the five criteria air pollutants, and the highest one dictates the overall AQI level for a given location each day.

### Option!

...

Younger participants (ages 4-8 years old) can read or watch "Why is Coco Orange?" to learn more about the AQI and air pollution health effects or read "Why is Coco Red?" to learn more about wildfire smoke, air quality, and health effects (also available in Spanish):

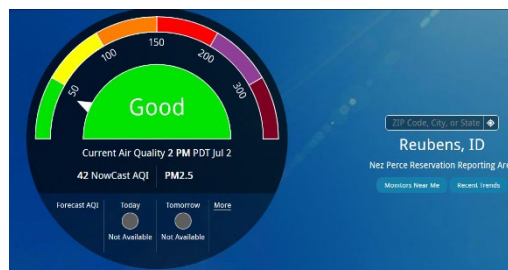
<https://www.airnow.gov/education/why-is-coco-orange/>

<https://www.airnow.gov/education/why-is-coco-red/>

**Table 1.** This table shows the different AQI levels, including their color, level of concern, index value, and description of the air quality for each category.

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	150 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions; everyone is more likely to be affected.

You might be wondering how the AQI level is calculated. In simplified terms, these levels are calculated from regulatory monitor data across the United States. The AQI is calculated for each pollutant and is based on the health-based National Ambient Air Quality Standard (NAAQS) averaging time. For PM, the AQI is based on a 24-hour average of concentration data. Using the average value, an equation is used to convert the concentration to an AQI value. You can find the PM<sub>2.5</sub> concentration associated with each AQI category in Table 1. The AQI for locations across the United States is reported on the AirNow website, [www.airnow.gov](http://www.airnow.gov). Visit the AirNow website to check the AQI in your area or other locations. You can also download the AirNow app to your smartphone! **Figure 9** shows an example of AQI information from the website.



**Figure 9.** A screenshot of AQI information from the AirNow website.

For more information about the AQI, see: <https://www.airnow.gov/aqi/aqi-basics/>.

As mentioned previously, air sensors provide an opportunity for the public to measure more local- and neighborhood-level pollution. In combination with the data from regulatory monitors, air sensors can help fill in the air quality gaps by allowing us to make measurements closer to where we live, work, and play. Additionally, some regulatory monitors and most air sensors can provide data

more frequently, for instance every hour. Since air quality can change quickly and sometimes unexpectedly during smoke events like wildfires, the U.S. EPA calculates the AQI values for real-time data using a method called NowCast. The NowCast method relates hourly data to the 24-hour AQI by using a calculation that involves multiple hours of past data. The NowCast uses longer averages during periods of stable air quality and shorter averages when air quality changes rapidly, such as during a wildfire event. Note that the NowCast AQI values only exist for O<sub>3</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub>, because these are the most prominent pollutants.

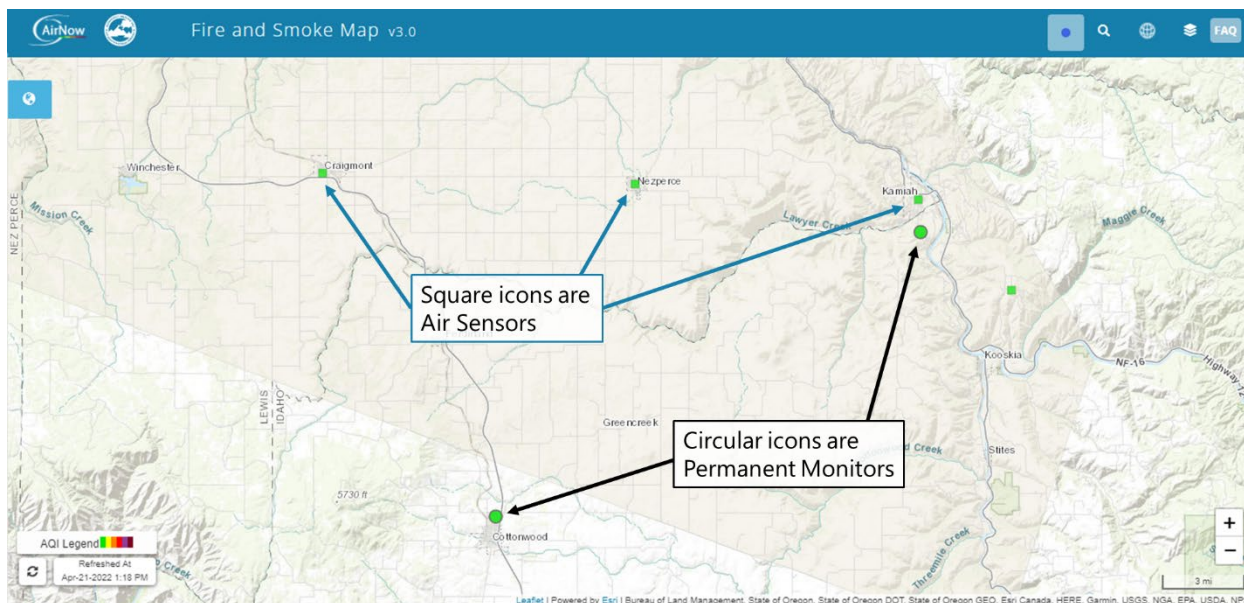
For more information about the NowCast AQI, see: <https://www.airnow.gov/aqi/aqi-basics/using-air-quality-index/>.

## AirNow Fire and Smoke Map

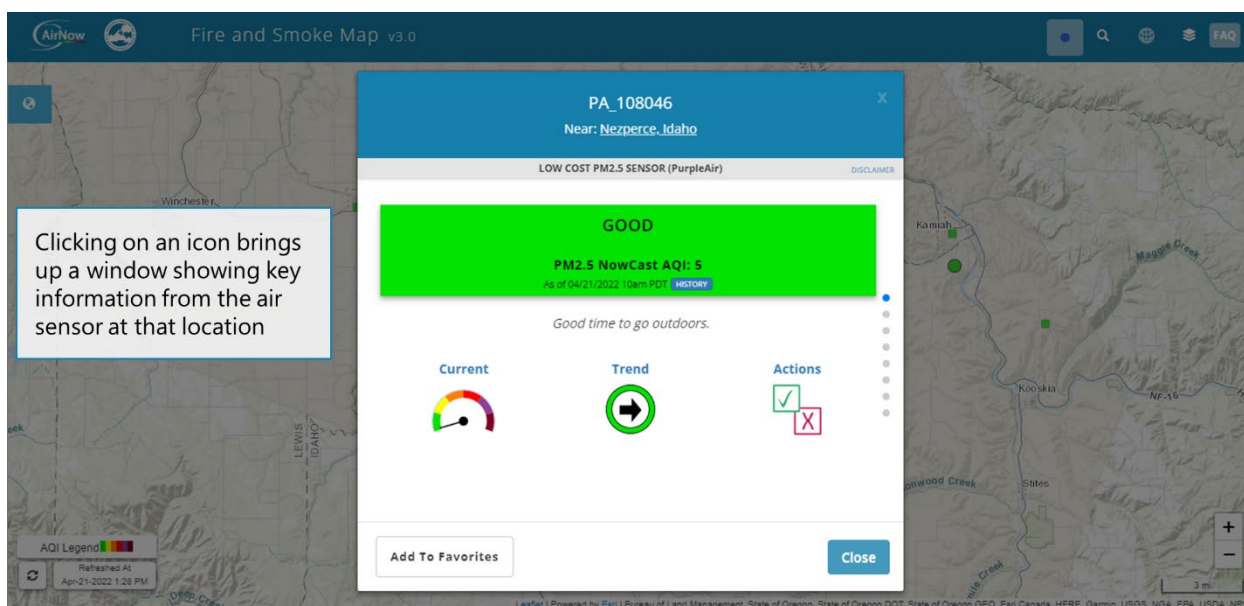
With so many air quality websites and apps available these days, it can be challenging to know which one to use for information, especially during a wildfire. Together with the United States Forest Service, U.S. EPA has developed the AirNow Fire and Smoke Map to provide a wealth of information to help you better understand PM<sub>2.5</sub> levels in your area. The map features PM<sub>2.5</sub> data from the regulatory grade air pollution monitors that report to AirNow, temporary monitors deployed by the U.S. Forest Service, and all publicly reporting PurpleAir sensors, along with information on large fire incidents, satellite-detected fires, smoke plumes, and special smoke statements. Additional data, including other air sensor data, could be added in the future. The map is located at <https://fire.airnow.gov>.

As mentioned, this map shows PM<sub>2.5</sub> levels for regulatory monitors, temporary monitors, and PurpleAir sensors (denoted as “low-cost” sensors). The PurpleAir sensor data have been corrected with the extended U.S.-wide correction equation, and quality control steps have been applied to all the PurpleAir sensor data which makes it easy for all users to quickly view a comparable and consistent picture of air quality conditions regardless of where the data comes from. Permanent regulatory monitors are shown as circle icons, temporary monitors are shown as triangles, and the PurpleAir sensors are shown as square icons. Depending on the PM<sub>2.5</sub> levels measured at a given monitor, the icons will be a different color based on the AQI levels. **Figure 10** shows an example of what these icons look like. In this figure, the color of the icon reflects the current PM<sub>2.5</sub> levels. On this Map, if you click on a monitor, you are then shown more information about the monitor, including a plot of the PM<sub>2.5</sub> levels over time. **Figure 11** provides an example of what you might see on the Fire and Smoke Map website after you click an icon.



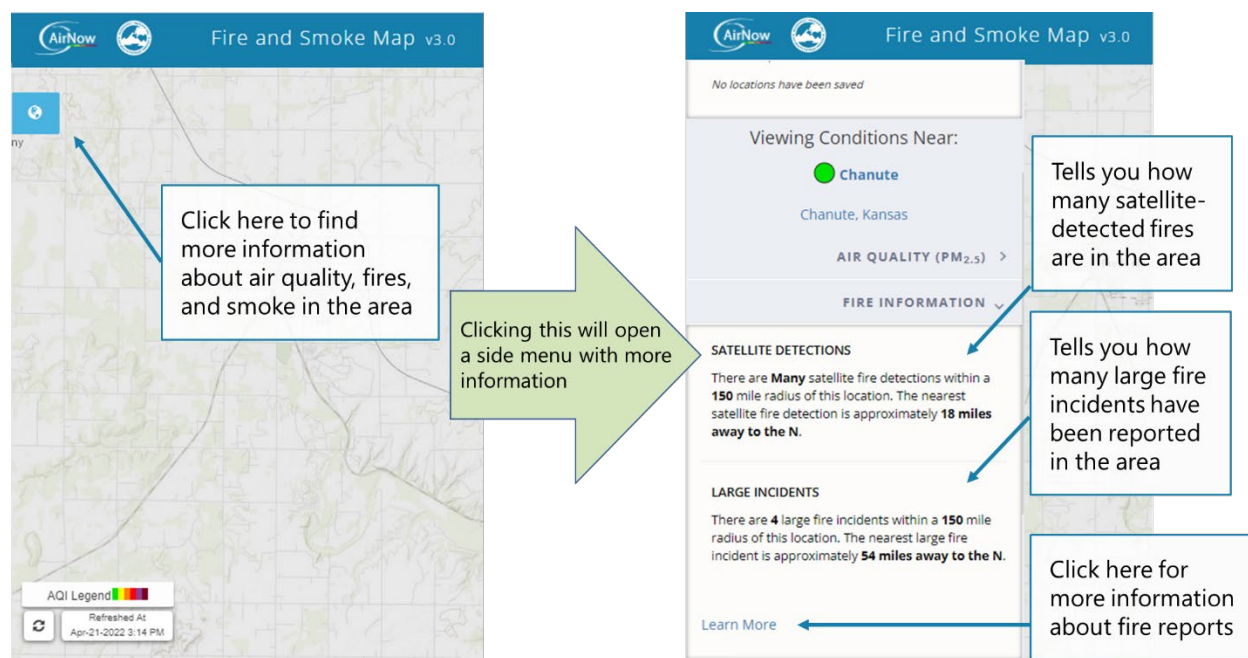


**Figure 10.** AirNow Fire and Smoke Map. On the map, permanent monitors are shown as circles and low-cost sensors are shown as squares. Temporary monitors (not show in this map) are shown as triangles. Icons are colored based on the current PM<sub>2.5</sub> NowCast AQI level, which is calculated for each monitor or sensor.



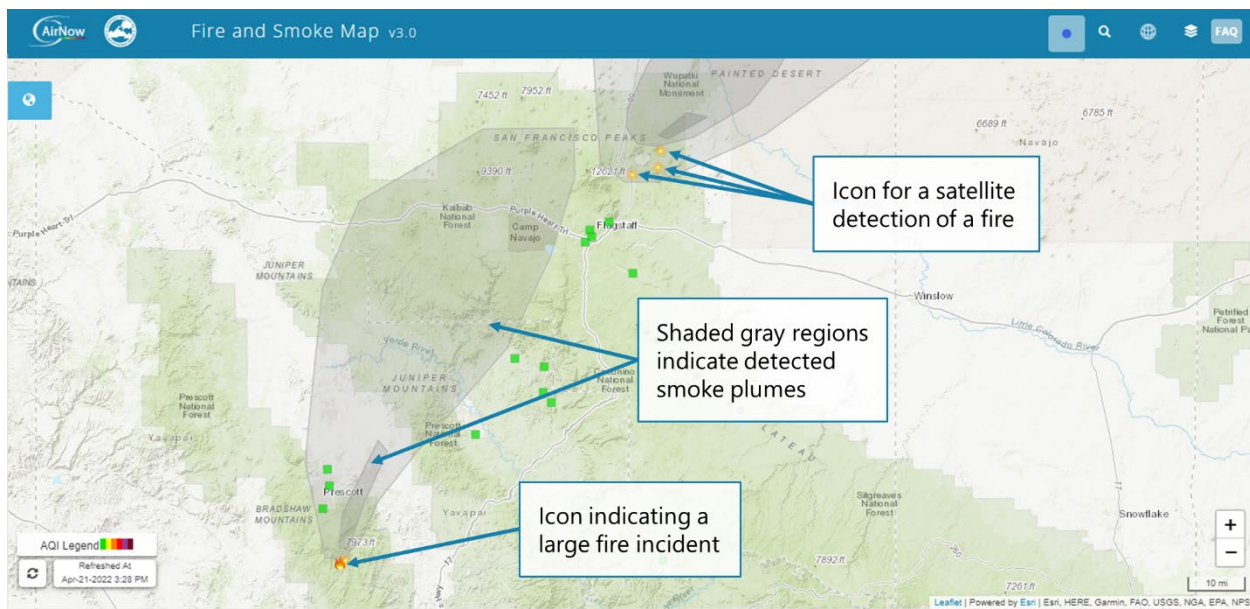
**Figure 11.** Clicking on an icon will bring up more information including measurements from the monitor for the past week.

Active wildfire information is also shown on the Fire and Smoke Map. The locations of active wildfires come from two places: the U.S. National Interagency Fire Center's active incident feed, which collects reports on large fires, and the National Oceanic and Atmospheric Administration's (NOAA) Hazard Mapping System (HMS), which uses satellites to detect large fire incidents. **Figure 12** shows where to find information on active fires in your area, and **Figure 13** provides an example of the icons for each type of fire report.



**Figure 12.** Instructions on using the Fire and Smoke Map website to find out information about possible fires in your area.





**Figure 13.** The Fire and Smoke Map showing an area reporting smoke (grey shaded area), large fires (fire icon), and satellite fire detections (yellow glowing circles).

The Fire and Smoke Map also shows where smoke from wildfires is located. Satellite-observed smoke is shown as grey shaded areas on the map (see the shaded region in **Figure 13**). Although smoke may be observed by satellite, it is unclear how high the smoke plume is in the atmosphere. Ground observations, like those from permanent or temporary monitors and air sensors, can help determine if smoke is impacting people on the ground or not. The wildfire and smoke information displayed on the map can give you an idea of some of the possible PM<sub>2.5</sub> sources that are impacting an area.

## The PurpleAir Map

While this lesson focuses on the AirNow Fire and Smoke Map, you might wish to look at data from only the PurpleAir sensors. Alternatively, if you have chosen to run your PurpleAir sensor in “private” mode, you will need to log in and view your data via the PurpleAir map ([map.purpleair.com](https://map.purpleair.com)). This section will provide some important information about the PurpleAir Map that you should keep in mind if you plan to use the site.

**Figure 14** shows an example of the PurpleAir map. Each sensor appears as a circle, and each circle is colored according to the PM<sub>2.5</sub> AQI level. The map default is to show the PM<sub>2.5</sub> value from a 10-minute average, but you can use the drop-down menus to change what is shown on the display. For instance, you can view temperature data instead, or use hourly-averaged data to determine the AQI. You can also click on a sensor to see a line graph of the requested data recorded over the last few days.


The default PurpleAir Map displays the PurpleAir sensor data without corrections for known inaccuracies such as the overestimation of PM<sub>2.5</sub> concentrations and humidity impacts. Due to this difference, the PM<sub>2.5</sub> values shown on the PurpleAir map cannot be directly compared to regulatory monitor values shown on the Fire and Smoke Map. To make PurpleAir data more useful, U.S. EPA has developed a mathematical correction equation that can be applied to the PurpleAir sensor data to make the data more comparable to regulatory monitors. If you plan to use the PurpleAir Map to look at data, be sure to select the “US EPA” conversion to view the data. **Figure 14** also shows where you can select this option.

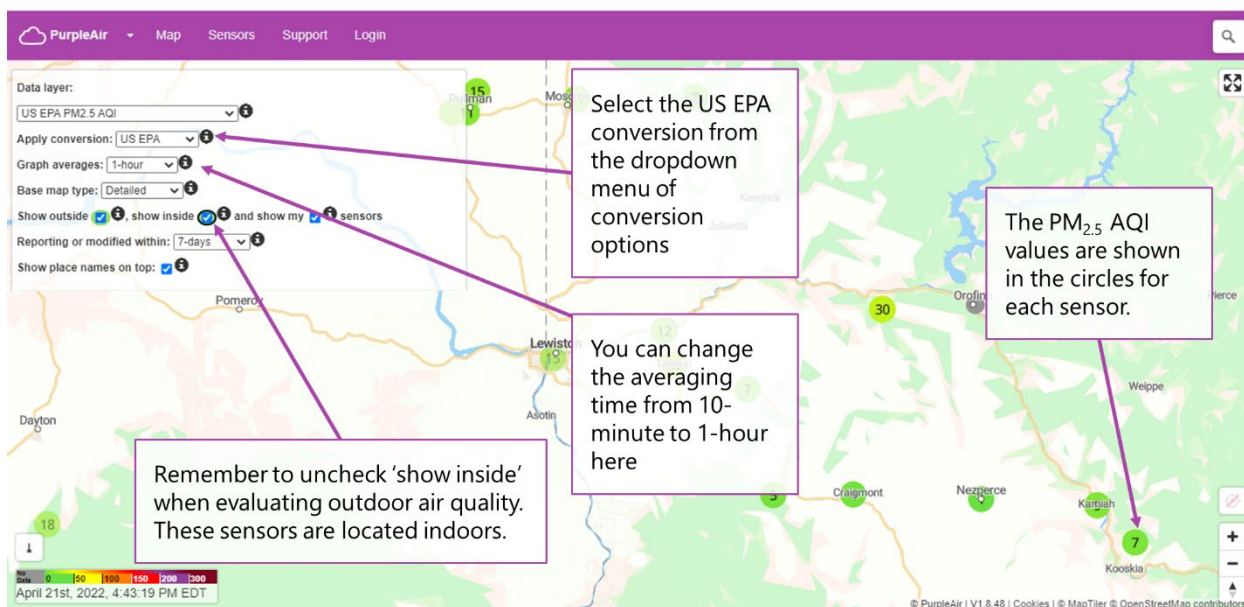
## Global Air Quality

...

PurpleAir sensors are not only located in the U.S.; people use them all over the world!

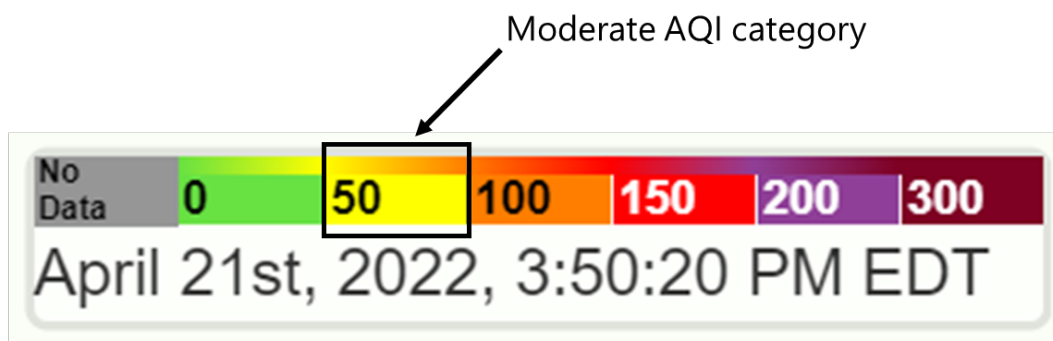
If you zoom out on the PurpleAir map ([map.purpleair.com](http://map.purpleair.com)), you can investigate PM levels around the globe.





**Figure 14.** The PurpleAir map. Inset boxes show how to unselect indoor sensor data from the map, where to change the averaging time of the data shown on the map, where to apply the U.S. EPA conversion, and an explanation of the numbers in each sensor icon.

An important note: The PurpleAir Map uses a continuous-color scale to display the AQI scale, which is different from the EPA AQI color scale that uses a solid color for each category. **Figure 15** shows a zoomed in version of the color bar found at the bottom of the Map Data Layer box on the PurpleAir map. Here, we can see that the Moderate AQI category, which should be yellow in color, may actually look yellow or orange when displayed on the PurpleAir Map. This can skew our interpretation of the data because the map may look more orange, indicating less healthy conditions. Keep this in mind if you are using the PurpleAir Map to look at your data and note the AQI numbers to compare to the chart in **Table 1** instead. The AirNow and AirNow Fire and Smoke Maps use the EPA AQI color scale with solid colors for each category.



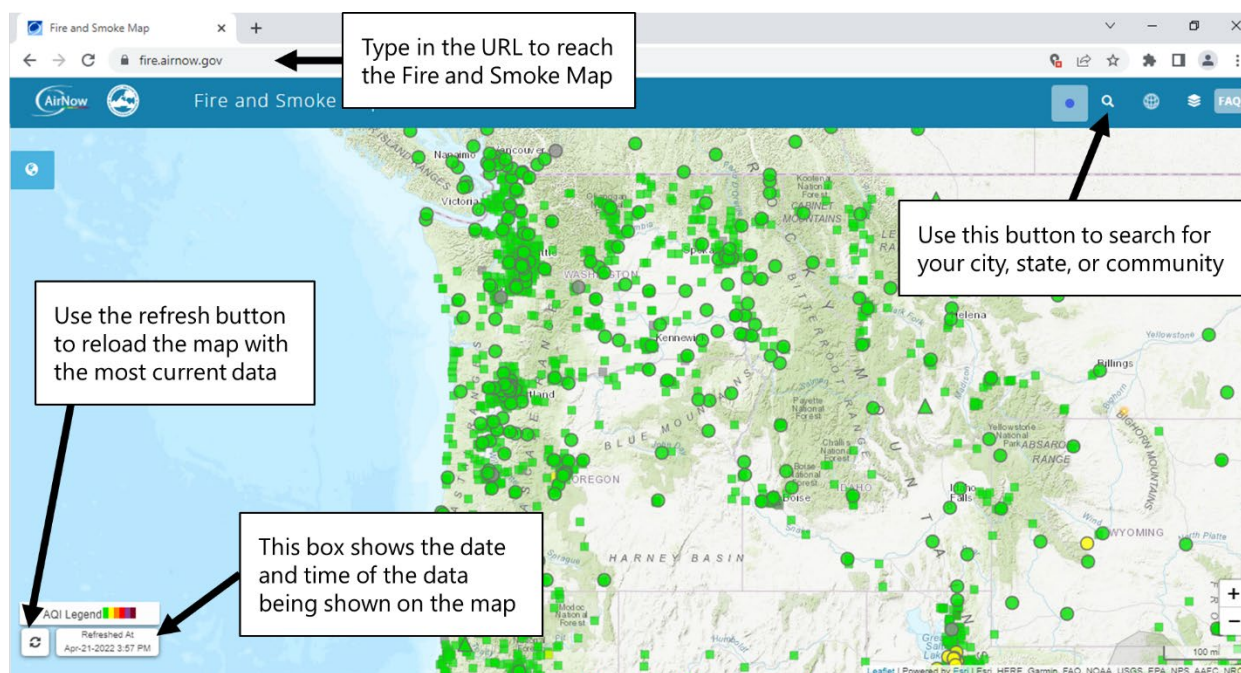
**Figure 15.** A zoomed in version of the color bar found at the bottom of the Map Data Layer box on the PurpleAir Map. Note that the colors shown on this map may differ from the true AQI scale colors. For example, the moderate category (AQI scale values of 51-100) is highlighted and spans from yellow to orange in the color bar key on the PurpleAir Map website. Refer to Table 1 for the accurate AQI color scale.

# Map Activity

## Part 1: Investigating Your Regional Air Quality

In Part 1 of this activity, you will be using the AirNow Fire and Smoke Map to investigate air quality in your region.

1. Using a computer that has access to the internet, navigate to the AirNow Fire and Smoke Map by typing <https://fire.airnow.gov> into the URL bar. See **Figure 16**.
2. Once the map has loaded, find your location. The map may automatically identify your computer's location. If you want to look at a different location, you can either:
  - a. Click on the map and drag the cursor to find your desired location or,
  - b. Use the magnifying glass icon at the top of the screen and type in the desired city, state, or community. See **Figure 16** to locate this icon.



**Figure 16.** The Fire and Smoke Map website. Highlighted boxes show where to type in the URL, how to search for your community, the date and time of the data being shown on the map, and how to refresh the screen to update the data.

3. If there are very few sensors/monitors in your community, try to zoom out a bit further on the map to a more regional scale. From this perspective, you may be viewing half of your state or your entire region, for example. In box ① on your **Data Collection Worksheet**, write down the number of circles, squares, and triangles that you see. Approximately how far is the

nearest marker from you? If there is not a monitor near you, you may want to borrow one from your local lending program to check out the air quality closer to you.

4. Design challenge: If you were to design a sensor network for your community, where are the important places that monitors should be placed? In box ① on your **Data Collection Worksheet**, list where you would place five permanent monitors by address or landmark. Also, list where might you place a temporary monitor and why? Who would be in favor of creating an air quality monitor network in your town? Who might be opposed? Why?
5. The map should automatically display the current data. At the bottom-left of the screen is a box that reads “Refreshed At” which displays the date and time of the data currently shown on the map. See **Figure 16** to help locate the “Refreshed At” box.
  - a. To make sure the most current data is displayed, click the circular refresh arrows button to the left of the ‘Refreshed At’ box in the bottom left of the webpage. See **Figure 16** to help identify the refresh button.
  - b. Every so often, the screen might prompt you to click this refresh button to show the most up-to-date measurements.
6. Use the + and – buttons in the lower right of the screen to zoom to your community. If you only see one monitor icon, try zooming out further until you can see a few more on your screen. Alternatively, if you would prefer to look at the air quality in another location—perhaps one that is experiencing elevated levels of PM—you can navigate to that location.
7. From the permanent regulatory monitors, temporary regulatory monitors, and air sensor icons in your community, identify which (if any) are showing elevated PM<sub>2.5</sub> levels right now (colors other than green). Remember that the color of the icon will indicate the PM<sub>2.5</sub> level and the corresponding AQI level (refer to **Table 1** for a reminder of the AQI categories and what they mean).
  - a. In box ② on your **Data Collection Worksheet**, write down the current date and time, along with the type and color of each air monitor or sensor icon. If there are lots of icons, choose up to three and write down the information for them. Consider choosing ones that are showing different PM<sub>2.5</sub> AQI colors.



## Fire and Smoke Map Reminder

...

Below is a reminder of the various monitor icons used on the Fire and Smoke Map:

- Circles = permanent monitors
- ▲ Triangles = temporary monitors
- Squares = low-cost sensors



8. Next, find the current PM<sub>2.5</sub> NowCast AQI and hourly PM<sub>2.5</sub> concentration at each of these monitors. To do this, click on a monitor to open the information window.

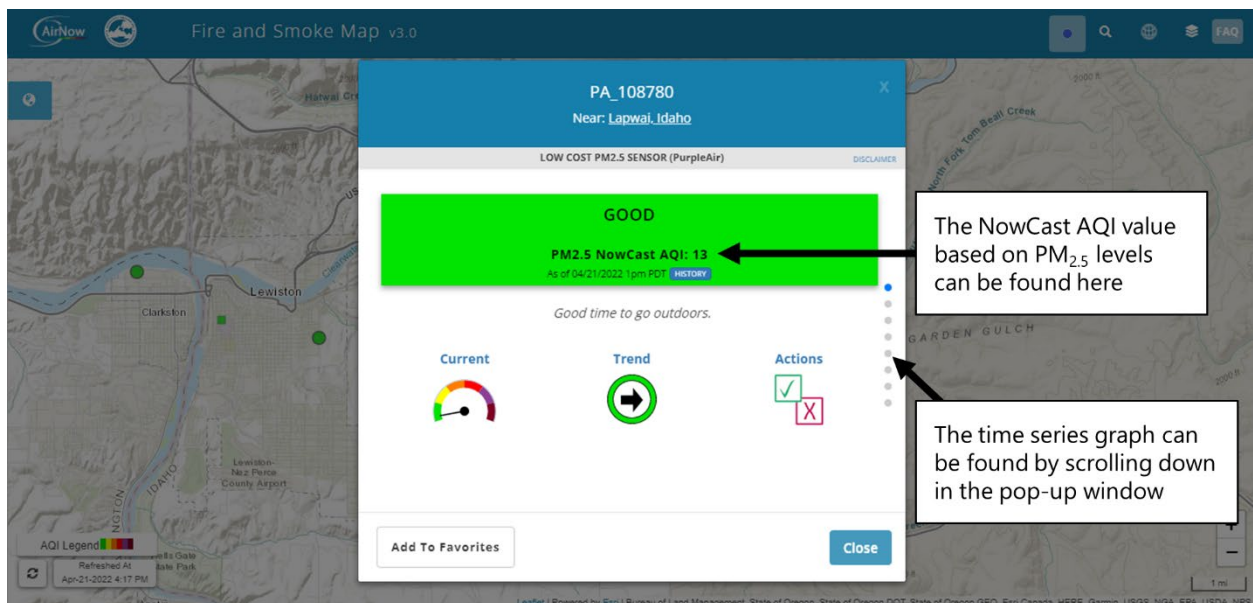
- The first tab of the pop-up shows the PM<sub>2.5</sub> NowCast AQI level. **Figure 17** shows where you can find this value. For each of the monitors you identified in Step 5, write down the NowCast AQI value on your **Data Collection Worksheet** box ③.
- For each of the monitors you identified in Step 5, scroll through the pop-up to view the time series graph and write down the last hour's PM<sub>2.5</sub> concentration value on your **Data Collection Worksheet** box ④.

## Borrowed PurpleAir Sensor

...

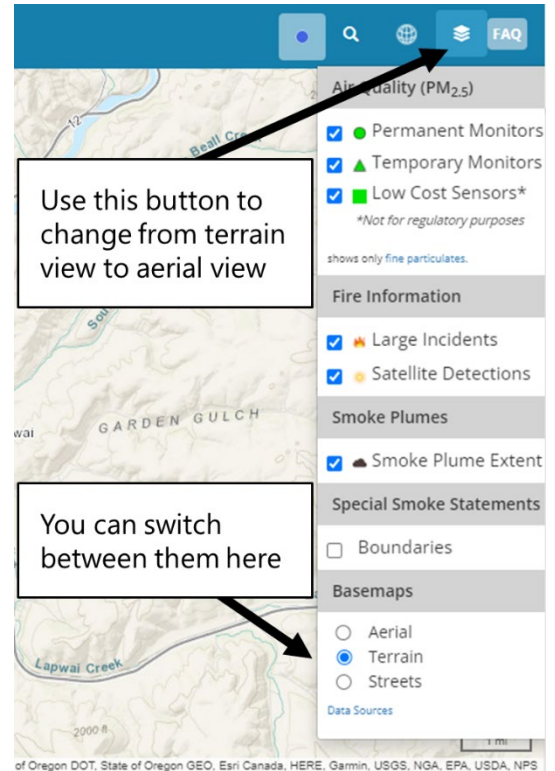
On the Fire and Smoke Map, you should be able to see the PurpleAir sensor(s) you may have borrowed (if the sensor is set to "public" mode), as well as any other public sensors that members of the community are using.

Note that it may take up to 48 hours for a new sensor to appear on the Fire and Smoke Map.



**Figure 17.** How to find the current AQI PM<sub>2.5</sub> value from your chosen low-cost sensor using the Fire and Smoke Map.

9. Do you see any fire icons (either satellite detections or large incidents) on the map? Mark your answer in box ⑤ on your **Data Collection Worksheet**.
10. Are any smoke plumes visible on the map (remember that they will show up as shaded areas)? Mark your answer in box ⑥ on your **Data Collection Worksheet**.
- If you see a fire icon or smoke plumes on the map, describe how the fire or smoke is affecting the PM<sub>2.5</sub> levels that you see.
  - If there is no fire or smoke on your map, describe what you think would happen to the PM<sub>2.5</sub> levels if fire or smoke was present. Would all sensors be affected equally?
11. Find a monitor or air sensor icon that is showing yellow, orange, or red levels. You may need to zoom in or out to find one. By studying the surrounding area, can you predict what source of PM<sub>2.5</sub> might be near this monitor or sensor, or why they might be experiencing poor air quality today? Fill in your answer in box ⑦ of the **Data Collection Worksheet**.



**Figure 18.** Instructions on switching between the terrain map and aerial map using the Fire and Smoke Map.

- Hint: Look around on the map and try zooming in to see if you can identify any nearby sources or try switching to aerial view to get a better idea of what might be in the area. See **Figure 18** for instructions on how to change the map from terrain view to aerial view.
  - Hint: Are some monitors or sensors near an active fire or in a smoke plume? Are sensors in an area that may be experiencing smoke from residential home heating (e.g., fireplace chimneys or woodstoves)? Are the monitors or sensors near an agricultural area that might be burning crop residue or clearing crops? Are the monitors or sensors near a busy road or construction zone where there might be lots of diesel vehicles driving by?
12. Problem solving challenge 1: Are there alternate methods that farmers could use instead of burning crop residue or clearing crops? Write three sentences describing an alternate method that would not create smoke. Fill in your answer in box P1 on your **Data Collection Worksheet**.
13. Problem solving challenge 2: Can you think of ways to reduce particulate matter from busy roads or construction sites? How about alternates to diesel vehicles? Write a paragraph

describing your ideas regarding reduction of particulate matter in these situations. Fill in your answer in box **P2** on your **Data Collection Worksheet**.

## Part 2: Air Quality in Your Community

In Part 2 of this activity, you will be using the Fire and Smoke Map to investigate the air quality in your community and then will focus on a particular sensor.

1. Zoom in on the map to show where you are and find the closest air sensor or regulatory monitor. You can do this by using the + and – buttons on the screen, or by following Step 2 in Part 1. If there are two sensors, choose one.
2. Click on the sensor/monitor and scroll down to bring up the PM<sub>2.5</sub> AQI time-series plot of the data.
3. How has the PM<sub>2.5</sub> level changed over the past 7 days (or so), as shown in the data plot? Describe what the data looks like in box **8** on your **Data Collection Worksheet**.
  - a. Hint: You might include a description of how the AQI level changes with time, or whether the values are always high, or if the data shows any repeating pattern, etc.
4. Are there times when the data spikes up to high values? If so, when are these? Write your answer in box **9** on your **Data Collection Worksheet**.
  - a. Tip: If you scroll your mouse over the PM<sub>2.5</sub> AQI plot, you will notice a box pops up telling you the level, date, time, and category. Use this to help you identify times when PM<sub>2.5</sub> concentrations are higher.
5. Does the data have just one high point, or is there a pattern? Write your answer in box **10** on your **Data Collection Worksheet**.
6. Based on what you know about the area and the activities that occur there, what might be the cause of the elevated levels? For example, is a neighbor always burning leaves? Are there woodstoves being used more often in early mornings? Are levels higher during harvest or wildfire smoke events? The time of day when the higher levels are present may help give you a hint to the cause too. For instance, could an inversion be trapping pollution near the ground at night? Write your answer in box **11**.
7. In box **12** on your **Data Collection Worksheet** comment on how you think the data would look if it was a different season.

### Option

If the monitors and air sensors in your community do not show much variation in PM<sub>2.5</sub> concentrations across the past 7 days, feel free to select another that is outside of your community for Part 2 of the activity.



- a. Hint: Wildfires occur in the summer and fall, more woodstove activity might take place when it is cold in the spring and winter, etc. How would these sources impact the PM<sub>2.5</sub> readings of your selected sensor/monitor? Think about if the sensor/monitor readings would be higher at a certain time of day or whether they will be high all the time. This will depend on the source of PM<sub>2.5</sub>.
8. Are the levels currently elevated (a color other than green)? If not, move on to Part 3.
  - a. If the answer is yes, and it is safe to go outside, do so, or open the door/window and briefly smell the air.
  - b. Do you smell anything that might help you determine why the PM levels are high?

Write your answer in box 13 on your **Data Collection Worksheet**. You may possibly smell:

- Dust (perhaps there is sweeping, construction activity, or agricultural land cultivation/digging going on),
- Burning (is there a wildfire in the area, agricultural burning, residential outdoor burning, or is someone having a bonfire, burning wood in a fireplace or woodburning stove at home?),
- Something else?

## Part 3: Linking Observation to Measurement: Wildfires and Visibility

This part of the lesson can be done during a smoke event. That could be a wildfire or a smaller local smoke event (where someone is burning leaves or trash).

1. When you notice smoke outside, take a photo of the sky from your window using a cell phone or camera.

 **4–8-year-old option:** Draw what the sky looks like outside.

2. In the table provided on the **Data Collection Worksheet** in box 14, mark the date and time that you took the photo and rank the PM level (1 being the clear sunny day, 10 being the worst pollution). Example data are shown in the table below.

Photo number	Date	Time	How would you rank the air outside	PM <sub>2.5</sub> AQI value from Fire and Smoke Map
1	June 1 2021	9:00 am	7	
2	June 1 2021	12:00 pm	5	
3				

- Record these readings at least 3 times, throughout the day, or over the course of a few days. It would be ideal to have at least 3 photos or drawings of the sky outside your window.
- Go to the Fire and Smoke Map website and locate the sensor/monitor closest to you. Mark down PM<sub>2.5</sub> AQI level for each of the times you recorded in the table. Example data are shown in the table below.

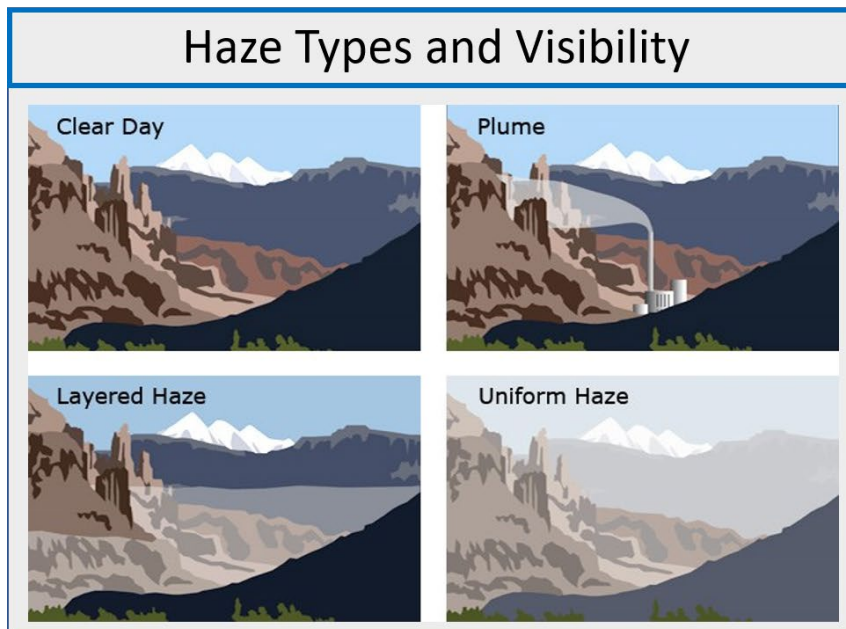
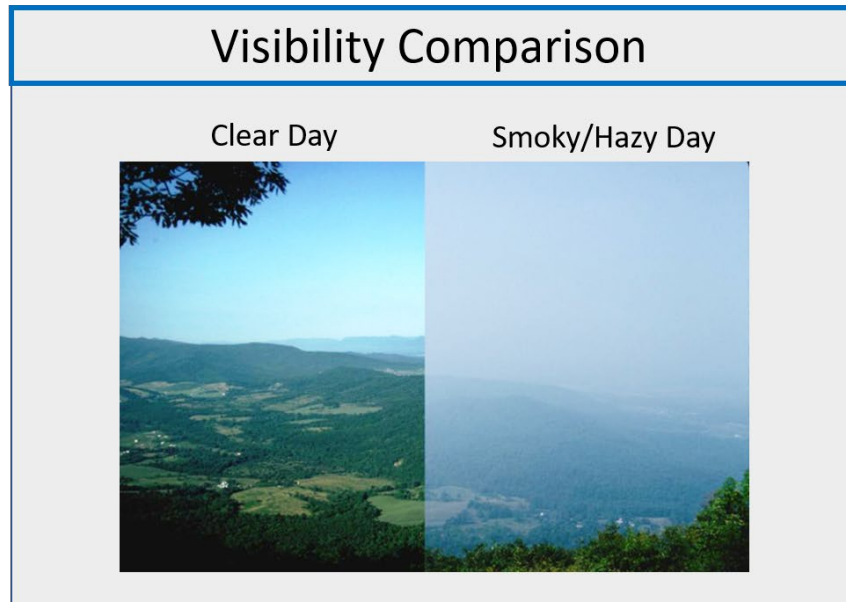
**Tip:** If you scroll your mouse over the PM<sub>2.5</sub> time-series plot in the pop-up on the Fire and Smoke Map, you will notice a box pops up telling you the level, date, time, and category. Use this information to help you find the times that match your photos.

Photo number	Date	Time	How would you rank the air outside	PM <sub>2.5</sub> AQI value from Fire and Smoke Map
1	June 1 2021	9:00 am	7	106 (red)
2	June 1 2021	12:00 pm	5	78 (yellow)

- Compare the photos you took and the PM<sub>2.5</sub> AQI values from the Fire and Smoke Map. What do you notice about the relationship between visibility (what you saw outside when you took photos) and the PM levels (what you recorded from the Fire and Smoke Map site)? Do they follow each other (both increase and decrease at the same time)? Write your answer in box 15 on your **Data Collection Worksheet**.

## How Does PM Impact What We See Outside?

PM can cause many environmental impacts too. For example, PM can cause the air to become hazy, which reduces visibility, or your ability to see far away. Have you looked outside of your house on a clear day and then again on a day when the air is polluted – perhaps by wildfire smoke? You may have noticed that you cannot see as far when there is smoke in the air is because PM interacts with sunlight and makes it harder to see long distances. **Figure 19** shows an example of this phenomenon.



**Figure 19. (Top panel)** An example of how PM in the air can affect our ability to see into the distance. Photo credit: <https://ecology.wa.gov>. **(Bottom panel)** a diagram illustrating how different types of haze can impact visibility (<https://www.nps.gov/subjects/air/visibility.htm>).

## How to Reduce Your Personal Exposure to PM and Steps to Take to Improve Air Quality

This section describes a number of suggestions to limit your exposure to PM and improve air quality while you are indoors.

Your **personal exposure** is the amount of PM you are personally exposed to from environments you spend time in or from activities you do. There are many ways you can minimize your personal exposure to PM. **Figure 20** summarizes some strategies you can use to reduce your personal exposure to PM during wildfires or burning activities that may be impacting your air quality. These include:

**Turn on air cleaners indoors (if available) and close doors and windows.** Air cleaners can either be installed in your home's central heating and cooling system or can be free-standing units that you can set up in a room to help to keep indoor air cleaner. Air cleaners need to be right sized for the volume of air or space they need to clean. If you are running an indoor air cleaner during a smoke event and have your windows and doors closed, remember to also try to minimize indoor sources of pollution. Indoor sources of pollution might include sweeping, vacuuming, burning candles, running a woodstove or fireplace, cooking without using the vent above the stove, or smoking. For more information and considerations to keep in mind when choosing and using an HEPA-filter air cleaner, refer to the EPA Indoor Air Quality website at: <https://www.epa.gov/indoor-air-quality-iaq>; specific information about indoor air quality during wildfires is available at <https://www.epa.gov/indoor-air-quality-iaq/wildfires-and-indoor-air-quality-iaq>.

**Develop a cleaner air space.** A cleaner air space is a room in your house where you can (1) comfortably fit everyone, (2) close the windows and door safely (without making it hard to get out), and (3) run fans, window air conditioners, or central air conditioning. You could also place a portable air cleaner in the room to help filter the air. Having a smaller, defined cleaner air space may make it possible to use a smaller air cleaner. For more information on creating a clean room at home, see <https://www.epa.gov/indoor-air-quality-iaq/create-clean-room-protect-indoor-air-quality-during-wildfire>.

**Make a DIY fan filter.** If you do not have central air conditioning with a MERV-13 or higher filter installed or a portable HEPA filter air cleaner, consider creating a DIY air filter. This involves connecting a box fan and furnace filter so that the air being pushed out by the fan is filtered. There are many videos available online to help you build a DIY air filter. Here are a few examples from air agencies in the Pacific Northwest: Confederated Tribes of the Colville Reservation at [www.cct-enr.com/box-fan-filter](http://www.cct-enr.com/box-fan-filter); Puget Sound Clean Air Agency at <https://pscleanair.gov/525/DIY-Air-Filter>, Washington Department of Ecology at [www.youtube.com/watch?v=4qr1Aj6Di7w](http://www.youtube.com/watch?v=4qr1Aj6Di7w).

**Limiting time outside on days with poor air quality.** Spending less time outside when the air quality is poor will reduce the amount of PM you breathe in. If you must spend time outside, try to wear an N-95 mask to help filter out particles.



**Figure 20.** Potential ways to reduce your personal exposure to PM.

There are also ways to help reduce the PM pollution we contribute to the air. Below are a few examples of lower PM options:

- Walk or bike to school, work, or around town instead of driving (if it is safe to do so).
- Composting leaves rather than burning them.
- Disposing or recycling trash instead of burning it.

What other ways can you think of that you could help reduce PM pollution? Fill in ways you can help reduce PM pollution on your **Data Collection Worksheet** in box 16.

Based on the presented list of ways you can lessen your exposure to PM, as well as those you came up with in the question above, describe how you might be able to personally implement one or two of these approaches in your day-to-day life. For example, you might decide to walk to school with your friends two days a week rather than driving. Or you might decide to spread the word to your community members about the benefits of composting leaves and chipping branches instead of burning plant waste. List your proposed changes in box 17 of your **Data Collection Worksheet**.

## Extension Activity

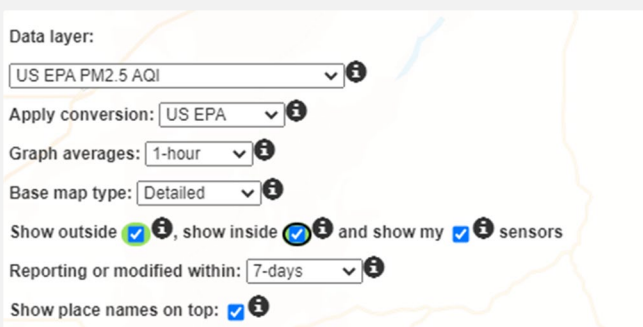
### Air Quality – Inside vs. Outside

Just as we are concerned about air quality outside, we should also think about the air quality indoors, especially since this is the place where we spend most of our day! In this extension activity, you will compare the air quality indoors and outdoors and try to understand why they might differ from one another.

In this activity, you will need to use the PurpleAir Mapping website, since this will allow you to look at indoor and outdoor monitors.

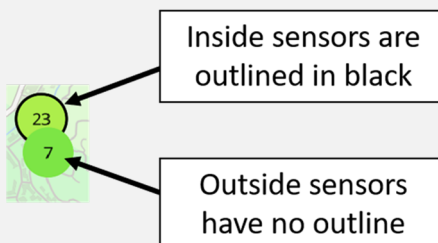
**First, let's bring up the website and make sure the settings are correct:**

1. Go to the PurpleAir Mapping website ([www.map.purpleair.com](http://www.map.purpleair.com)).
2. Navigate the map to your community or place of interest by zooming on the map.
3. In the bottom left-hand corner of the screen, select the following options:
  - a. Make sure that **U.S. EPA PM<sub>2.5</sub> AQI** is selected.
  - b. Use the **U.S. EPA conversion**.
  - c. Change the averaging time from **10-minute** to **1-hour graph averages**.
  - d. You can leave the **"show inside"** box checked.



After selecting these options, the map shows both the indoor and outdoor sensors in your community.

Indoor sensors are shown on the map outlined in black, while outdoor sensors have no outline.



## Extension Activity

Before we look at the data, we first want to find an indoor sensor that is near one of the outdoor sensors. This activity may be most meaningful if you borrow and deploy a pair of sensors inside and outside of your own home. To find an indoor and outdoor sensor pair, look closely at the map (you may have to adjust the zoom level) to find an indoor and outdoor sensor that are in close proximity to one another.

Once you have identified an inside and outside sensor pair, answer the following questions:

- a. Are the sensors reporting the same U.S. EPA PM<sub>2.5</sub> AQI value (the number in the circle)?
- b. If they are showing the same value, why might that be the case?
- c. If the indoor sensor reading is higher, why might that be the case?
- d. If the outdoor sensor reading is higher, why might that be the case?

# Is That Smoke Affecting Me?

## Using Crowdsourced Public Data to Explore Air Quality During Smoke Events



**Goal:** Use crowdsourced particulate matter (PM) measurements from your community to explore air quality.

### In this activity you will learn about:

- Sources and health impacts of PM.
- The differences between regulatory monitor and air sensor measurements.
- What the Air Quality Index is and what it can tell you.
- How to navigate and use the AirNow Fire and Smoke Map.
- How to navigate the PurpleAir Sensor Map.
- How to mitigate personal exposure to PM during smoke episodes.
- How to actively reduce your contribution to PM.



# Air Pollution and Particulate Matter

**Pollution is any substance in the air that can cause harm to humans, animals, or the environment.**

**Air pollution includes gas pollutants and particle pollutants.**

**Particulate Matter (PM) is the focus of this activity.**

**Sources of PM are all around us!**

# What Is Particulate Matter (PM)?

- PM can be made of soil, soot, dust, pollen, metals, and more.
- PM is extremely small!
- Classes of PM are based on size:
  - $PM_{10}$  ( $<10\ \mu\text{m}$  in diameter)
  - $PM_{2.5}$  ( $<2.5\ \mu\text{m}$  in diameter)

$PM_{2.5}$  is the focus  
of this activity!

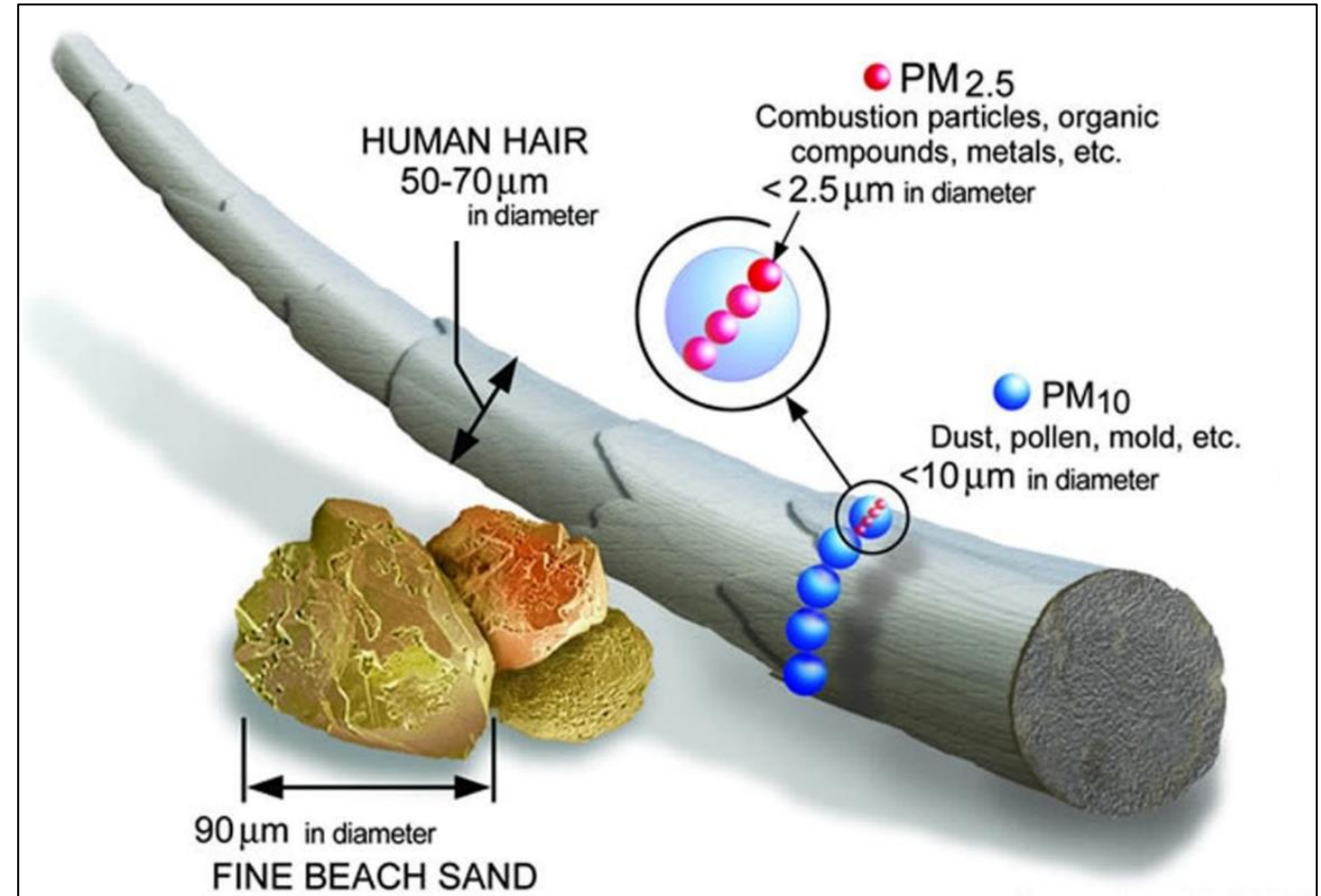


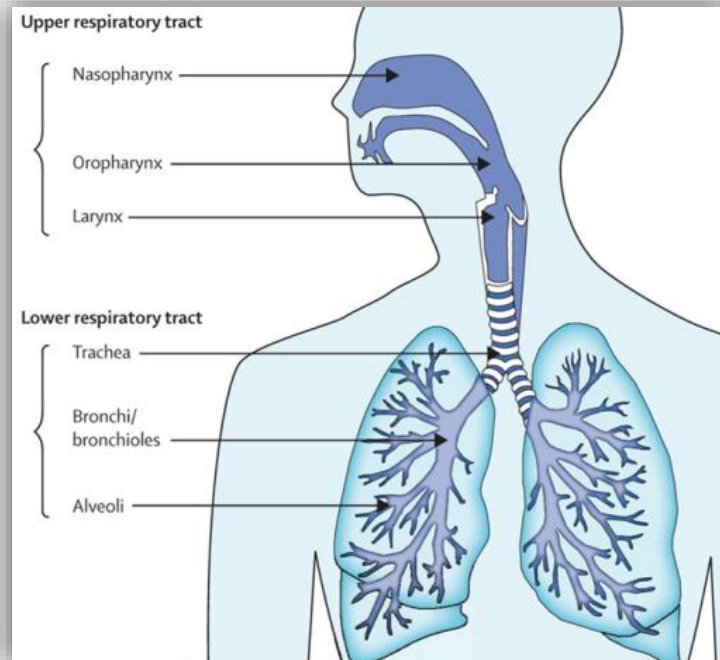
Image Credit: U.S. EPA

# How Does PM Affect Us?

## Health Effects

Small particles, like **PM<sub>2.5</sub>**, can travel deep into your lungs, causing:

- **Breathing problems**, such as coughing, throat irritation, difficulty breathing, asthma, bronchitis, and many other ailments.
- **Heart problems**, such as heart attacks or an irregular heartbeat.



## Visibility Effects

In the environment, PM can cause many issues.

For example, PM can contribute to making the air hazy, which reduces "**visibility**", or our ability to see far away.



# Sources of PM in the Environment

- There are many human-made and natural sources of PM in your environment.
- This means you might be exposed to different PM levels depending on what you are doing, where you are, the time of day, and even the season!
- Here are some human-made sources of PM that you may encounter each day:

## Sources of Particles: Human-Made



Wildfires

Mostly PM<sub>2.5</sub>



Woodstoves

Mostly PM<sub>2.5</sub>



Agricultural  
Burning

Mostly PM<sub>2.5</sub>



Industrial  
Facilities

Either PM<sub>2.5</sub> or PM<sub>10</sub>  
depending on  
industry



Residential  
Burning

Mostly PM<sub>2.5</sub>



Agricultural  
Activities

Dust: PM<sub>10</sub>  
Diesel equipment: PM<sub>2.5</sub>

# Sources of PM in the Environment

- Here are some natural sources of PM that you may encounter each day:

## Sources of Particles: Natural Processes



Wildfires

Mostly PM<sub>2.5</sub>



Wind-Blown Dust

PM<sub>10</sub>



Volcanic  
Eruptions

Both PM<sub>2.5</sub> and PM<sub>10</sub>



# How Does PM Move in the Air?

A variety of weather conditions and other factors can influence PM<sub>2.5</sub> levels:

Some factors that influence how PM moves in the air include:



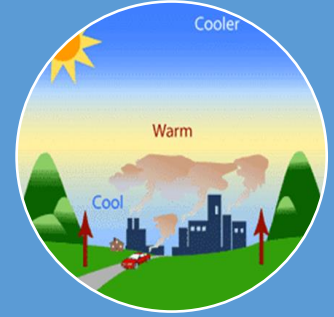
## Wind

- PM can be carried over long distances by wind before it settles on the ground.



## Rain

- When it rains, PM can be cleared out of the air.



## Topography & Temperature Inversions

- Communities in valleys can be more susceptible to temperature inversions that trap air pollution near the surface.



# How is PM<sub>2.5</sub> Measured? – Regulatory Monitors

- Agencies use both permanent year-round and temporary regulatory monitors to monitor the PM<sub>2.5</sub> levels.
- **Regulatory monitors:**
  - Undergo regular quality assurance and quality control checks.
  - Provide high quality measurements.

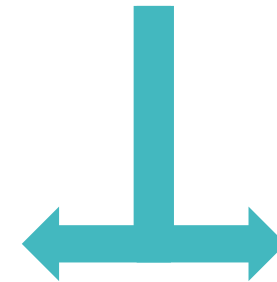


A photo of a regulatory monitoring station.  
Image credit: U.S. EPA

## Regulatory monitors

### Permanent monitors

Placed in specific and carefully chosen locations to provide data at one site over many years.



### Temporary monitors

Placed in areas where higher pollution levels are expected for a period of time, such as near a wildfire or a construction site.

# How is PM<sub>2.5</sub> Measured? – Air Sensors

- Air sensors are another class of technologies.
- Air sensors can help empower communities by helping them build awareness about local air quality.
- Air sensors tend to be smaller, more portable, more affordable, and easier to use than regulatory instruments.
- Important factors to keep in mind:
  - Air sensors are not as accurate as regulatory monitors.
  - Air sensors can have shorter lifespans.
  - The data quality can vary greatly depending on the sensor type and how it is used.
- There are many different types of air sensors available.
  - This lesson focuses on the **PurpleAir sensor**.



PurpleAir sensors can be mounted in your backyard, school, library, or workplace, and can help inform you about the PM levels around your community, neighborhood, or street.

# How Can I Tell How Clean the Air Is?

U.S. EPA developed the Air Quality Index (**AQI**) so people can better understand how healthy or unhealthy the air is outdoors.

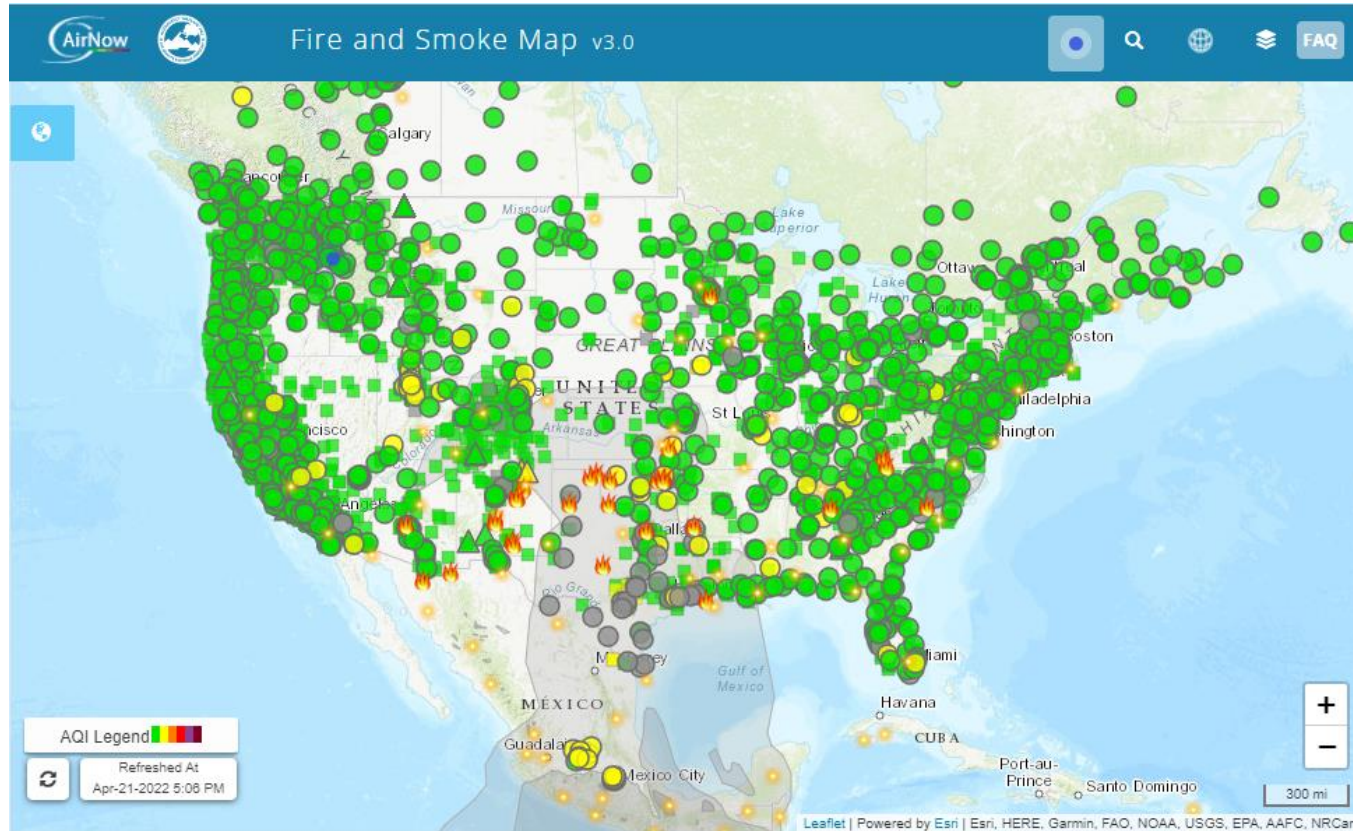
Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	150 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions; everyone is more likely to be affected.

- There is an AQI scale for five major air pollutants, that are regulated by the Clean Air Act to protect human health – PM is one of them!
- The AQI scale is broken down into six different categories each with a distinct color, level of concern, and range of AQI values.
- These categories tell people how clean or polluted the outdoor air is and the associated health effects.

NOTE! The daily AQI value is determined for each of the five major air pollutants and then the highest one dictates the overall AQI level for a given location. PM<sub>2.5</sub> and ozone (a common gas pollutant) tend to drive the AQI.

# The AirNow Fire and Smoke Map

<https://fire.airnow.gov/>

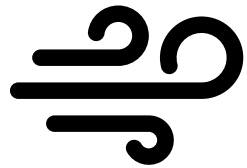


You will be using this map in the main activity to investigate PM<sub>2.5</sub> in your community!

- The AirNow Fire and Smoke Map provides information on PM<sub>2.5</sub> levels in your area particularly during wildfires
- The map shows PM<sub>2.5</sub> data from:
  - Regulatory grade air pollution monitors.
  - Temporary monitors.
  - All public PurpleAir sensors.
- Other features:
  - Large fire incidents
  - Satellite-detected fires
  - Smoke plumes
  - Special smoke statements
- The monitor and air sensor icons are colored based on the AQI scale 0.

# How to Reduce Your Personal Exposure to PM

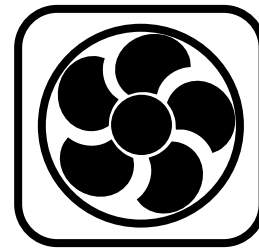
Here are a few examples (but there are many more!)



Turn on air  
cleaners and  
close windows  
and doors.



Develop a  
clean air  
space.



Make a DIY  
fan filter.



Limit time  
outside on  
poor air  
quality days.

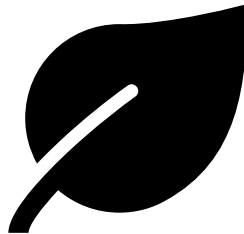
To check the air quality outside,  
check your local AQI at [AirNow.gov](https://www.airnow.gov)

# Steps You Can Take to Reduce Your Contribution to PM

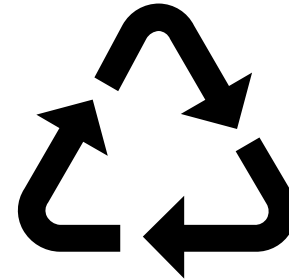
Here are a few examples (but there are many more!)



Walk or bike  
instead of  
driving.



Compost leaves  
rather than  
burning.



Dispose of or  
recycle trash  
rather than  
burning.



# Reminders:



Data on Fire and Smoke Map shows corrected PurpleAir data using the US EPA correction factor.



Only public PurpleAir data are displayed on Fire and Smoke Map.



Don't forget to refresh the Fire and Smoke Map for the most recent monitor and sensor readings.



If there are not any/many monitors or sensors on the map, try zooming out further.



# Let's Discuss

**Can you think of any sources of PM<sub>2.5</sub> you encounter frequently?**

**This could include:**

- **at the library**
- **at home**
- **at school/in the community**

**Do you think you are exposed to low or high PM<sub>2.5</sub> levels from this source? Why?**

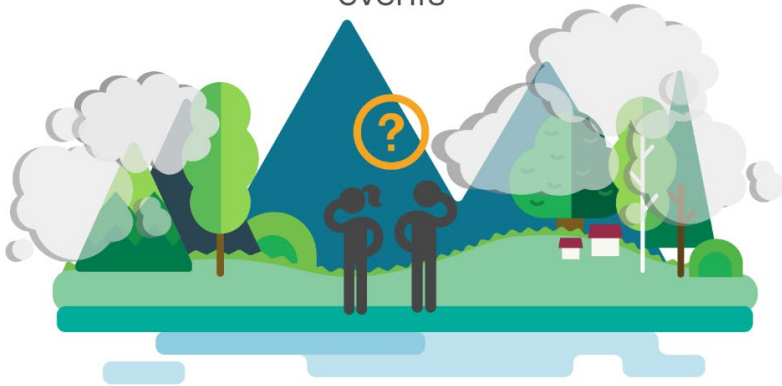
# Is That Smoke Affecting Me?

## Supplemental Slides

Is that Smoke Affecting Me?



Using crowdsourced  
public data to explore air  
quality during smoke  
events



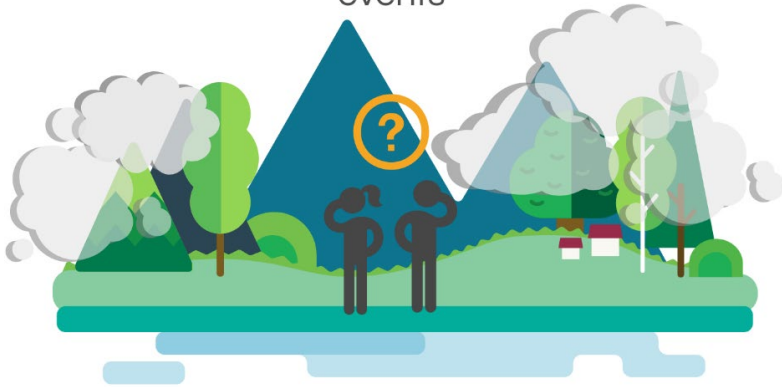
### In this slide set:

- Examples of wildfire smoke in different AQI categories
- Example of the Fire and Smoke Map during a wildfire
- Sample additional activity for younger learners
- Sample additional activity for more advanced learners

Is that Smoke Affecting Me?



Using crowdsourced  
public data to explore air  
quality during smoke  
events



# What Can Air Quality Look Like?

Examples of wildfire smoke in different  
AQI categories

# What Can Air Quality Look Like?

The Hoopa Valley Tribe in California experienced severe smoke episodes during the 2021 Red Salmon Complex Fire.

Good

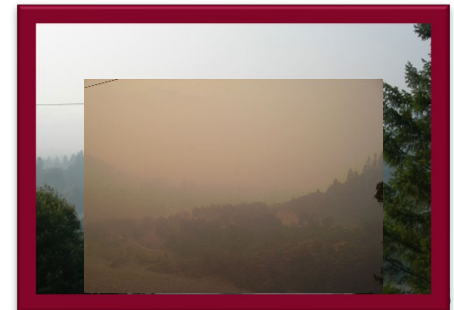
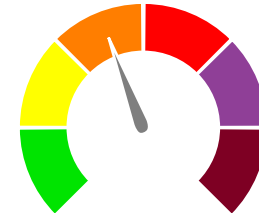
Moderate

Unhealthy for  
Sensitive Groups

Unhealthy

Very Unhealthy

Hazardous





# What Can Air Quality Look Like?

The Hoopa Valley Tribe in California experienced severe smoke episodes during the 2021 Red Salmon Complex Fire.

Good

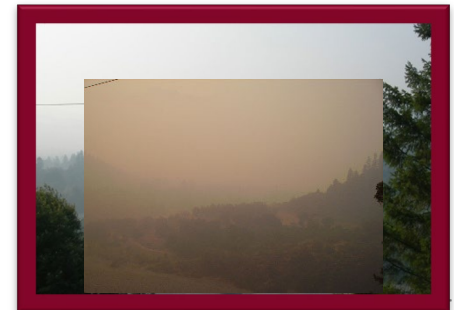
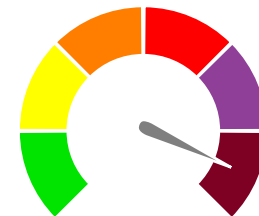
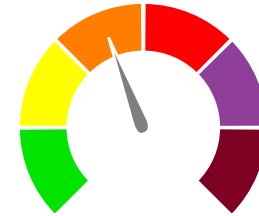
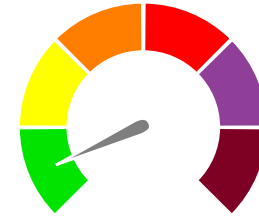
Moderate

Unhealthy for  
Sensitive Groups

Unhealthy

Very Unhealthy

Hazardous



# What Can Air Quality Look Like?

The Hoopa Valley Tribe in California experienced severe smoke episodes during the 2021 Red Salmon Complex Fire.

Good

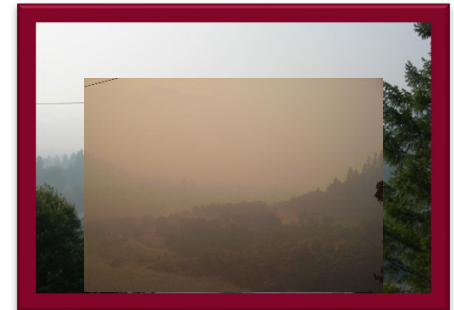
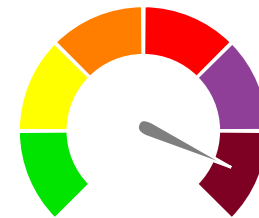
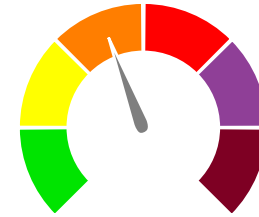
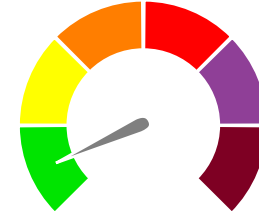
Moderate

Unhealthy for  
Sensitive Groups

Unhealthy

Very Unhealthy

Hazardous





# What Can Air Quality Look Like?

The Hoopa Valley Tribe in California experienced severe smoke episodes during the 2021 Red Salmon Complex Fire.

Good

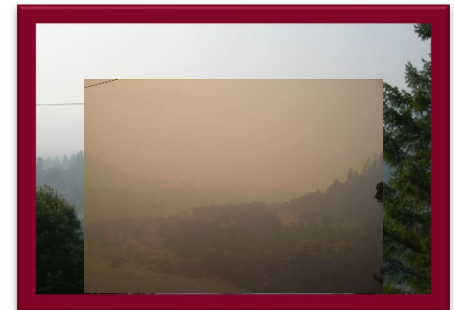
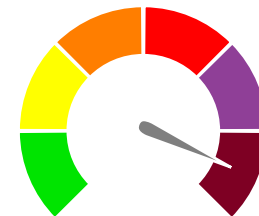
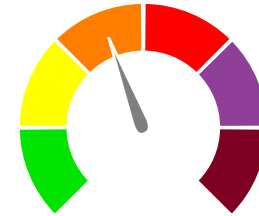
Moderate

Unhealthy for  
Sensitive Groups

Unhealthy

Very Unhealthy

Hazardous

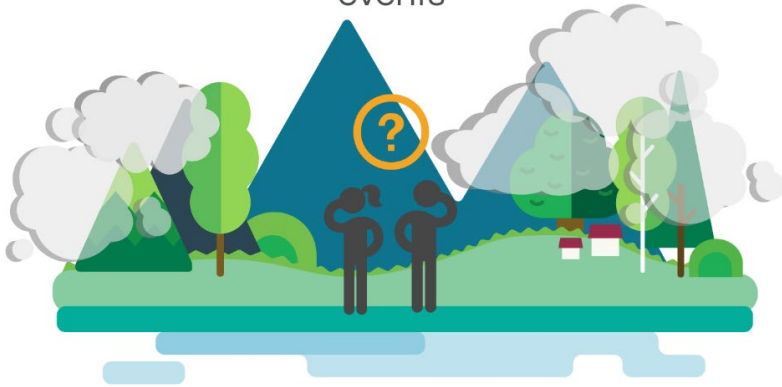




Is that Smoke Affecting Me?



Using crowdsourced  
public data to explore air  
quality during smoke  
events

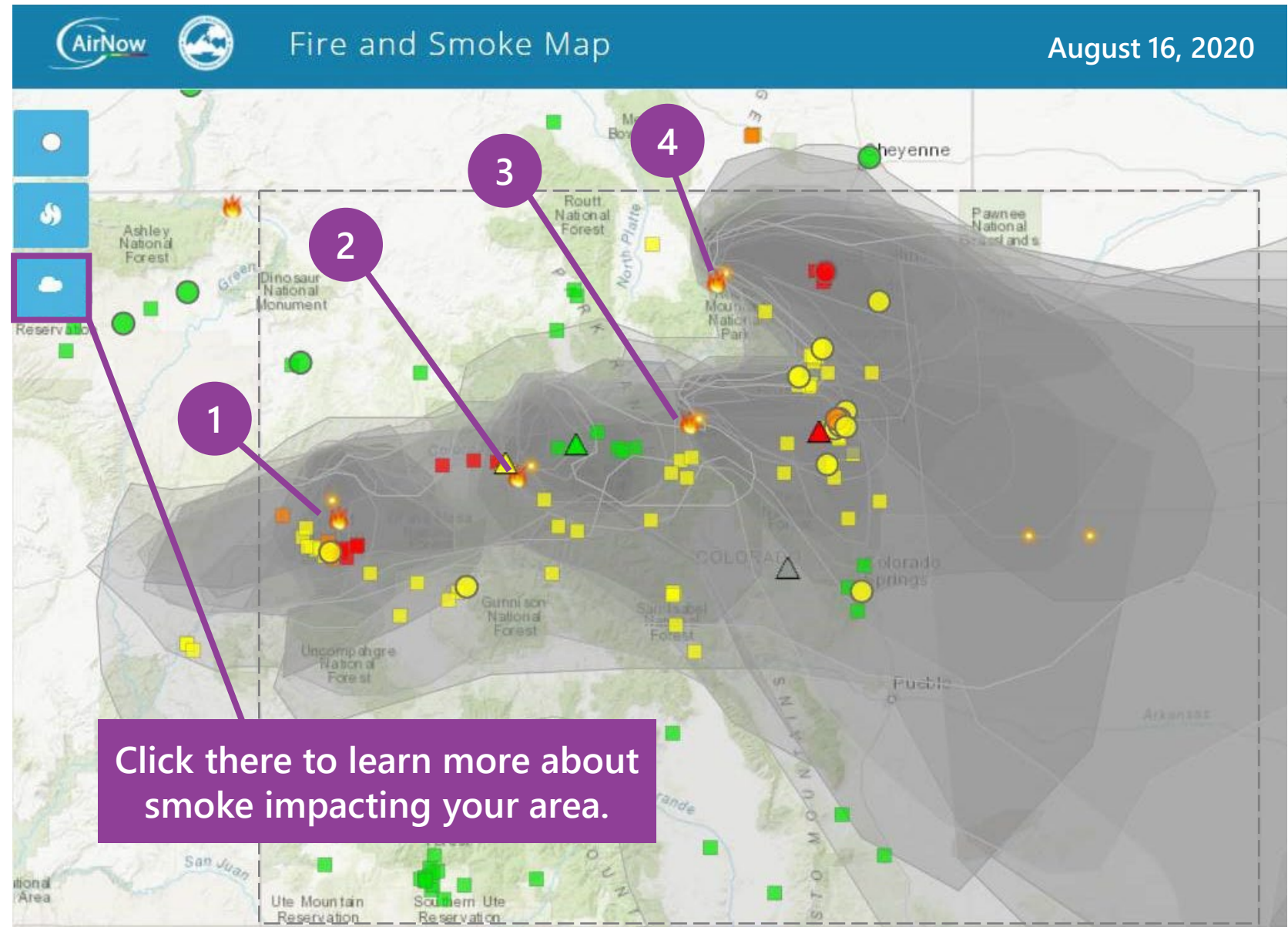


# What Can Smoke Look Like on the Map?

Example from the Fire and Smoke  
Map during a wildfire

# What Can Smoke Look Like?

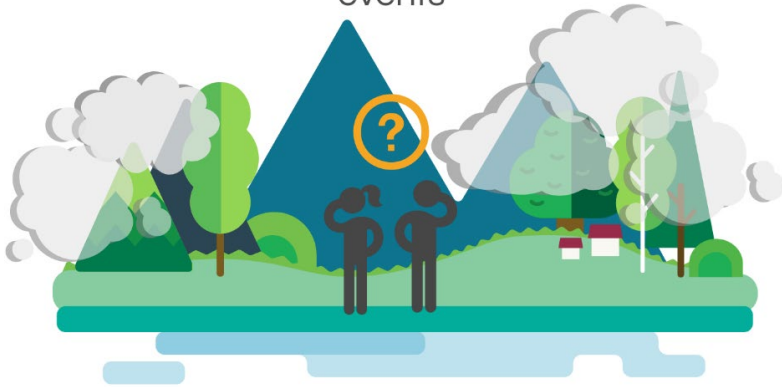
- Colorado experienced severe wildfires in August 2020.
- Four severe wildfires were burning at the same time.
- Mixed smoke plumes can reduce air quality.
- Air quality can be affected by altitude and terrain.



Is that Smoke Affecting Me?



Using crowdsourced  
public data to explore air  
quality during smoke  
events



# Air Quality and My Day

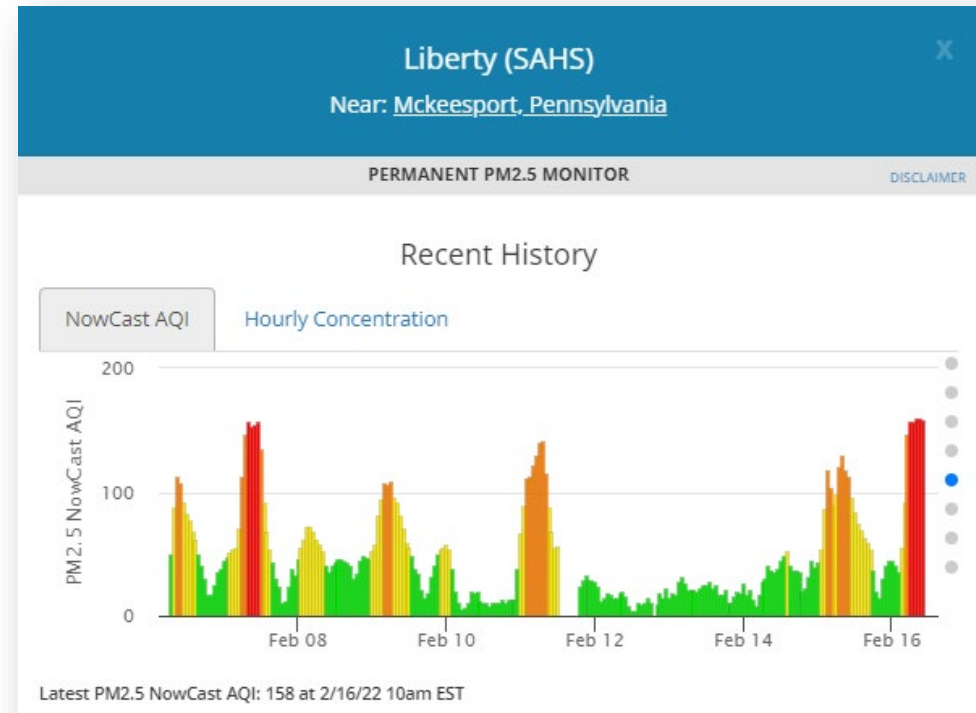
Sample additional activity for  
younger learners

## Required materials:

- AirNow Smoke and Fire Map
- Paper
- Writing materials
- Drawing materials

# Air Quality and My Day – Collect Data

1. Go to the [AirNow Fire and Smoke Map](#).
2. Find an air monitor or sensor that is not green.
3. Click on the colored icon.
4. Scroll until you see “Recent History.”
5. Record four recent colors and the dates and times that they appeared on your paper.



AQI Color	Date	Time
Red	02/16/2022	10:00 AM
Green	02/15/2022	10:00 PM
Yellow	02/15/2022	4:00 PM
Orange	02/15/2022	8:00 AM

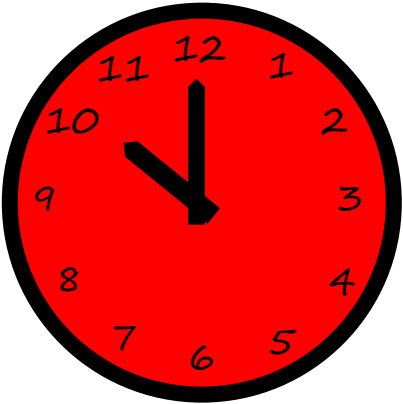
# Air Quality and My Day – Visualize Data

5. For each time in your list, write the date and draw a clock face showing that time.

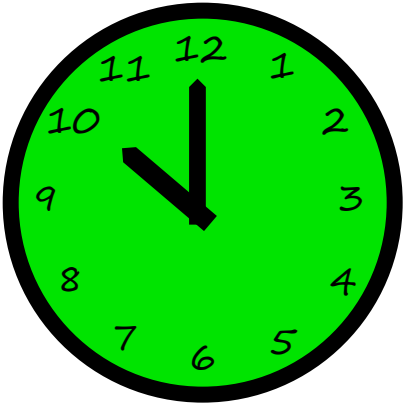
6. Color each clock face with its AQI color from your list.

AQI Color	Date	Time
Red	02/16/2022	10:00 AM
Green	02/15/2022	10:00 PM
Yellow	02/15/2022	4:00 PM
Orange	02/15/2022	8:00 AM

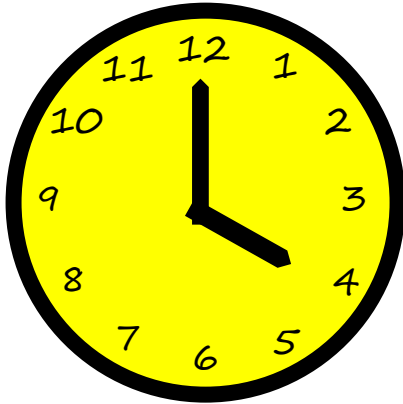
February 16, 2022



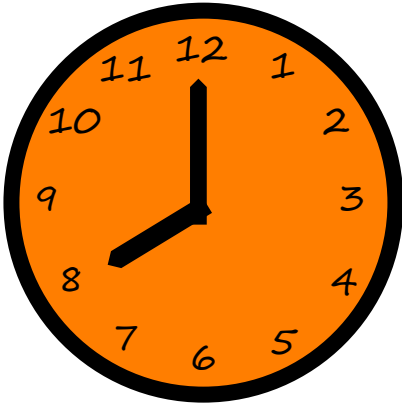
February 15, 2022



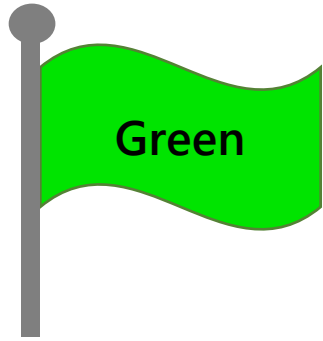
February 15, 2022



February 15, 2022

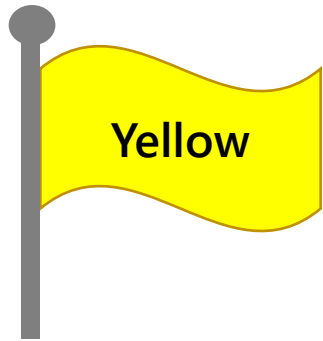


# Air Quality and My Day – Interpret Data



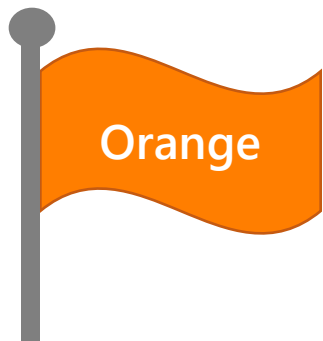
## Good

Great day to be active outside!



## Moderate

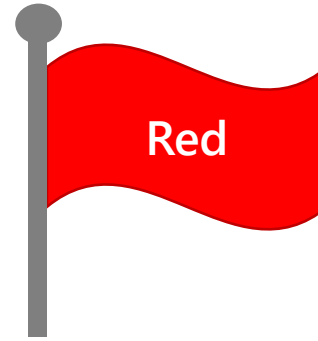
Good day to be active outside!



## Unhealthy for Sensitive Groups

It's OK to be active outside, especially for short activities.

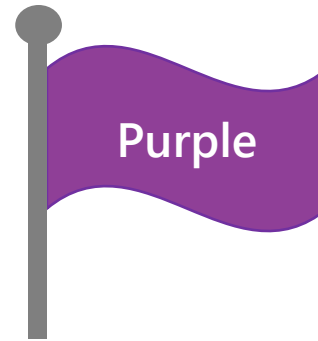
For longer activities, take more breaks and do less intense activities.



## Unhealthy

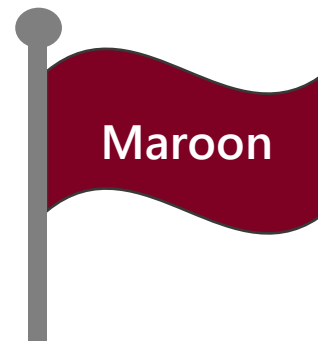
For all outdoor activities, take more breaks and do less intense activities.

Consider moving longer or more intense activities indoors or rescheduling them.



## Very Unhealthy

Move all activities indoors or reschedule them to another day.



## Hazardous

Move all activities indoors or reschedule them to another day. Try to keep indoor air clean too.



[Click to learn more about the Air Quality Flag Program](#)

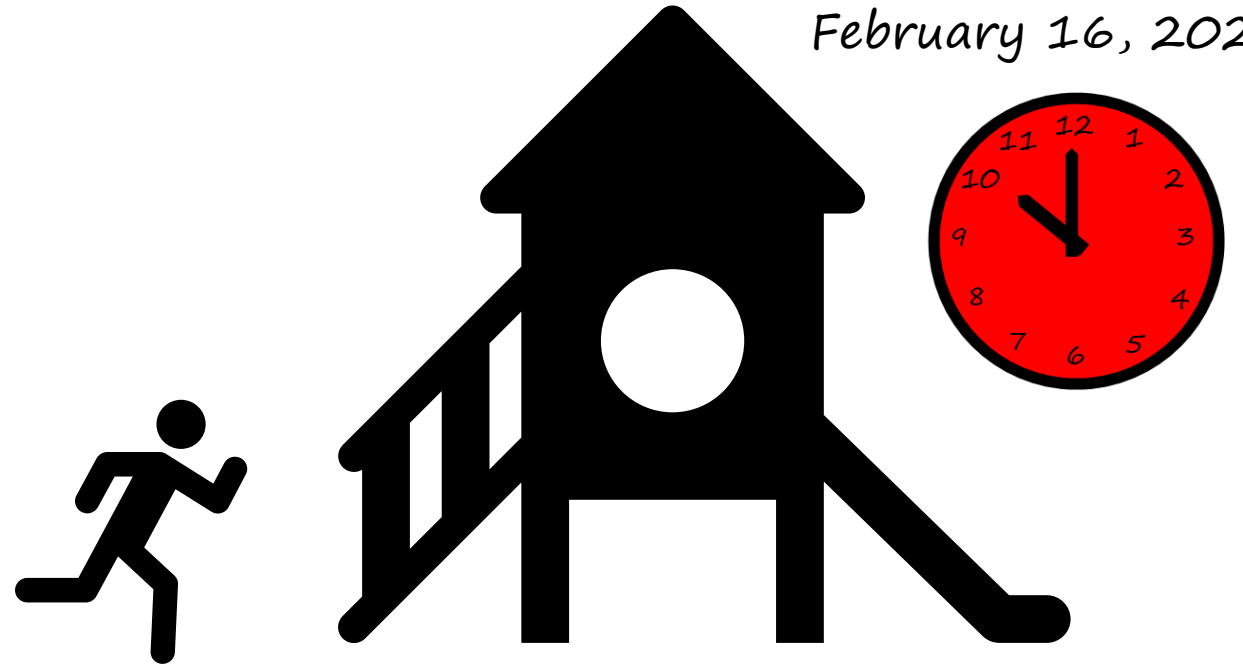


# Air Quality and My Day – Interpret Data

7. For each clock, draw a picture of something you might be doing at that time when the air quality is the clock's color. Remember flags on the last slide!

8. Write a sentence or two describing each picture and how your activity relates to your clock color.

February 16, 2022



*At 10:00 AM I play on the playground. The red means that I need to take lots of breaks while I play and not run too much.*



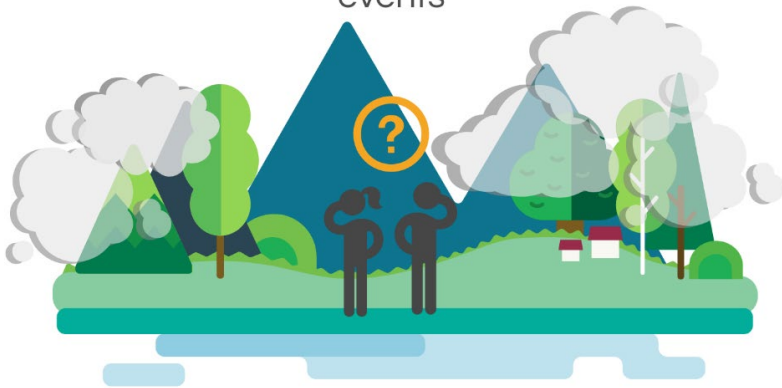
# What Are the Effects of a Wildfire?

Sample additional activity for more advanced learners

Is that Smoke Affecting Me?



Using crowdsourced public data to explore air quality during smoke events

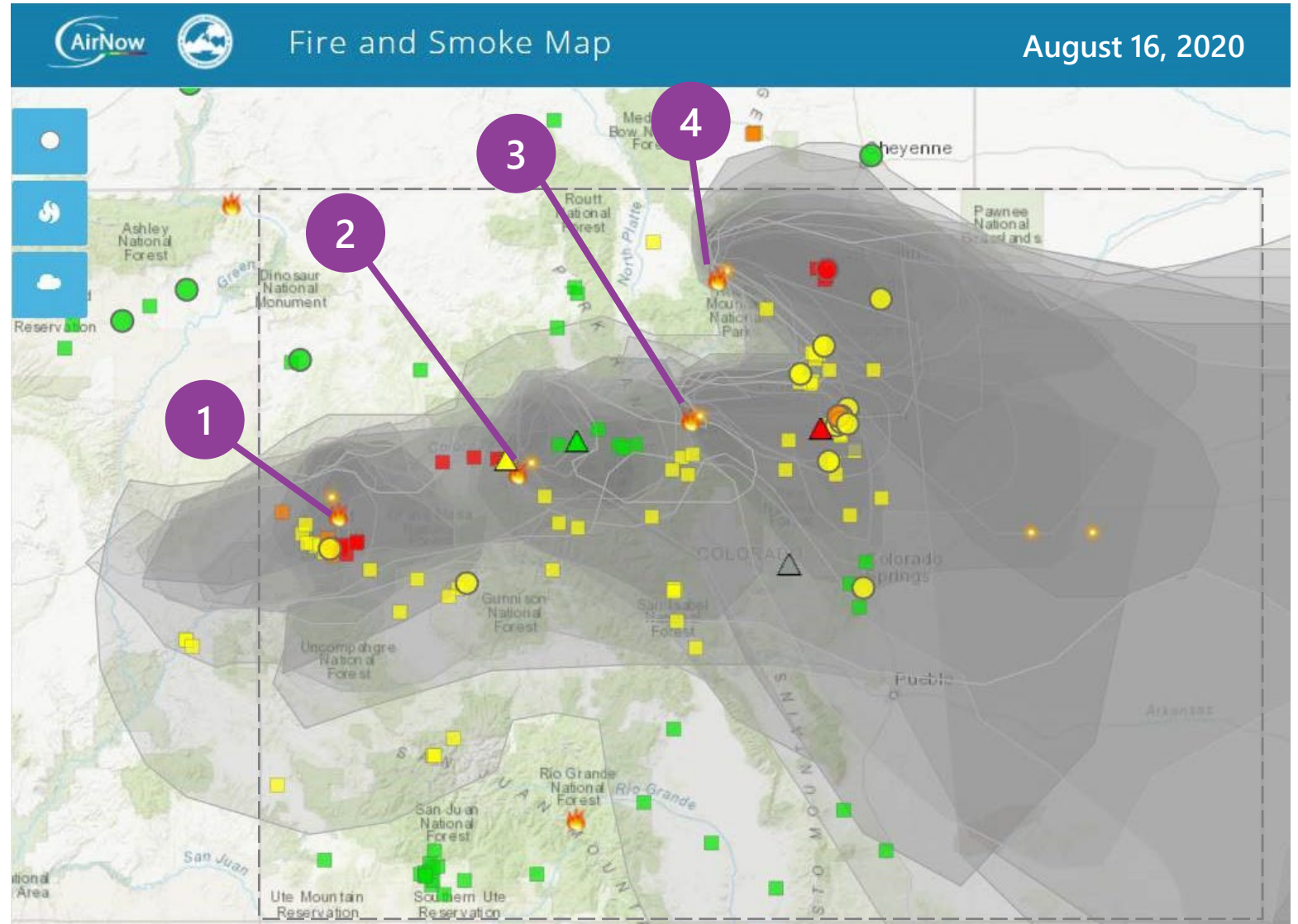


## Required materials:

- AirNow Smoke and Fire Map
- Paper or word processor
- Optional presentation software

# In this activity, your groups will...

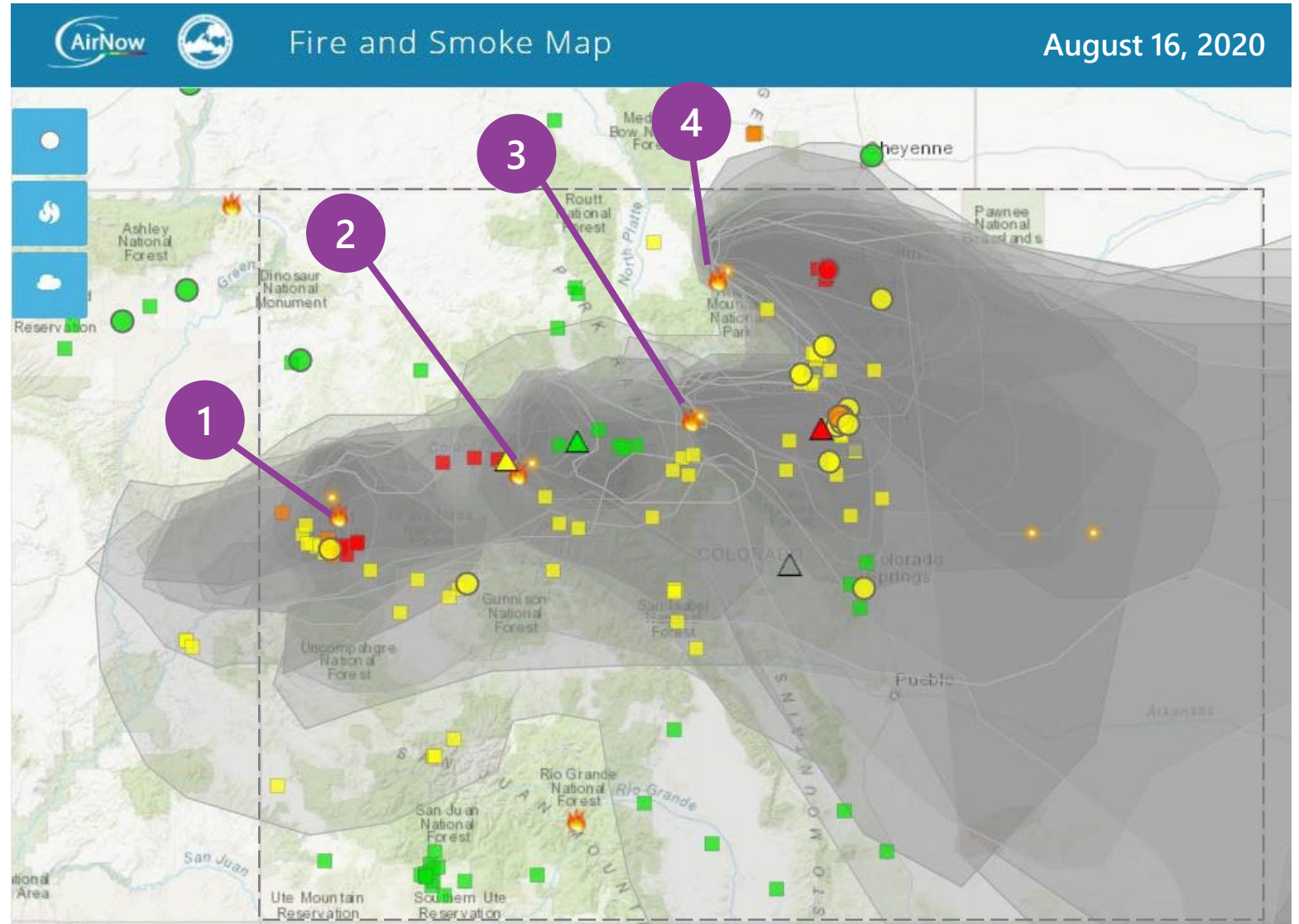
- Identify four August 2020 Colorado wildfires.
- Discover additional information about wildfires.
- Present your findings to the class.



# Break into groups for this activity.

Each group should have...

- 2-4 people.
- At least one internet-enabled device.
- A way to record and share ideas.



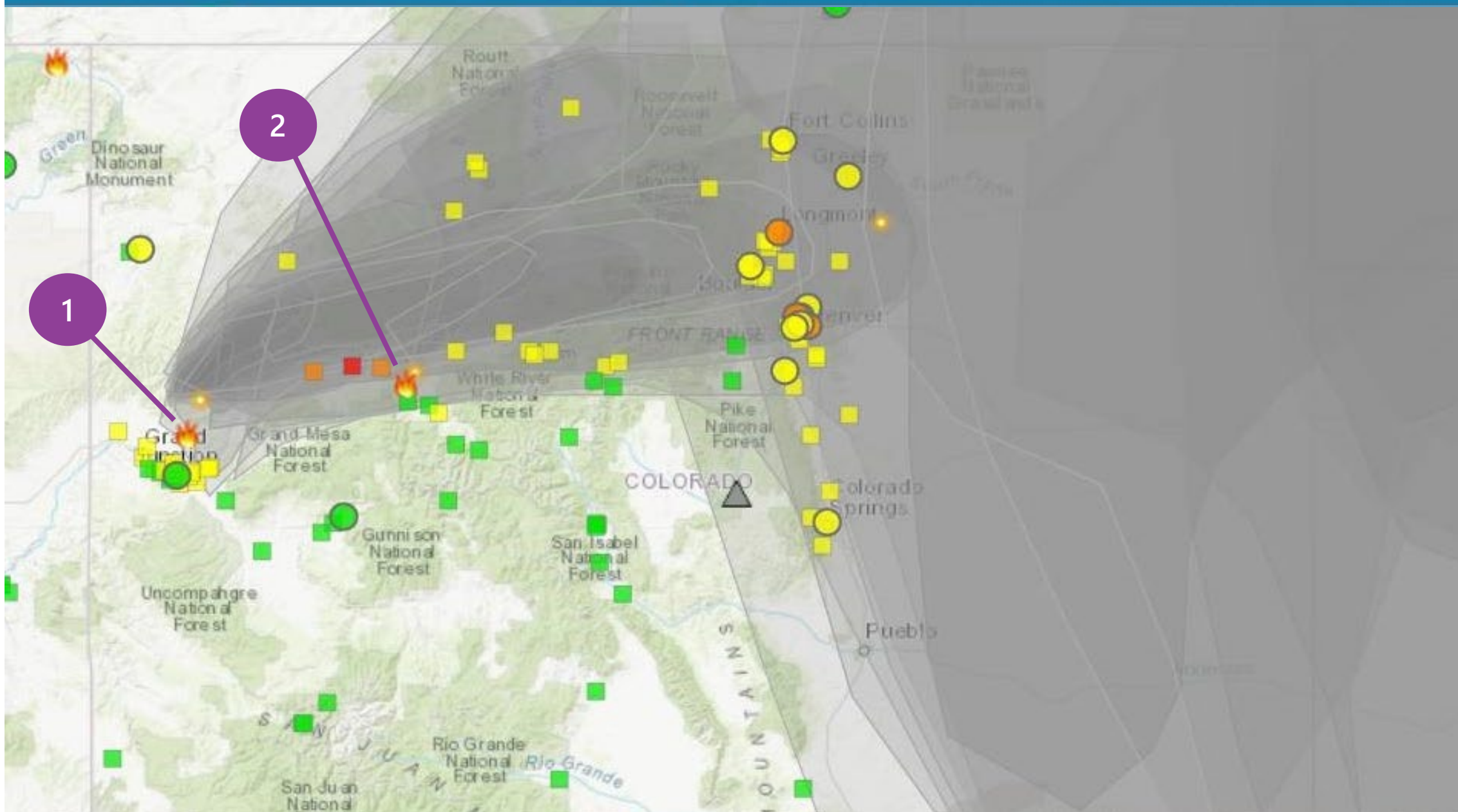
Use the following AirNow Fire and Smoke Map images to identify four major Colorado wildfires in August 2020

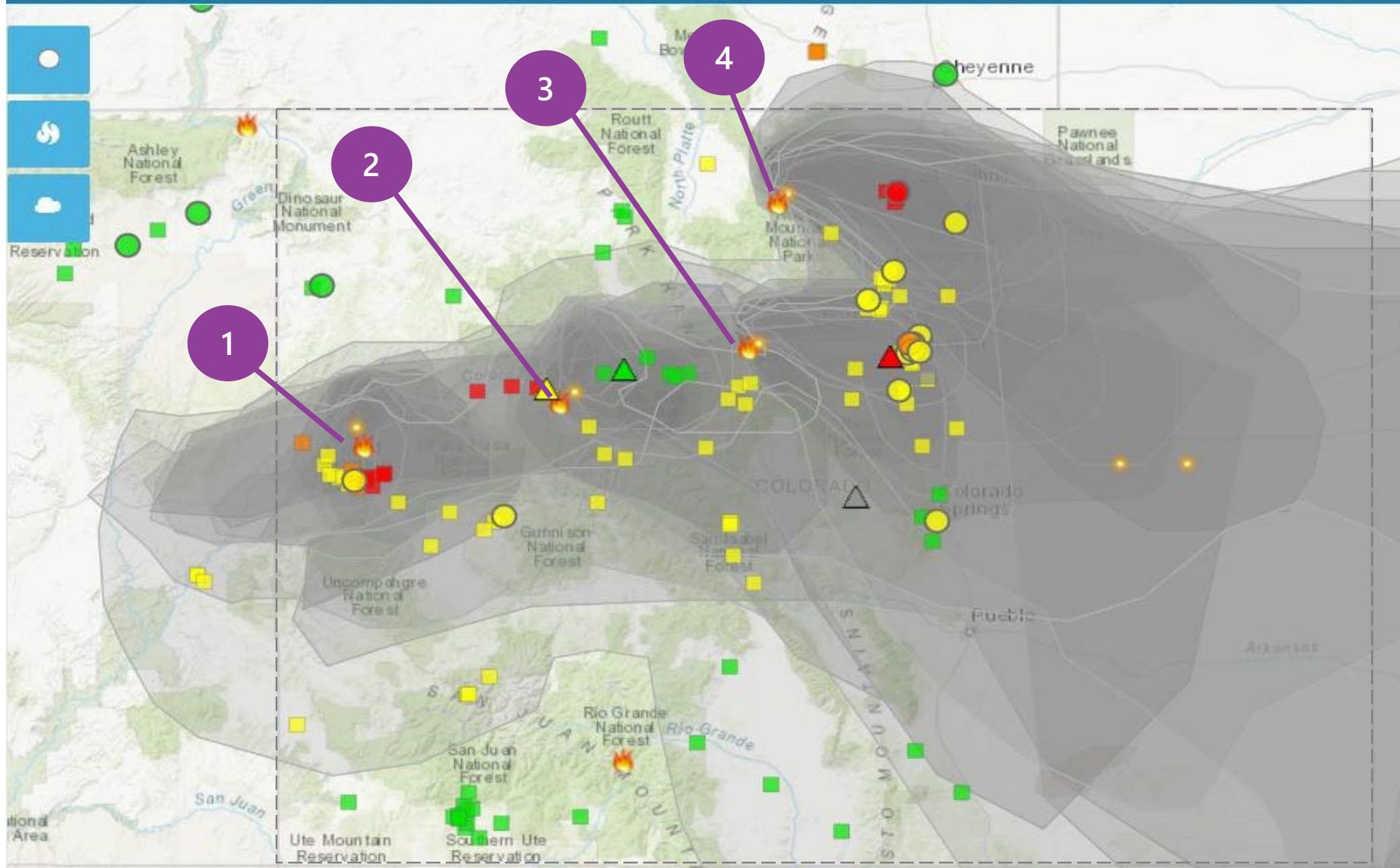
Hints:

The dates will help!

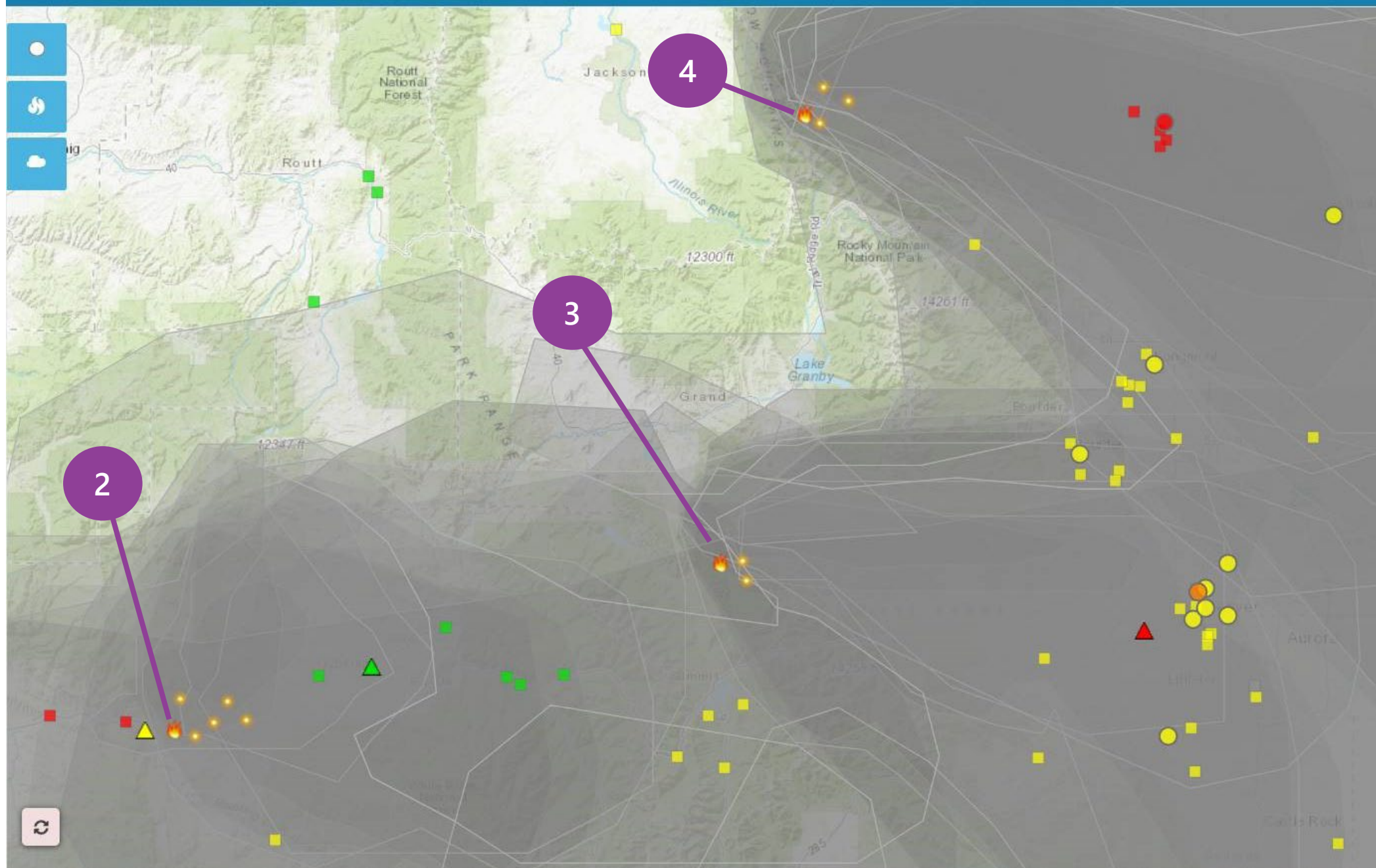
Note the city names visible on the first map



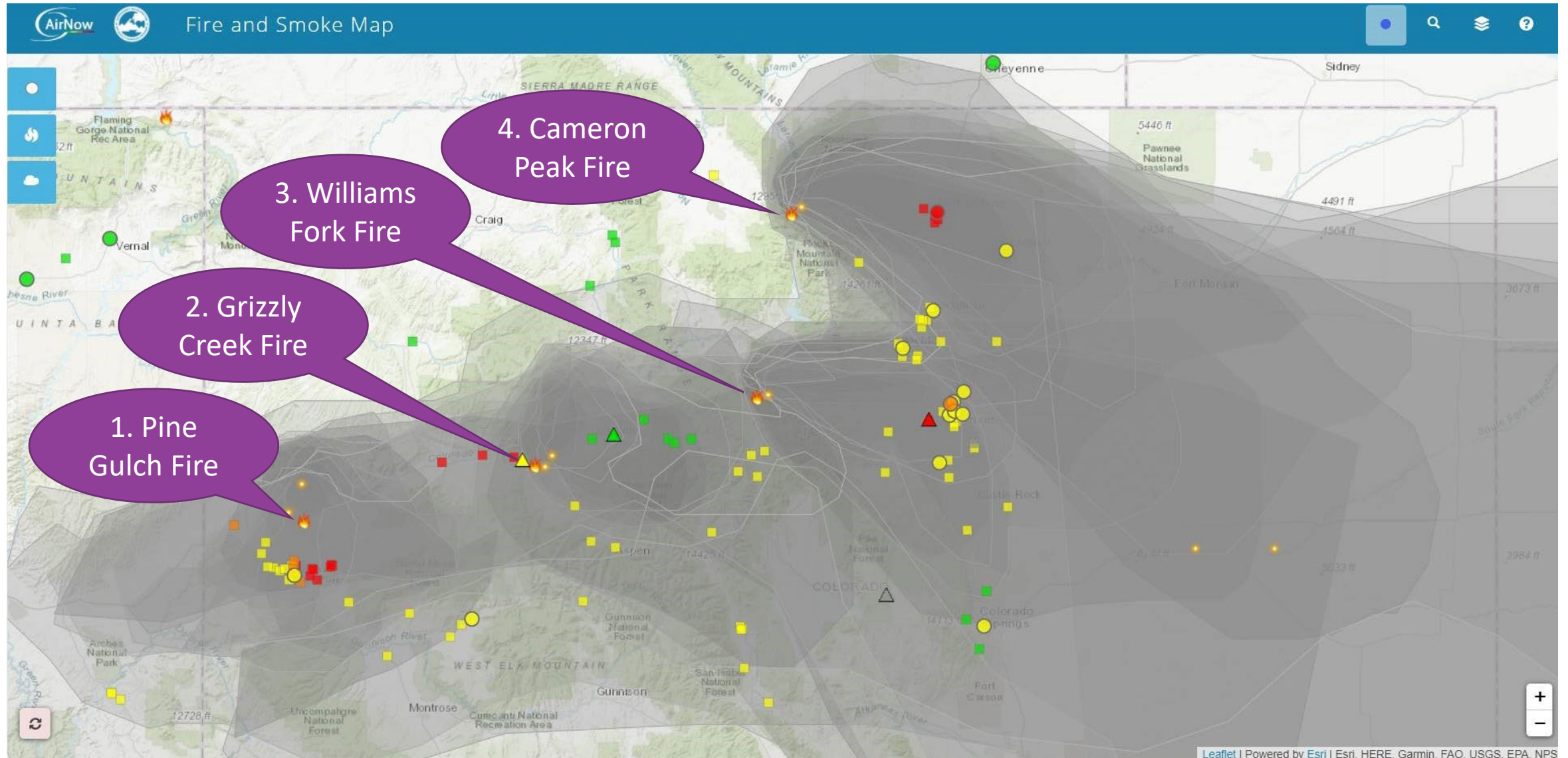








# What fires were these?



# What can we learn about wildfires?

Each group should...

- Pick a topic from the list.
- Research relevant information about these wildfires or, if necessary, wildfires in general.
- Develop a ~ 5-8 minute presentation to share with the class.



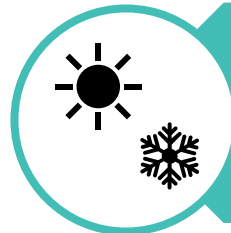
Wildfire  
causes



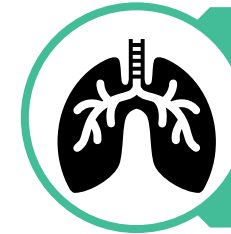
Controlling  
wildfires



US and global  
fire trends



Climate & air  
quality



Human health  
effects



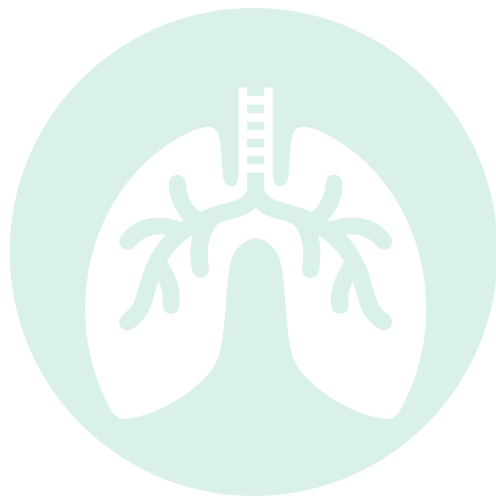
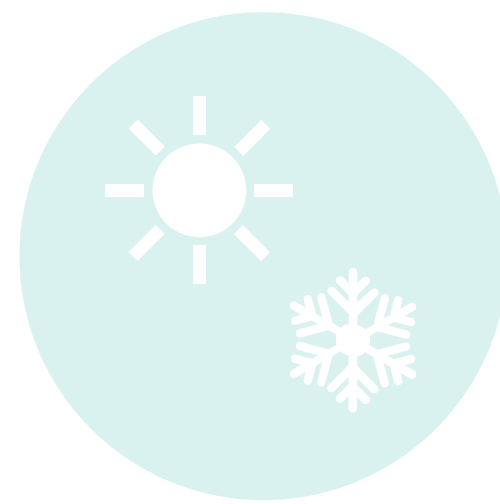
Environmental  
impacts



Economic  
effects



Impacts on  
individuals



**Share what you've learned**

# Instructor Notes and Resources



# Instructor notes and resources

- Slide 8: What Can Smoke Look Like On the Map?
  - A set of green air sensors between Fires 2 and 3 are located near Vail, CO at relatively high altitude, and the wind appears to be blowing to the southeast. This could explain why these sensors are showing green. Additional resources about the influence of terrain and weather on smoke are available ([Wildfire Smoke: A guide for public health officials](#), page 15 & [National Park Service: Wildland Fire Behavior](#))



# Instructor notes and resources

- Slide 12: Air Quality and My Day – Interpret Data
  - Sensitive groups include people with asthma. Air pollution can make asthma symptoms worse and trigger attacks. Students with asthma may need to be monitored more closely on days with yellow and higher air quality.
  - Additional Air Quality Index interpretation resources:
    - [Outdoor Activity Guide for Schools](#)
    - [Outdoor Activity Guide for Particle Pollution](#)
- Slide 13: Air Quality and My Day – Interpret Data
  - Other examples include:
    - At 10:00 pm I am asleep in bed. The green means it is a good night to open the window while I sleep.
    - At 4:00 pm I am at soccer practice. The yellow means that it is a good day to practice outside.
    - At 8:00 am I wait for the bus. The orange means that it is OK to wait outside for a short time.

# Instructor notes and resources

- Slide 17: Identify wildfires
  - If students are having trouble finding sources, a local news article about August 2020 wildfires can be a good place to start. One is [here](#).
- Slide 22: What can we learn about wildfires?
  - For fire-specific information, search “InciWeb” and the fire name
    - Click for [Pine Gulch](#), [Williams Fork](#), and [Cameron Peak](#) fires
  - Check out the following pages for information about wildland fires: [AirNow Fires page](#), [National Park Service Wildland Fires](#)

**Is that smoke affecting me? Using crowdsourced public data to explore air quality during smoke events.**

**Part 1: Investigating Your Regional Air Quality**

1

How many sensors/monitors are by you?

Number of circles (permanent monitors):

Number of squares (air sensors):

Number of triangles (temporary monitors):

Approximately how far is the nearest marker from you?

DC

Design Challenge! If you designed a sensor network for your community, where would you locate 5 monitors?

Where might you place a temporary monitor, and why?

Who would be in favor of creating an air quality monitor network in your town?

Who might be opposed? Why?

2

Today's date:\_\_\_\_\_ Current time:\_\_\_\_\_

For each monitors showing elevated PM<sub>2.5</sub> levels:

	Monitor type (permanent / temporary monitor, air sensor)	Icon Color
1		
2		
3		

1

Name: \_\_\_\_\_

## Data Collection Worksheet

Date: \_\_\_\_\_

3

For each monitor you identified in Step 5, write down the NowCast AQI value and last hour's PM<sub>2.5</sub> concentration.

4

	PM <sub>2.5</sub> NowCast AQI level	Last hour's PM <sub>2.5</sub> concentration
1		
2		
3		

5

Do you see any fire icons?

**Satellite detections** (yes/no):  
What is the "incident type"?

**Large Incidents** (yes/no):  
What is the "incident type"?

6

Are any smoke plumes visible on the map (yes/no)?

If you see a fire icon or smoke plumes on the map, describe how the fire or smoke is affecting the PM<sub>2.5</sub> levels that you see.

If there is no fire or smoke on your map, describe what you think would happen to the PM<sub>2.5</sub> levels if fire or smoke was present. Would all sensors be affected equally?

7

Find a monitor or air sensor icon that is showing yellow, orange, or red levels. By studying the surrounding area, can you predict what source of PM<sub>2.5</sub> might be near this monitor or sensor, or why they might be experiencing poor air quality today?

Name:

## Data Collection Worksheet

Date:

**P1**

Are there alternate methods that farmers could use instead of burning crop residue or clearing crops? Write three sentences describing an alternate method that would not create smoke.

**P2**

Can you think of ways to reduce particulate matter from busy roads or construction sites? How about alternates to diesel vehicles? Write a paragraph describing your ideas regarding reduction of particulate matter in these situations.

Name:

## Data Collection Worksheet

Date:

### Part 2: Air Quality in Your Community

8

How has the  $PM_{2.5}$  level changed over the past 7 days (or so), as shown in the data plot? Describe what the data looks like.

9

Are there times when the data spikes up to high values? If so, when are these?

10

Does the data have just one high point, or is there a pattern?

11

Based on what you know about the area and the activities that occur there, what might be the cause of the elevated levels?

12

How do you think the data would look if it was a different season?



Part 3: Linking Observation to Measurement:  
Wildfires and Visibility

13

If the PM<sub>2.5</sub> levels are currently elevated:  
Do you smell anything outside that might help you determine why the PM levels are high?

14

Mark the date and time you took the photo and rank the PM level  
(1 being the clearest sunny day, 10 being the worst pollution):

10

5

1

Worst polluted day

Clearest sunny day

Photo number	Date	Time	How would you rank the air outside?	AQI value from Fire and Smoke Map

15

Compare the photos you took and the PM<sub>2.5</sub> AQI values from the Fire and Smoke Map.  
What do you notice about the relationship between visibility (what you saw outside when you took photos) and the PM levels (what you recorded from the Fire and Smoke Map site)?  
Do they follow each other (both increase and decrease at the same time)?

Name:

Date:

## How to Reduce Your Personal Exposure to PM and Steps to Take to Improve Air Quality

16

What other ways can you think of that you could help reduce PM pollution?

17

Based on the presented list of ways you can lessen your exposure to PM, as well as those you came up with in the question above, describe how you might be able to personally implement one or two of these approaches in your day-to-day life.

O.S. Ryder, S.G. Brown, A.L. Clements, R.M. Duvall, R.A. Smoak, C. Duboiski, S. Waldo, I.J. Young, "Is that Smoke Affecting Me? Using Crowdsourced Public Data to Explore Air Quality During Smoke Events", Air Sensor Loan Program in Tribal Communities, Funded by U.S. EPA, 2021

# Is that smoke affecting me? Using crowdsourced public data to explore air quality during smoke events: **Worksheet Answer Key**



This document provides the answers to questions posed in the main lesson document.

## **Worksheet Box 1**

- Number of circles (permanent monitors): [Answers will vary.](#)
- Number of squares (air sensors): [Answers will vary.](#)
- Number of triangles (temporary monitors): [Answers will vary.](#)
- Approximately how far is the nearest marker from you? [Answers will vary.](#)

## **Worksheet Box "DC" – Design Challenge**

If you were to design a sensor network for your community, where are the important places that monitors should be placed? List, by address or landmark, where you would place 5 permanent monitors. Also, where might you place a temporary monitor, and why? Who would be in favor of creating an air quality monitor network in your town? Who might be opposed? Why?

Important places participants may suggest are locations near schools, homes, community centers, parks, outdoor shopping centers, or other places the public spends time outdoors. Other responses might include locations near large pollution sources.

Temporary monitors should be placed in areas where temporary activities that generate high levels of PM are occurring, such as construction zones or locations where wildfires are burning, etc.

Those who might be in favor of creating an air quality plan may include community members, environmental proponents, school officials, and individuals who work in healthcare and help those who suffer from breathing issues.

Those who might not be in favor of creating a local air quality network are harder to identify by could potentially include local industrial groups.

## **Worksheet Boxes 2-4**

Students will fill out tables and answers will depend on their location and the data from the monitor.

### Worksheet Box 5

Answers will vary based on the map.

### Worksheet Box 6

- Are any smoke plumes visible on the map (yes/no)? *Answers will vary.*
- If you see a fire icon or smoke plumes on the map, describe how the fire or smoke is affecting the PM<sub>2.5</sub> levels that you see. *Answers will vary.*
- If there is no fire or smoke on your map, describe what you think would happen to the PM<sub>2.5</sub> levels if fire or smoke was present. Would all sensors be affected equally? *Answer: The sensors closest to the fire or within the smoke plume would have higher PM<sub>2.5</sub> levels. However, this may not always be the case because of terrain or the height of the smoke plume.*

### Worksheet Box 7

Find a monitor or air sensor icon that is showing yellow, orange, or red levels. By studying the surrounding area, can you predict what source of PM<sub>2.5</sub> might be near this monitor or sensor, or why they might be experiencing poor air quality today? *Answers will vary but should relate to sources of PM in the community and may involve discussion of items in the two hints below. Map clues may be needed in the area is unfamiliar to participants.*

### Worksheet Box "P1" - Problem Solving Challenge

Are there alternate methods that farmers could use instead of burning crop residue or clearing crops? Write three sentences describing an alternate method that would not create smoke. *Answers should describe methods that would not involve combustion. These might include techniques such as using machinery to perform raking and sweeping to clear crops and turn over soil. Leaves and natural waste products can be composted or disposed of as waste rather than through incineration.*

### Worksheet Box "P2" - Problem Solving Challenge

Can you think of ways to reduce particulate matter from busy roads or construction sites? How about alternates to diesel vehicles? Write a paragraph describing your ideas regarding reduction of particulate matter in these situations. *Answers that indicate thought about how PM is produced and ways to lessen emissions are all acceptable. They might be very imaginative and creative ideas or ones that are already starting to be seen in society. Those that are starting to be implemented in society include switching cars trucks and buses switching from diesel cleaner burning fuels or electric.*

Regarding construction sites, measures are often implemented to dampen soil to prevent dust from being kicked up by heavy duty machinery and construction activities. However, PM is also released by the diesel machinery, so alternative fuels for construction equipment is advisable as well.

**Worksheet Box 8** How has the PM<sub>2.5</sub> level changed over the past 7 days (or so), as shown in the data plot? Describe what the data looks like. *Answers will vary but should comment on peaks, variability and changes in the data over time.*

**Worksheet Box 9** Are there times when the data spikes up to high values? If so, when are these? *Answers should reflect the data from the chosen monitor.*

**Worksheet Box 10** Does the data have just one high point, or is there a pattern? [Answers should reflect the data from the chosen monitor.](#)

**Worksheet Box 11** Based on what you know about the area and the activities that occur there, what might be the cause of the elevated levels? [Answers will vary but should relate to sources of PM in the community.](#)

**Worksheet Box 12** How do you think the data would look if it was a different season? [Answers will vary but should relate to sources of PM in the community that are common during different seasons. These are mentioned in the hint below.](#)

**Worksheet Box 13** If the PM<sub>2.5</sub> levels are currently elevated: Do you smell anything outside that might help you determine why the PM levels are high? [Answers will depend on location, time of day, and activities happening outside.](#)

#### **Worksheet Box 14**

Data table

**Worksheet Box 15** Compare the photos you took and the PM<sub>2.5</sub> AQI values from the Fire and Smoke Map. What do you notice about the relationship between visibility (what you saw outside when you took photos) and the PM levels (what you recorded from the Fire and Smoke Map site)? Do they follow each other (both increase and decrease at the same time)? [Answer: Lower visibility/more haze or smoke is associated with higher PM<sub>2.5</sub> values from the Fire and Smoke Map.](#)

**Worksheet Box 16** What other ways can you think of that you could help reduce PM pollution? [Answer: Other strategies that participants might identify could include limiting BBQ or bonfire burning, raking leaves instead of sweeping, wetting the ground before sweeping to minimize dust in the air, reducing wood stove use, etc.](#)

**Worksheet Box 17** Based on the presented list of ways you can lessen your exposure to PM, as well as those you came up with in the question above, describe how you might be able to personally implement one or two of these approaches in your day-to-day life. [Answers will depend on the strategies chosen and the lifestyle of the participant answering the question. Any answer that indicates consideration of their own practices and the mitigation strategies is acceptable.](#)

#### **Extension Activity**

- a. Are the sensors reporting the same U.S. EPA PM<sub>2.5</sub> AQI value (the number in the circle)? [Answers will vary.](#)
- b. If they are showing the same value, why might that be the case? [Answer: If they are showing the same value, it is possible that the window or door is open.](#)

- c. If the indoor sensor reading is higher, why might that be the case? Answer: It is possible that there is a source of particles inside the house (such as cooking, sweeping, or dusting), or possibly the windows and doors were open earlier in the day when particle counts were higher, and these particles have become trapped inside.
- d. If the outdoor sensor reading is higher, why might that be the case? Answer: There could be a nearby source of particles that the outdoor sensor detects, but the doors and windows are shut on the house, preventing the outside source from getting inside. Alternatively, the house or building might have an air filter running helping to keep indoor PM levels low.