

# Volcanic Activity & the Atmosphere - a My NASA Data Inspired Lesson

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Eyes on Earth - Fall 2022

<b>Grade/Grade Band:</b> 10-12	<b>Topic:</b> Atmosphere - Aerosols; Lithosphere - Volcanic Eruptions	<b># of Lessons:</b> 2, 45-minute periods
<b>Brief Lesson Description:</b> Students will investigate data for aerosols and SO <sub>2</sub> in the atmosphere above Hawaii. Students will identify when volcanic activity is likely to have happened in Hawaii according to the data, explaining their answer using evidence from the data. Students will explore how the aerosols and SO <sub>2</sub> released during volcanic eruptions affect human health and other human activities, such as aviation. Finally, students will brainstorm and briefly research other aerosols, their sources, and their potential effects on human health and activity. This lesson was inspired by, and uses resources from, a lesson entitled <i>Using Aerosol Data to Find Evidence of Volcanic Activity</i> , published by My NASA Data (n.d.). Portions of this lesson plan that were adapted from this My NASA Data lesson are highlighted in yellow. The original lesson and its accompanying materials may be found at <a href="https://mynasadata.larc.nasa.gov/lesson-plans/using-aerosol-data-find-evidence-volcanic-activity">https://mynasadata.larc.nasa.gov/lesson-plans/using-aerosol-data-find-evidence-volcanic-activity</a>		
<b>Performance Expectation(s):</b> <i>HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.</i> <i>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.</i>		
<b>Specific Learning Outcomes:</b> Students will be able to: <ul style="list-style-type: none"><li>- Analyze data of atmospheric aerosols and SO<sub>2</sub></li><li>- Make a claim as to when volcanic activity may have occurred, using evidence from aerosol and/or SO<sub>2</sub> data</li><li>- Describe the potential effects of aerosols on human health and activity</li></ul>		
<b>Narrative/Background Information</b>		
<b>Prior Student Knowledge:</b> Students will have already learned about the basic mechanisms behind volcanoes after covering the theory of plate tectonics in a prior unit. I picture this lesson as a bridge between the content of volcanoes/lithosphere and a unit on the atmosphere. Students should have already had a beginner lesson on what makes up the Earth's atmosphere, maybe even having made a model of the atmosphere with beads in a jar as was shown in one of our <i>Eyes on Earth</i> live sessions a few weeks ago! Going into this lesson, students should already know what the atmosphere is comprised of, so they can build their understanding of what might be considered more 'abnormal' in the atmosphere (like aerosols & SO <sub>2</sub> ) as results of specific events like natural disasters.		
<b>SEPs:</b> <i>Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational,</i>	<b>DCIs:</b> <i>ESS2.A: Earth Materials and Systems</i>	<b>CCCs:</b> <i>Cause and Effect: Empirical evidence is required to differentiate between cause</i>

<p><i>mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution (HS-ESS2-2).</i></p> <p><i>Engaging in Argument from Evidence: Construct an oral and written argument or counter-arguments based on data and evidence (HS-ESS2-7).</i></p> <p><i>Connections to Nature of Science:</i></p> <p><i>Science knowledge is based on empirical evidence (HS-ESS2-3); Science includes the process of coordinating patterns of evidence with current theory (HS-ESS2-3); Science arguments are strengthened by multiple lines of evidence supporting a single explanation (HS-ESS2-4).</i></p>	<p><i>Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes (HS-ESS2-1, HS-ESS2-2).</i></p>	<p><i>and correlation and make claims about specific causes and effects (HS-ESS2-4).</i></p> <p><i>Stability and Chance: Much of science deals with constructing explanations of how things change and how they remain stable (HS-ESS2-7); Change and rates of change can be quantified and modeled over very short or very long periods of time (HS-ESS2-1).</i></p>
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**Common Core State Standards:**

CCSS.ELA-LITERACY.RI.11-12.7: *“Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.”*

CCSS.ELA-LITERACY.RST.11-12.4: *“Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.”*

CCSS.ELA-LITERACY.RST.11-12.9: *“Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.”*

**Lesson Plan - 5E Model**

**Engage:**

To pre-assess, the instructor will ask students to think-pair-share about what the Earth's atmosphere is made of. Students should have learned this in a previous lesson. Once students have engaged their prior knowledge about the composition of Earth's atmosphere, ask students what they know about aerosols. What do they think of when they hear that word? Students might contribute ideas about aerosol sprays, like spray paint or hairspray. Some students might even bring up aerosols and the ozone layer. **At this point, the instructor should show the video called: “NASA's Earth Minute: My Name is Aerosol,” found at <https://youtu.be/4eh6lKahbok>** Students should be given a few minutes after the video to jot down brief notes about what aerosols are, and take a few moments to recap the video with a partner before moving on.

**Explore:**

Explain to students that they will be investigating data from the atmosphere over Hawaii for a certain time frame. The instructor should give a brief introduction to each data set to help scaffold students' understanding of the scales and representations of the data.

The data sets may be found at the following links for download and/or printing. Depending on available technology in the classroom, students may be provided a digital version of the data via the links below, or hard copies to investigate on paper.

Monthly data images for SO<sub>2</sub>:

[https://mydasdata.larc.nasa.gov/sites/default/files/2021-08/Monthly%20SO2%20Images%20for%20Students%20508\\_1.pdf](https://mydasdata.larc.nasa.gov/sites/default/files/2021-08/Monthly%20SO2%20Images%20for%20Students%20508_1.pdf)

Monthly data images for aerosols:

<https://mydasdata.larc.nasa.gov/sites/default/files/2021-08/Monthly%20Aerosol%20Images%20for%20Students%20508.pdf> )

Ten-year graph of SO<sub>2</sub>:

[https://mydasdata.larc.nasa.gov/sites/default/files/2021-08/10%20yr%20SO2%20Graph%20for%20Students%20508\\_0.pdf](https://mydasdata.larc.nasa.gov/sites/default/files/2021-08/10%20yr%20SO2%20Graph%20for%20Students%20508_0.pdf)

Ten-year graph of aerosols:

<https://mydasdata.larc.nasa.gov/sites/default/files/2021-08/10%20yr%20Aerosols%20Graph%20for%20Students%20508.pdf> )

Half the class will be assigned to analyze the aerosol data, while the other half of the class will be assigned to the SO<sub>2</sub> data. Within each half of the class, students can be grouped into pairs or small groups while they begin to analyze their assigned data. They will first analyze the monthly data together, looking for patterns, changes, anomalies, etc., and then move on to analyze the 10-year data. For the 10-year data, they will compare the graph with the images and answer the following questions provided by My NASA Data (n.d.):

- a. "Does this graph agree with the images for the same variable?"
- b. What was the trend over the course of a year? Decade?
- c. Was there any noticeable change? What might have caused this?
- d. How is the rate of change changing over time? Is this to be expected in the future?"

NASA's Data Literacy Cubes may be used to scaffold the data analysis section if appropriate for differentiation for the students in the class:

(<https://mydasdata.larc.nasa.gov/data-literacy-cubes-graphs-maps-and-data-tables>)

Once the pairs/small groups have had enough time to analyze their own set of the data, the class will "jigsaw" so that the student pairs now have one student from the aerosol group and one student from the SO<sub>2</sub> data group. These pairs will compare their findings, and see how their data are related or not. What can they infer from their data? Do higher aerosol levels always correspond to higher SO<sub>2</sub> levels? Why might this be or not be? How can they explain any differences they see in their data? Students will answer the following questions provided by My NASA Data (n.d.):

- a. "What are the similarities and differences among the aerosol and SO<sub>2</sub> graphs?"
- b. What patterns do you see?
- c. How might volcanic activity have caused the pattern you observe?
  - i. How do you know that the volcano caused the change in aerosol or SO<sub>2</sub>?
  - ii. What would you predict would happen if the volcanic activity were to decrease? How would this affect SO<sub>2</sub> values? Aerosol values?"

The instructor rotates around to student groups to provide clarification, refocusing/redirection, and further questioning to help students access the task and to informally assess throughout.

To wrap up this segment and help students connect the data to the volcanic eruption, the instructor should show clips from the video “2018 Kilauea Eruption and Summit Collapse,” found at <https://youtu.be/Jp1DhVLe2NQ> (My NASA Data, n.d.). The instructor should give students a chance to briefly reflect and respond. How did the footage make them feel? What did they notice and observe? How does their data relate back to what they see in the footage?

**Explain:**

Students will watch the video “Fire, Ice, and Safer Skies: NASA Satellites Track Volcanic Clouds,” found at <https://youtu.be/TP4vzFojewU> (My NASA Data, n.d.).

The teacher may show this video as a whole class, or students may watch it individually or in small groups if they have access to 1:1 devices such as Chromebooks. Individual/small-group watching is beneficial so that students can pause, rewind, rewatch the video as needed.)

After the video, students will be given a few minutes to free-write individually responding to the following general prompts:

- What did you learn in the video? What surprised you in the video? What are some questions you have?

After a few moments to reflect on the video individually, students will re-join their small groups and discuss the following questions and write responses out on paper:

- What effects does volcanic activity have on the atmosphere?
- Why is SO<sub>2</sub> a helpful thing to track when it comes to volcanic activity?
- Does aerosol data tell us the whole picture when it comes to hazardous conditions in the atmosphere?
- How are humans and other living things affected by volcanic activity and its impact on the atmosphere? Explain.

Students will be informally evaluated throughout their discussions and via their written responses as the instructor rotates around the room.

Per My NASA Data (n.d.), students will be given the prompt: “Make a claim using SO<sub>2</sub> data in relation to aerosols, volcanic eruptions, and safety. What evidence do you have to support this claim?” Students will respond to the prompt in writing, and if time allows, share their claim, evidence, and reasoning in a small group or to the class.

**Elaborate:**

Students will do a mini-research session with a small group to investigate the following questions, which help connect these specific data back to the bigger picture:

- Think back to the definition of aerosols that we learned in the video at the very start of the lesson. What other sources of aerosols, besides volcanic activity, can you think of?
  - Can you think of any human-contributed aerosols?
  - Can you think of any aerosols that come from other natural disasters/hazards?
- How do aerosols affect human health? Human activity (other than aviation)?
- How do aerosols influence our climate?
- Briefly explain the connection between Earth’s atmosphere and lithosphere based on what you learned today. Can you identify any connections with the other spheres (biosphere, hydrosphere) as well? Describe them here.

Students may choose to re-watch the video from the start of the lesson:

<https://youtu.be/4eh6IKahbok>

They can use any/all of the following resources as they conduct a brief investigation of aerosols and their effects:

- <https://www.nasa.gov/centers/langley/news/factsheets/Aerosols.html>
- <https://scied.ucar.edu/learning-zone/air-quality/aerosols>
- <https://www.nationalgeographic.com/environment/article/aerosols>
- <https://www.nature.com/scitable/knowledge/library/aerosols-and-their-relation-to-global-climate-102215345/>
- [https://www.usgs.gov/faqs/what-health-hazards-are-posed-vog-volcanic-smog#:~:text=Vog%20\(volcanic%20smog\)%20is%20a.oxygen%2C%20moisture%2C%20and%20dust.](https://www.usgs.gov/faqs/what-health-hazards-are-posed-vog-volcanic-smog#:~:text=Vog%20(volcanic%20smog)%20is%20a.oxygen%2C%20moisture%2C%20and%20dust.)
- <https://climate.nasa.gov/news/215/just-5-questions-aerosols/>

Students will provide written responses to the questions above, either on paper or in an online format like Google Forms or Docs.

### **Evaluate:**

In the explain section, per My NASA Data (n.d.), students will be given the prompt: “Make a claim using SO<sub>2</sub> data in relation to aerosols, volcanic eruptions, and safety. What evidence do you have to support this claim?” Students will also be pre-assessed in the ‘engage’ section to gauge prior understanding about aerosols which helps the instructor build the lesson to relate aerosols to volcanic activity and other sources. Students are also informally evaluated throughout the lesson as they analyze data, discuss questions with peers, and conduct informal research and respond to written prompts.

As students transition out of this lesson toward the rest of the unit on the atmosphere, this lesson is a jumping-off point to make predictions about what other substances in the atmosphere might correspond to other natural hazards (how does the atmosphere change during wildfires, hurricanes, tornadoes, etc.?). Basically, how can atmospheric data provide a window into what is happening on Earth’s surface as well? This lesson is a great way to get students thinking in terms of systems and the interactions between spheres, seeing that all of Earth’s spheres are interconnected and dependent on one another. This is also a great way to get students thinking not only about how natural hazards impact human behavior (i.e., volcanic eruptions affecting aviation), but also how human activity affects the atmosphere and the climate (man-made aerosols in the atmosphere contributing to climate change).

### **Materials:**

- Projector and/or Smart Board for showing videos to the class
- Videos on YouTube:
  - <https://youtu.be/4eh6IKahbok>
  - <https://youtu.be/Jp1DhVLe2NQ>
  - <https://youtu.be/TP4vzFojewU>
- Monthly data images for SO<sub>2</sub> and aerosols above Hawaii (sourced from My NASA Data:  
[https://mynasadata.larc.nasa.gov/sites/default/files/2021-08/Monthly%20SO2%20Images%20for%20Students%20508\\_1.pdf](https://mynasadata.larc.nasa.gov/sites/default/files/2021-08/Monthly%20SO2%20Images%20for%20Students%20508_1.pdf) AND  
<https://mynasadata.larc.nasa.gov/sites/default/files/2021-08/Monthly%20Aerosol%20Images%20for%20Students%20508.pdf> )
- Ten-year graph of SO<sub>2</sub> and aerosols above Hawaii (sourced from My NASA Data:  
[https://mynasadata.larc.nasa.gov/sites/default/files/2021-08/10%20yr%20SO2%20Graph%20for%20Students%20508\\_0.pdf](https://mynasadata.larc.nasa.gov/sites/default/files/2021-08/10%20yr%20SO2%20Graph%20for%20Students%20508_0.pdf) AND  
<https://mynasadata.larc.nasa.gov/sites/default/files/2021-08/10%20yr%20Aerosols%20Graph%20for%20Students%20508.pdf> )

- Data Literacy Cubes, if desired (<https://mynasadata.larc.nasa.gov/data-literacy-cubes-graphs-maps-and-data-tables>)
- Chromebooks or other internet-enabled devices for students to use to conduct online research

### **Reference**

My NASA Data. (n.d.). Using aerosol data to find evidence of volcanic activity.

<https://mynasadata.larc.nasa.gov/lesson-plans/using-aerosol-data-find-evidence-volcanic-activity>