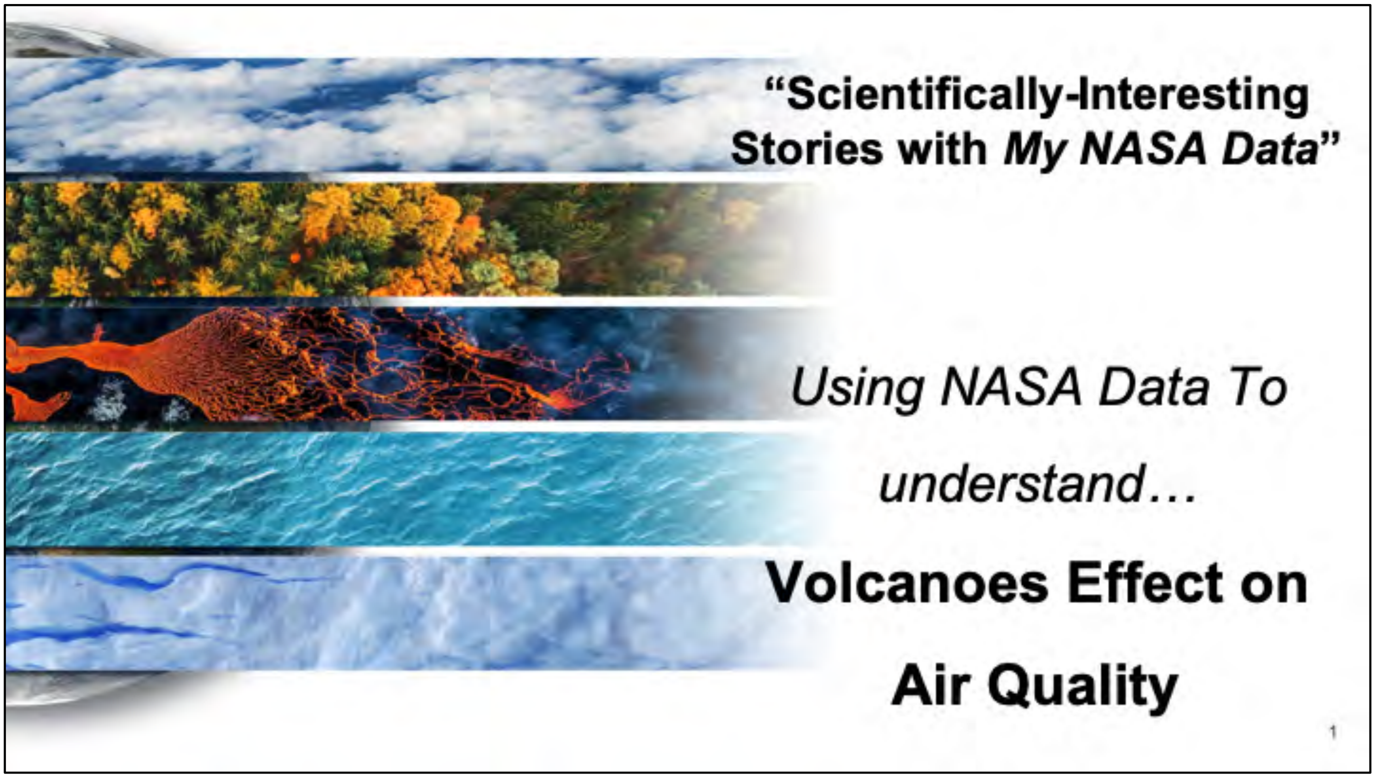
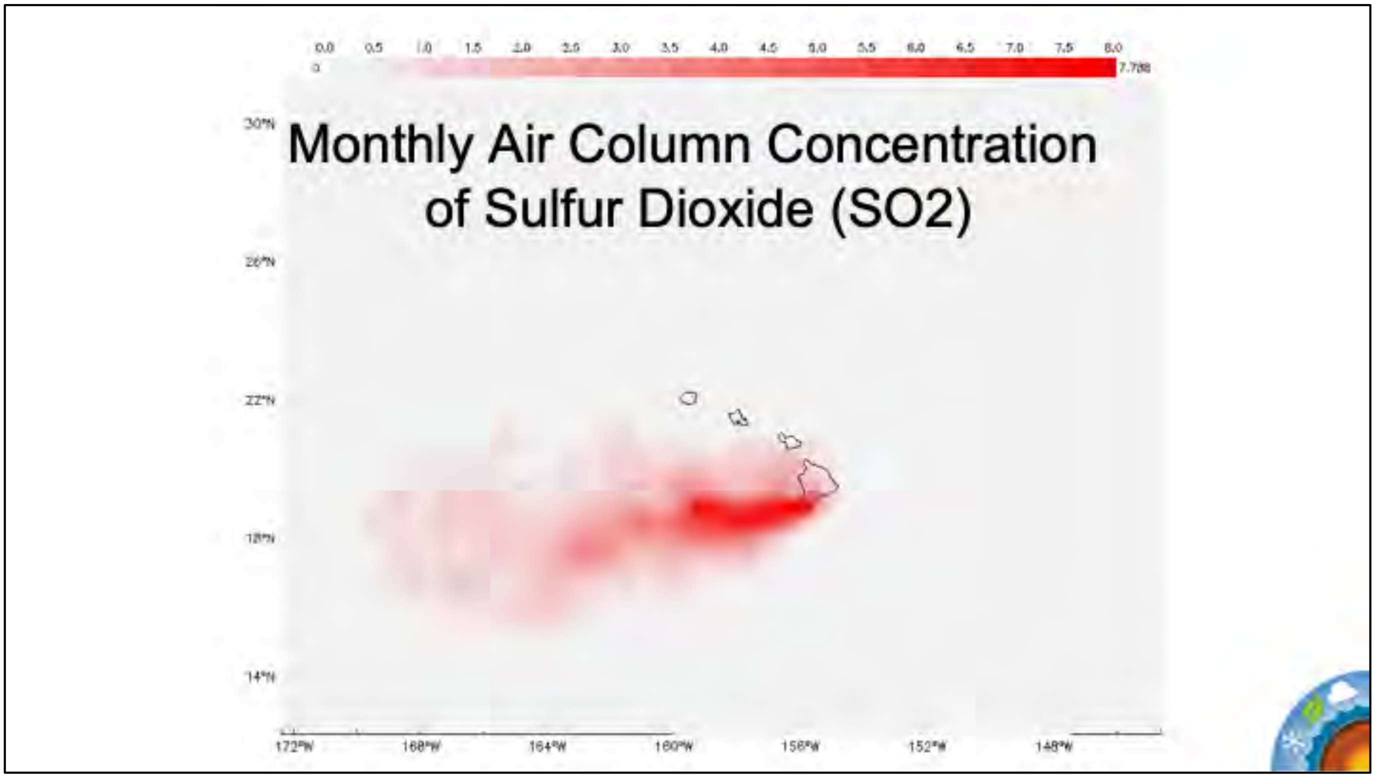

"Scientifically-Interesting Stories with *My NASA Data*"
Using NASA Data To understand…
Volcanoes Effect on Air Quality
1



Teacher Talking Points:

This mapped plot from the Earth System Data Explorer shows Monthly Air Column Concentration of Sulfur Dioxide (SO2) observed June 2018 of the Hawaiian Islands. Sulfur dioxide (SO2) is an atmospheric pollutant primarily sourced from fuel burning, industrial activity, and volcanic emissions. It also is the primary contributor to acid rain. The units of these data are parts per billion by volume, which is a ratio of the volume of this gas to a much larger volume of air. A concentration of 1 ppbv is equal to mixing a volume of SO2 equal to about one half of a teaspoon (2.5 milliliters or 0.084 fluid ounces) into a volume of air that would fit into an Olympic-sized swimming pool (2.5 million liters or 660,400 gallons).

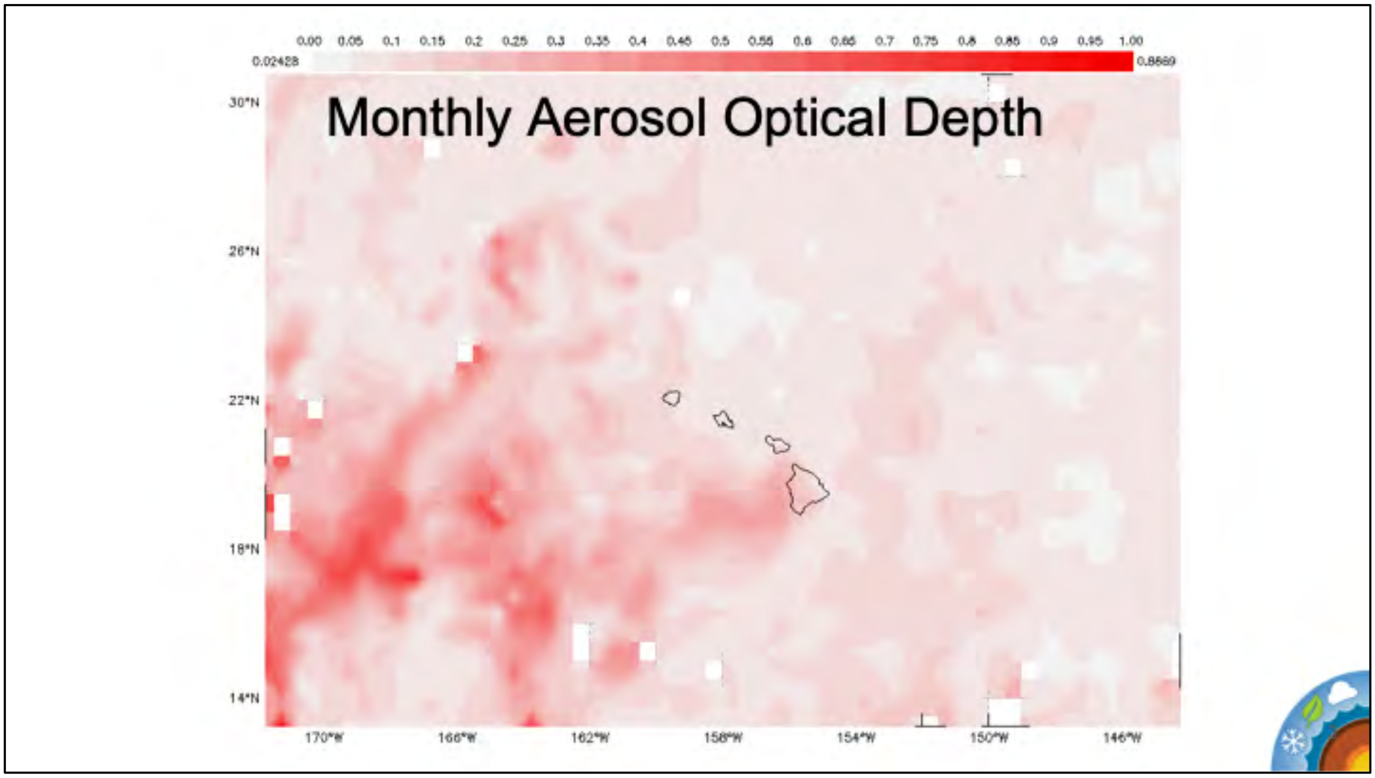
Focus Question:

1. Where do you observe the highest concentrations?

   There are much higher concentrations to the west of Hawaii than to the east. The high concentrations of sulfur dioxide seem to be coming from a small area on the southern end of the island of Hawaii. This is the eruption of the Kilauea volcano.

Related Resources: Consider using the My NASA Data Map Cube and Question Sheet with this map. See link for details.

Image Credit: Earth System Data Explorer (To visualize Monthly Air Column Concentration of SO2 in the Earth System Data Explorer, visit this link.)



Teacher Talking Points:

This mapped plot from the Earth System Data Explorer shows Monthly Aerosol Optical Depth observed June 2018 of the Hawaiian Islands. Aerosols are tiny solid and liquid particles suspended in the atmosphere. Examples of aerosols include windblown dust, sea salts, volcanic ash, smoke from fires, and pollution from factories.

<u>Focus Questions:</u>

1. Where do you observe the highest concentrations? *There are much higher concentrations to the west of Hawaii than to the*

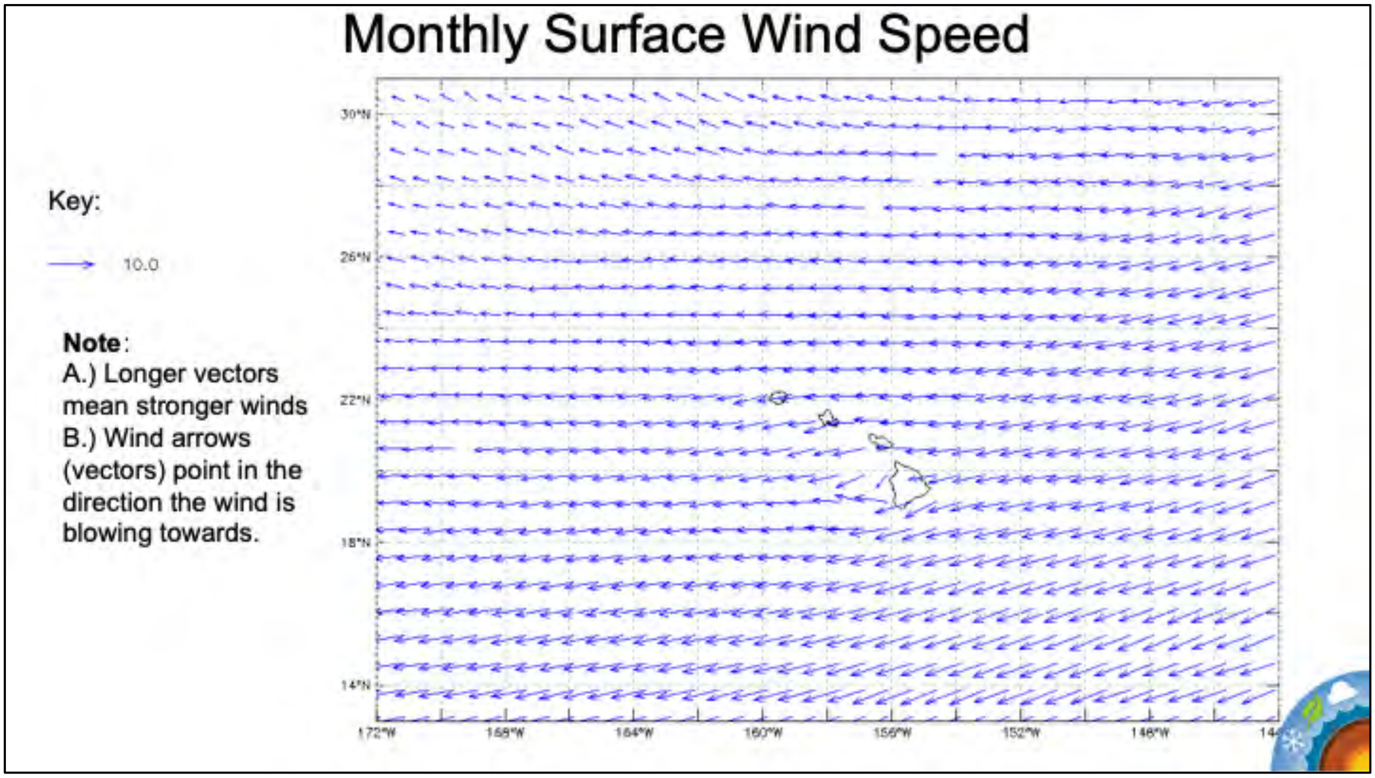
east. The high concentrations of aerosols seem to be coming from the south western end of the island of Hawaii. This is the eruption of the Kilauea volcano.

2. How do Monthly Aerosol Optical Depth compare to Monthly Air Column Concentration of Sulfur Dioxide (SO2)?

    There are higher concentrations of SO2 and aerosols over the same region west-southwest of Hawaii
    They both had the same orientation of plumes of aerosols and SO2.

Related Resources: Consider using the My NASA Data Map Cube and Question Sheet with this map. See link for details.

Image Credit: Earth System Data Explorer (To visualize Monthly Aerosol Optical Depth in the Earth System Data Explorer, visit this link.)



Teacher Talking Points:

This mapped plot from the Earth System Data Explorer shows Monthly Surface Wind Speed observed June 2018 of the Hawaiian Islands. This quantity describes the monthly average wind speed at 10 meters above the ocean surface (the standard height where scientists take surface wind measurements, equivalent to the height of a 3-story building).

This map shows the strength and direction of wind by using small blue arrows (vectors). Longer vectors mean stronger winds. Also, the vectors point in the direction the wind is blowing towards. The units of these data are meters per second. A speed of one meter per second is the same speed as a slow walk. A speed of 12 meters per second is the speed of the fastest human sprint ever recorded. A speed of 25 meters per second is the typical speed limit on an urban interstate highway or rural two-lane highway in the United States (55 miles per hour).

The seasons and latitude play an important role in determining where the strongest average surface winds are located. In general, surface winds are strongest in winter and in the middle and high latitudes. This is one factor that scientists use to determine the impacts of volcanic eruption on the atmosphere.

Focus Question:

1. Where do you observe the stronger winds?

   Longer vectors mean stronger winds and arrow points in direction of wind; the stronger winds appear to be the East of the islands blowing to the West.

Related Resources: Consider using the My NASA Data Map Cube and Question Sheet with this map. See link for details.

Image Credit: Earth System Data Explorer (To visualize Monthly Surface Wind Speed in the Earth System Data Explorer, visit this link.)

Teacher Talking Points:

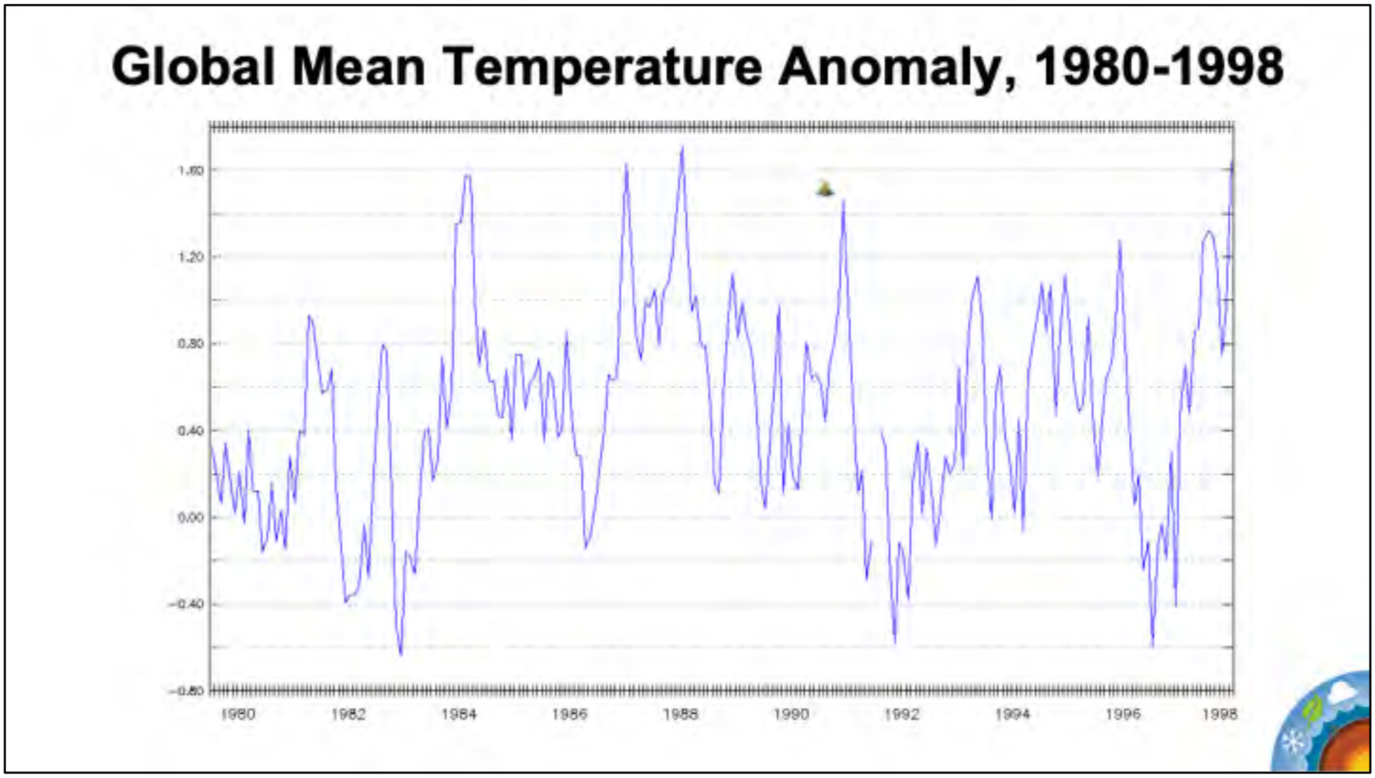
This is an animated GIF showing visible satellite images from June 16-24 (taken from NASA's Worldview) of the Hawaiian Islands. These slides demonstrate that the state of atmosphere (wind speed and direction) determine the impacts of volcanic eruption on the atmosphere.

<u>Focus Question:</u>

1. Using evidence from earlier datasets, how did the atmosphere impact the effects of the volcanic eruption?

a. Plumes of higher concentration SO_2 and aerosols are downwind of Hawaii. In other words, the plumes are in the same direction as the winds.
b. If the wind was from a different direction, then the impact of the volcanic eruption would have been different. For example, the plume of aerosols may have occurred over a more populated area rather than over the middle of the ocean.

Image Credit: Worldview



Teacher Talking Points:

This mapped plot from the Earth System Data Explorer shows Global Mean Temperature Anomaly, 1980-1998. The quantity describes the surface air temperature anomaly, which is the difference between the measured temperature and an average value taken across a long time period in the data (in this dataset, the 1951-1980 average temperature). Air temperature is in degrees Celsius.

The volcano image showcases the time when Mount Pinatubo erupted on June 15, 1991.

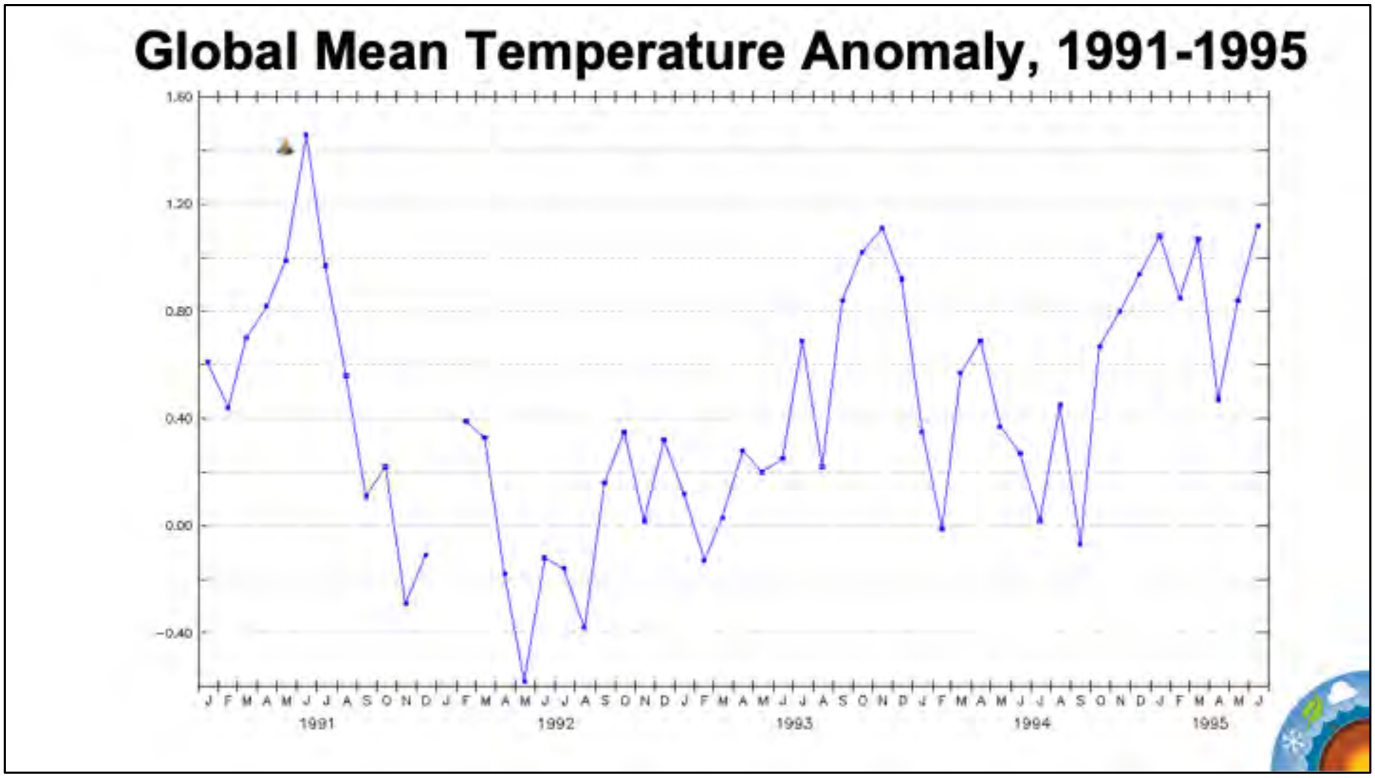
Positive values on the Y axis mean global temperature is higher than pre-industrial temperature (~1850).

Focus Questions:

1. Describe the pattern of global average temperature from 1980 until 1990. *The values cycle between an anomaly of about 0 degrees Celsius to approximately 1.60 degrees Celsius until about 1991 when there is a significant drop in global temperature anomaly to about -0.30 degrees Celsius.*
2. Describe the pattern you observe after the volcanic eruption in 1991. *There is a small increase then a large decrease in air temperatures that lasts about 2 years.*

Related Resources: Consider using the *My NASA Data* Graph Cube and Question Sheet with this map. See link for details.

Image Credit: Earth System Data Explorer (To visualize Global Mean Temperature Anomaly in the Earth System Data Explorer, visit this link.)



Teacher Talking Points:

This mapped plot from the Earth System Data Explorer shows Global Mean Temperature Anomaly, 1991-1995. The quantity describes the surface air temperature anomaly, which is the difference between the measured temperature and an average value taken across a long time period in the data (in this dataset, the 1951-1980 average temperature). Air temperature is in degrees Celsius.

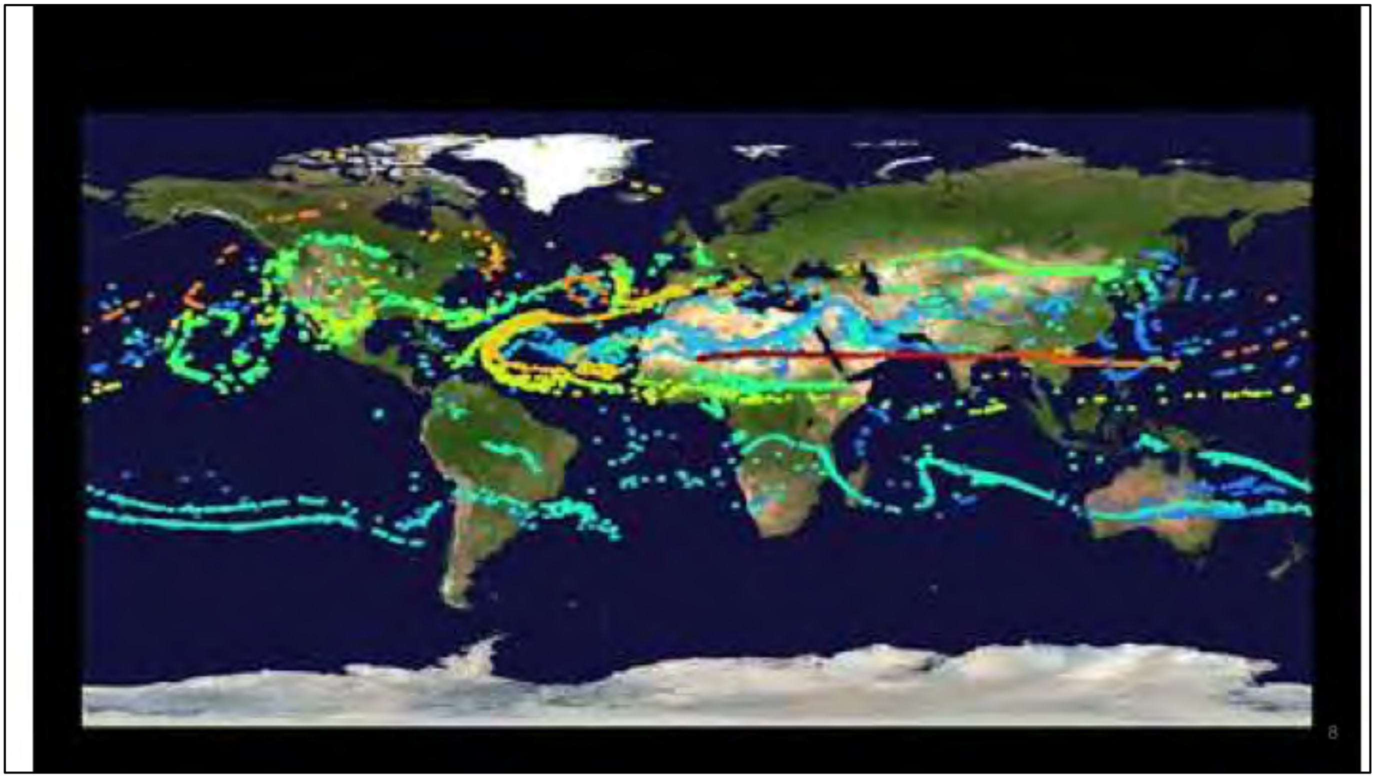
The volcano image showcases the time when Mount Pinatubo erupted on June 15, 1991.

Focus Questions:

1. What season and year experienced the most cooling effects from the eruption? *summer of 1992*
2. When did global temperatures return to pre-eruption levels? *Global temperature did not reach pre-eruption levels until late 1993 - 1994.*
3. Why do you predict that there is a delay in the onset of temperature decrease after the eruption? *There is a clear decrease in temperature (with a bit of delay) a few years after the eruption. The delay is because it takes time for the aerosols from the eruptions to reach the stratosphere and spread worldwide. (See video on next slide to illustrate this point.)*

Related Resources: Consider using the *My NASA Data* Graph Cube and Question Sheet with this map. See link for details.

Image Credit: Earth System Data Explorer (To visualize Global Mean Temperature Anomaly in the Earth System Data Explorer, visit this link.)

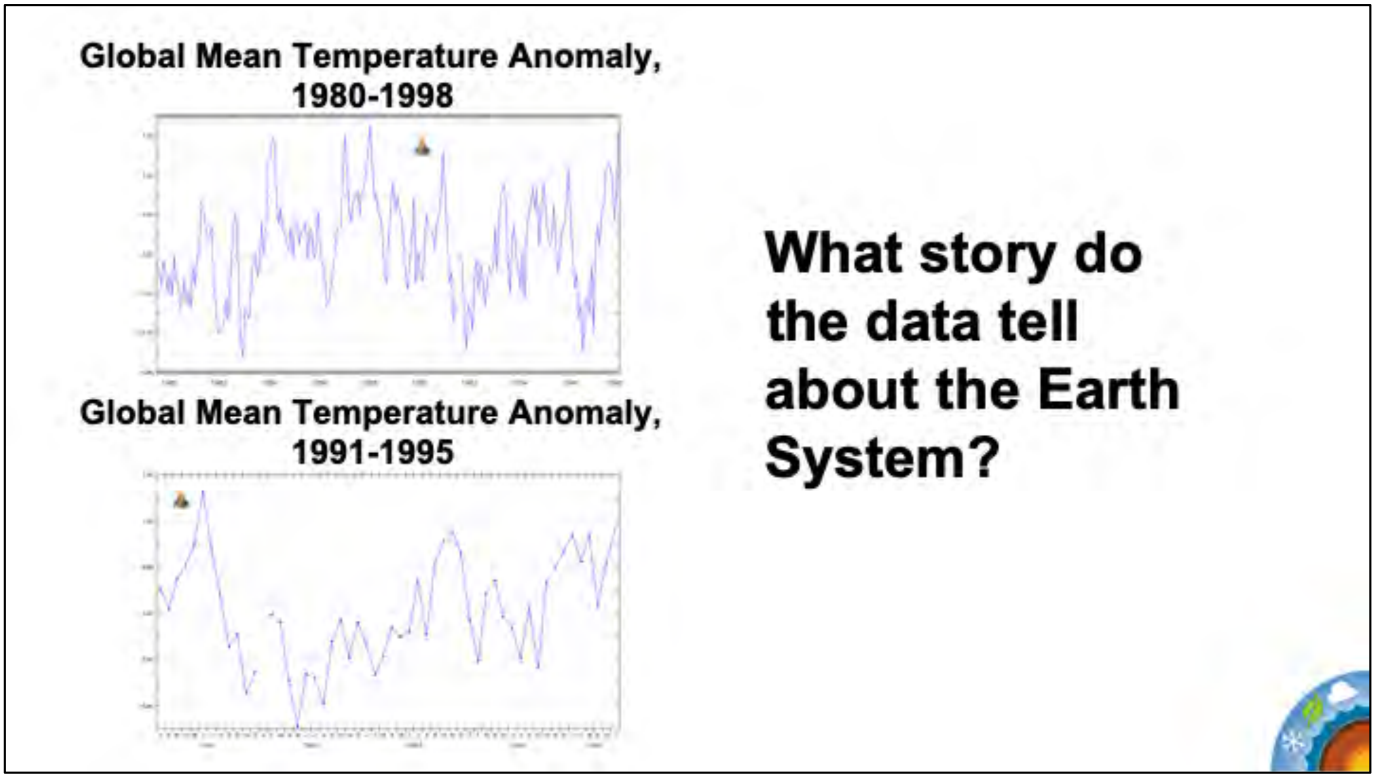


Teacher Talking Points:

The global impact of the June 1991 Mount Pinatubo eruption in the Philippines can be seen in this particle model. Volcanoes are known to eject huge columns of ash into the air, as well as sulfur dioxide and other gases, yielding sulfates. Immediately following the Pinatubo eruption large amounts of sulfur dioxide and dust spread through the earth's atmosphere. The result was a measurable cooling of the Earth's surface for a period of almost two years. For more information on the global effects of volcanic aerosols (and others), visit Earth Observatory: Aerosols and Incoming Sunlight (Direct Effects).

The colors in this animation reflect the atmospheric height of the particles. Red is high and blue is closer to the earth's surface.The model shows the tremendous amounts of sulfur dioxide and dust that spread throughout the earth's atmosphere".

Image Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio, visit this link.)



Teacher Talking Points:

A local event can have global impact.

Image Credit: Earth System Data Explorer