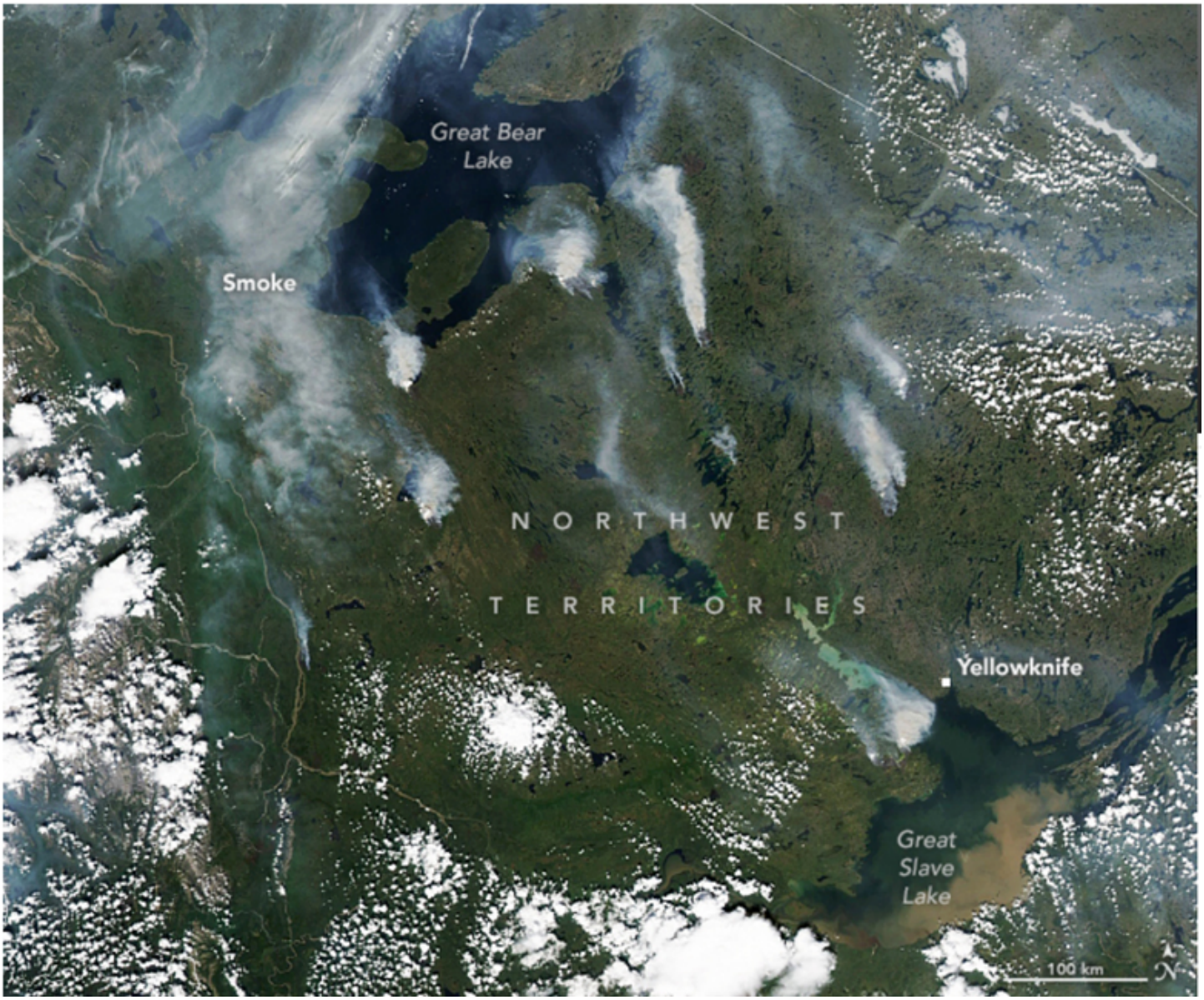
My NASA Data - Lesson Plans

Smoke Travels



Overview

Students will analyze images and data from a variety of NASA sensors and satellites depicting the wildfires of northern Canada to understand the state of the atmosphere at the time. Then they will answer a series of questions.

Learning Objectives

To familiarize students with images and data created from a variety of sensors and satellites used to

understand the current state of the atmosphere.

Why Does NASA Study This Phenomenon?

The importance of having data that is collected more frequently is the basis of the TEMPO Mission. Aerosol data that is collected only once a day, or only from the ground, is not complete enough for a thorough understanding of atmospheric events. TEMPO will provide frequent and higher quality data.

Materials Required

- Smoke Travels Student Sheets (optional)

Technology Requirements

- Internet Required
- One-to-One (tablet, laptop, or CPU)
- One-to-a-Group
- Teacher computer/projector only

Teacher Background Information

1. Read article titled Remote Sensing of Tropospheric Pollution from Space

Video: NASA Mission Update: CALIPSO

Video

NASA Mission Update: CALIPSO | https://www.youtube.com/watch?v=FzXa5r2A3TM&t=122s | Source: NASA Mission Update

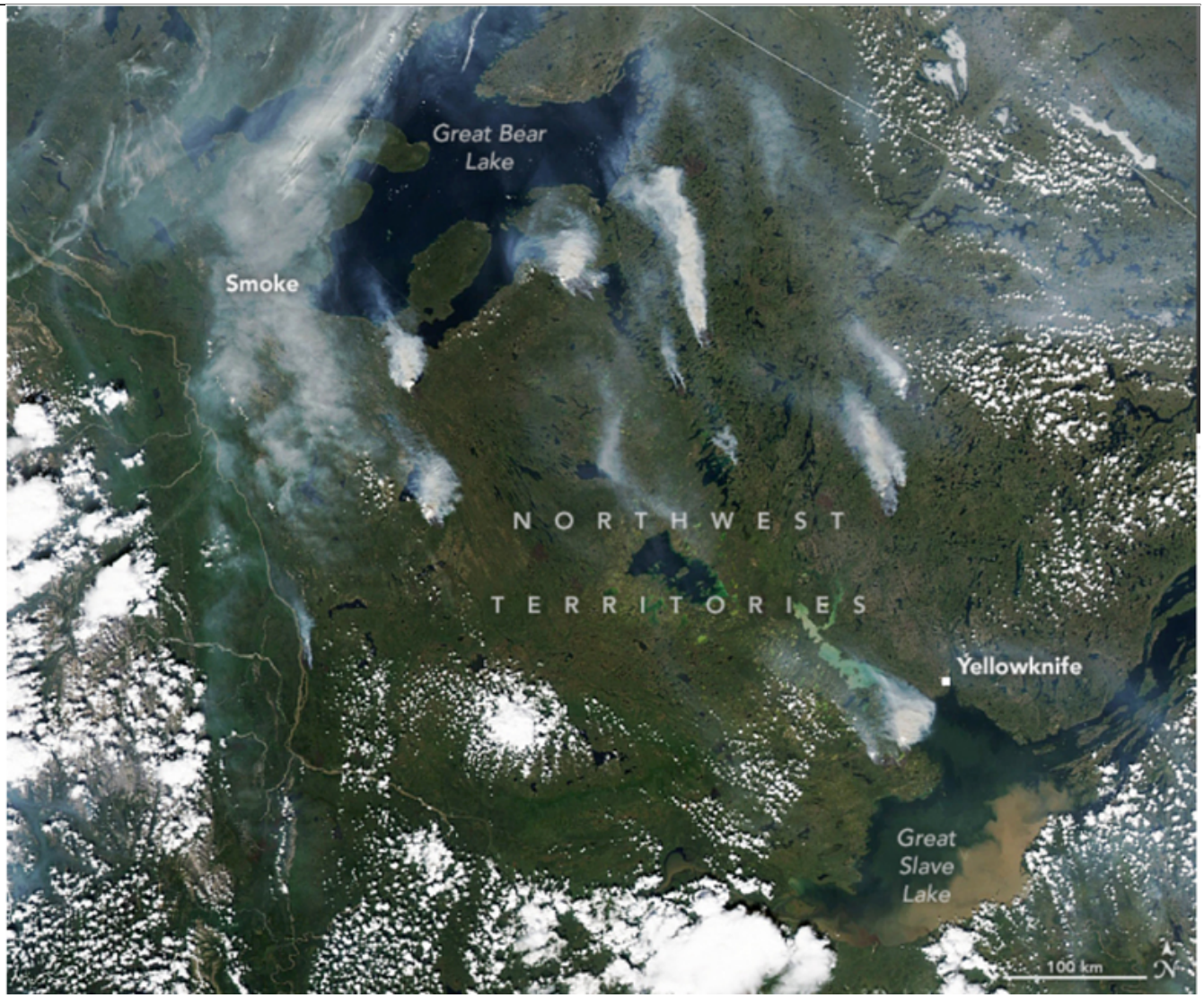
Procedure

This activity will familiarize students with images and data created from a variety of sensors and satellites used to understand the current state of the atmosphere. Instruct your students to read each section and answer the questions.

This can be conducted as a class discussion, or the Smoke Travels Student Sheets can be used to record answers.

2022 Canadian Wildfires

1. Introduce a recent event to students.
2. In July 2022, a combination of lightning, dry weather, and unusual heat fueled hundreds of wildland fires in northern Canada.

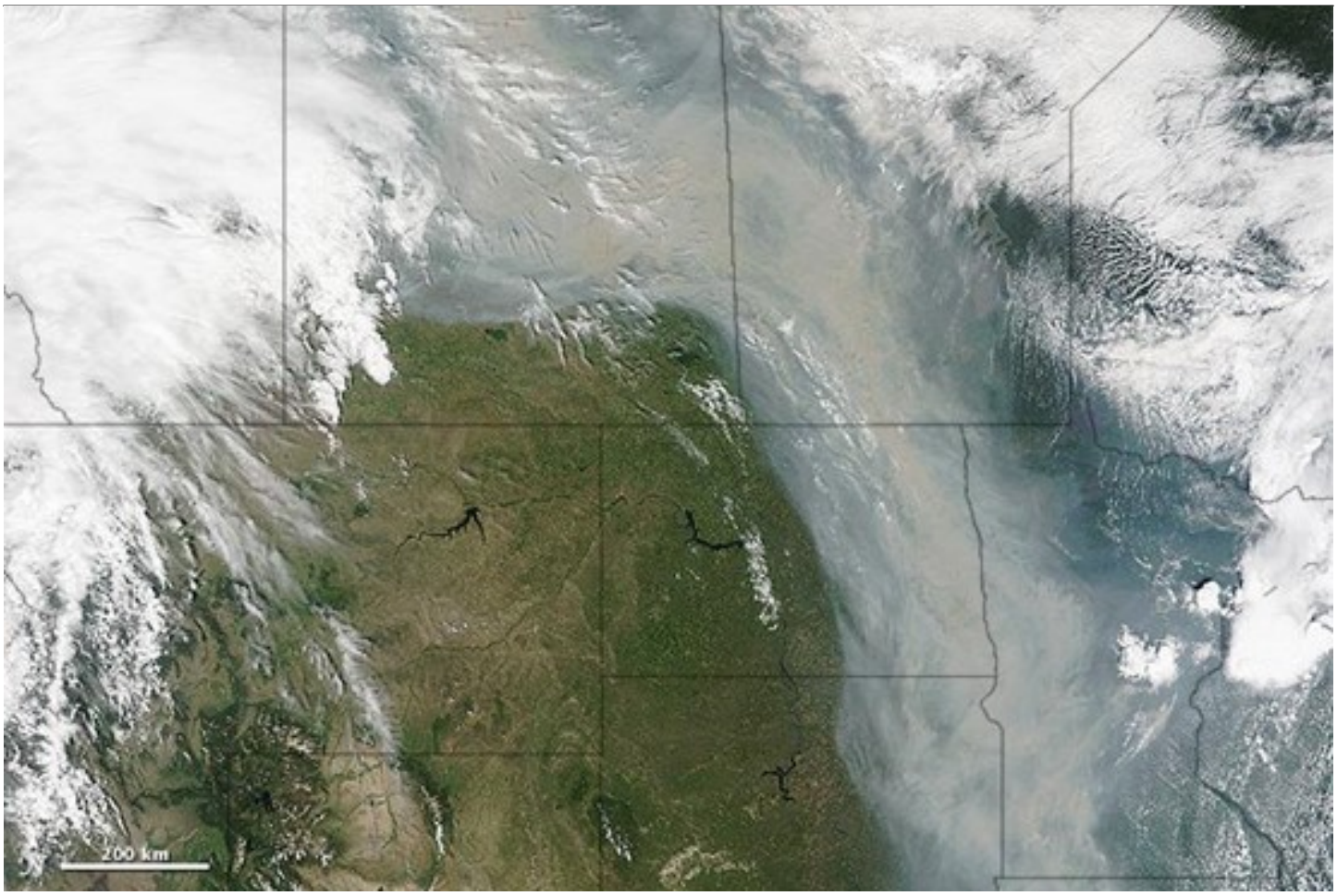


Wildland Fires in northern Canada. Image source: CALIPSO (https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Smoke%20Travels_0.png)

Where does the smoke go? How long before smoke arrives in a certain location? Air quality managers need this information in order to make predictions and help people prepare, if necessary. How much data is needed to make these predictions quickly enough to be useful?

2015 Canadian Wildfires

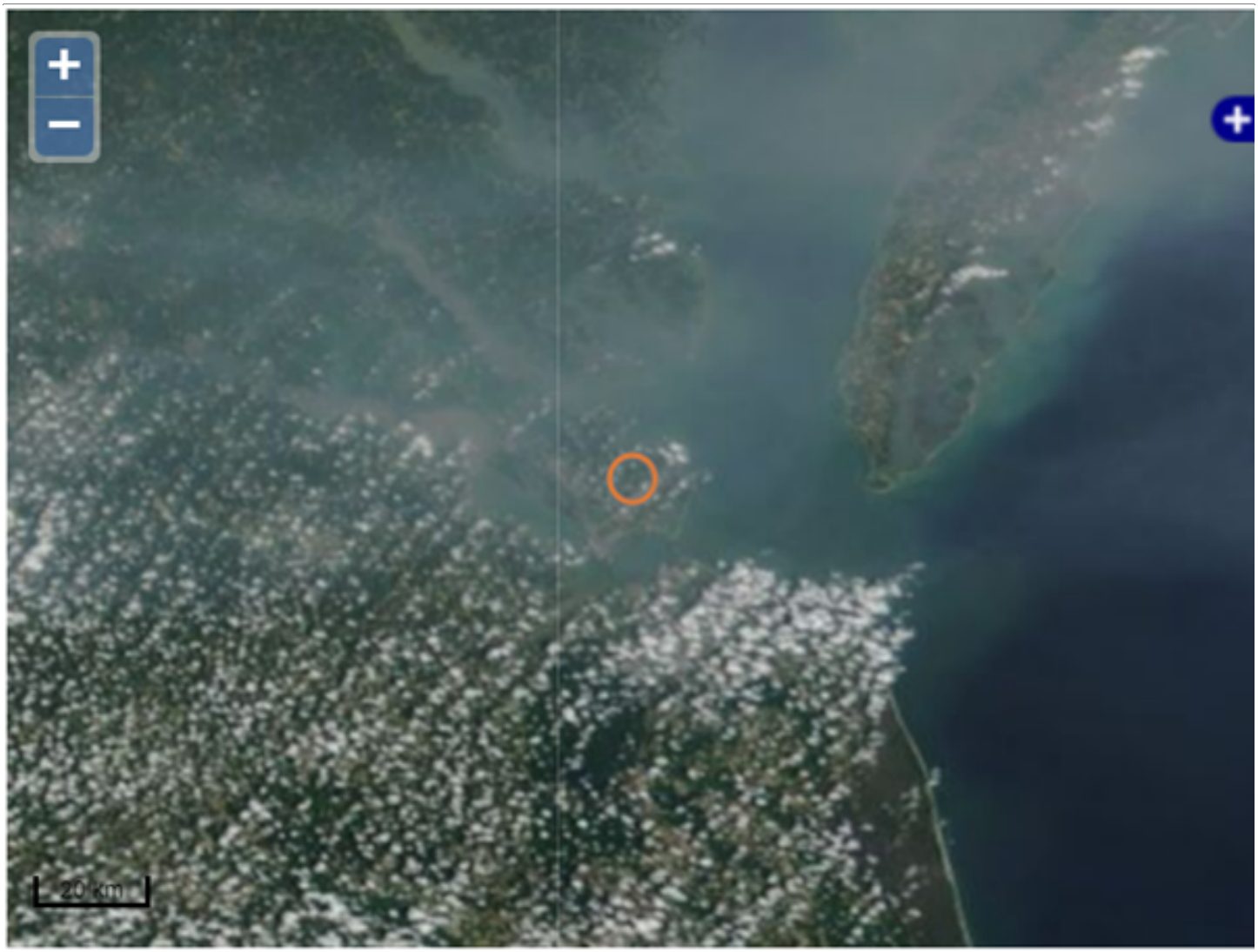
1. Let students know that there was a similar event in Canada in 2015 with smoke spreading all the way across the country.
2. The data in this lesson are from the event in 2015.
3. Guide students to read more about this event at Canadian Wildfires Produce River of Smoke (nasa.gov).



Smoke spreads from the fires in Canada south and east, across the United States. Source: MODIS (https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/MODIS.jpg)

Sources of Data

1. Discuss the following points with students.
2. NASA, USGS, and NOAA all use images from satellites to follow smoke and weather events. Ground-based sensors are used as well. Why are so many sources of data needed? Each provides different data that can be combined for a more complete picture.
3. Satellites may only get one image in a day, like the MODIS image of Hampton, VA. Also, satellites cannot “see” through clouds. While the smoke is visible, the actual impact near ground level is not known from a single satellite image.

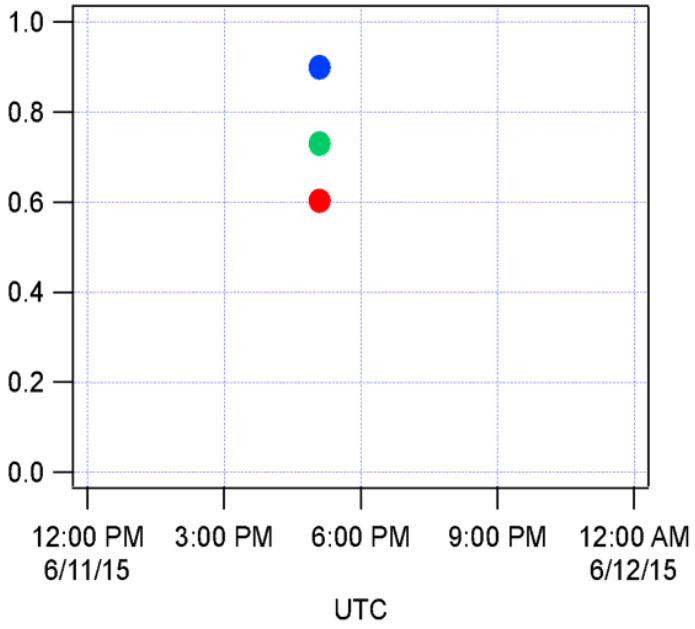


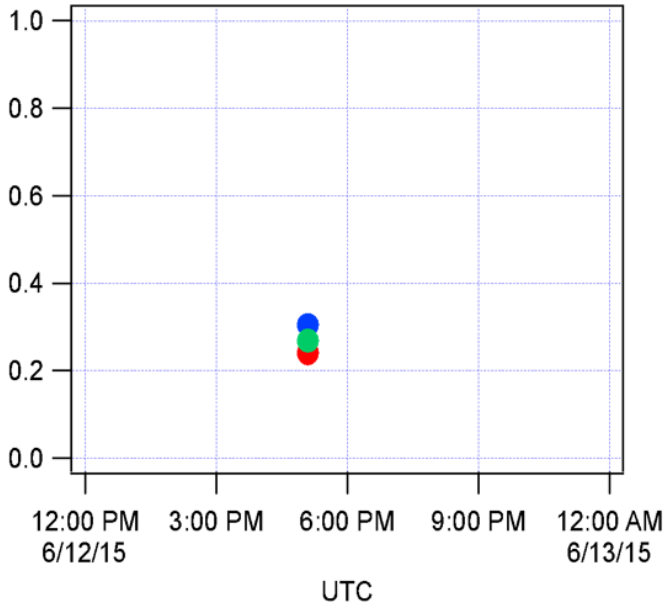
View of Hampton, Virginia with smoke visible. Source: MODIS (https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Smoke%202.png)

Data Points from Hampton, VA in 2015

1. Discuss the following points with students.
2. Sensors on the ground in Hampton, Virginia could detect the smoke, but only for a short time. Some sensors work 24 hours a day, and others just under certain conditions, like clear skies.
3. Using data from a variety of sensors provides scientists and air quality managers better data than just one source, especially if there are limited collection times.
4. Let's look at one ground-based sensor example, AERONET.

    1. Read more about AERONET. Source: NASA Aerosol Robotic Network
    2. Ask students: What data can be collected from a sensor such as AERONET (Aerosol Robotic Network)?
5. The following graphs are readings from an AERONET sensor, in Hampton, VA, taken over two different days. The three colors (blue, green, and red) represent wavelengths of light. Higher values mean less sunlight is passing through and can indicate that there is something blocking the light such as aerosols or smoke.



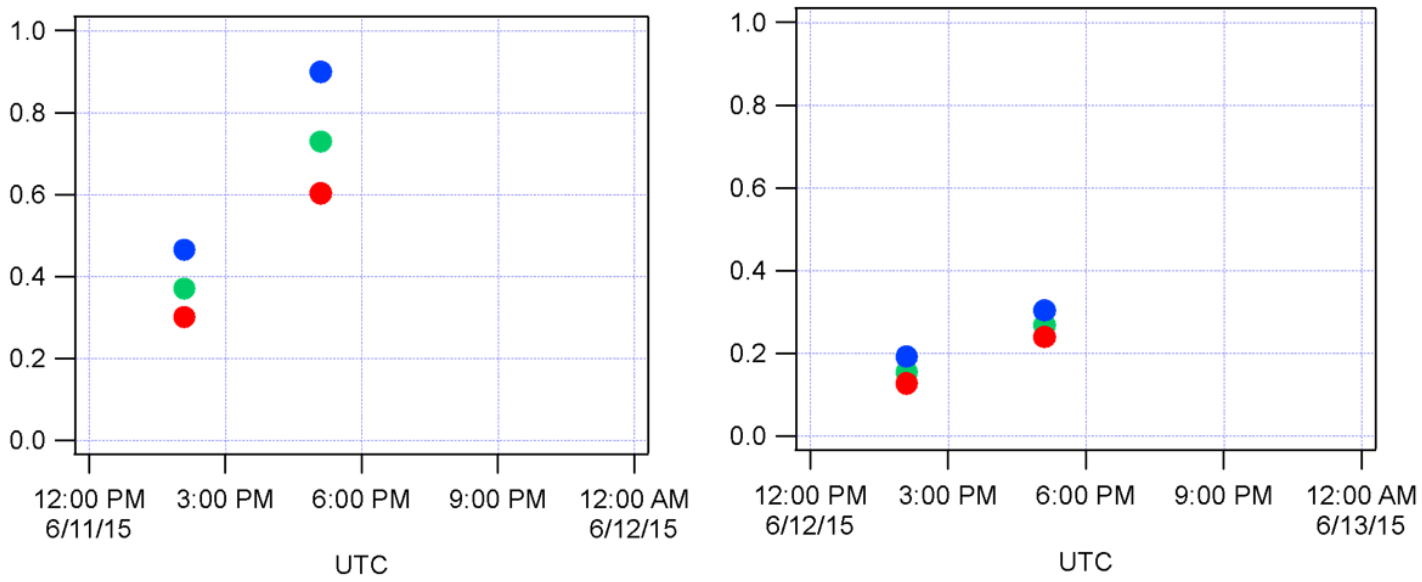


AERONET Reading from 6/11/15 - 6/13/15 Source: AERONET (https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Aeronet.png)

Question Set 1

1. What are two observations that can be made from the first two graphs?
2. What are two or more questions that cannot be answered?

Add Another Data Point



[AERONET Reading from 6/11/15 - 6/13/15 Source: AERONET (https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Aeronet2.png)]

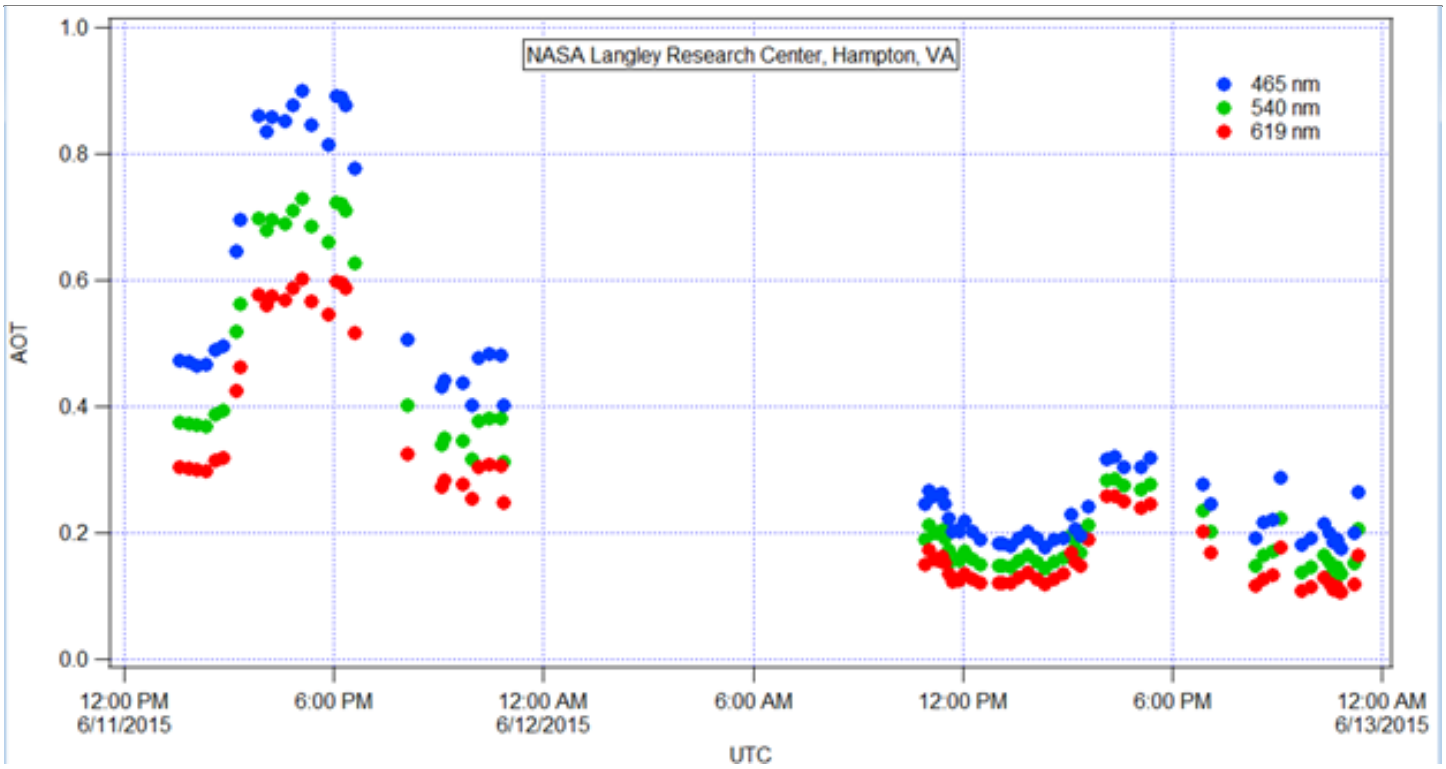
1. Lead students in a discussion about adding more data.
2. Look at the graphs after adding another data for one more time for each day.

Question Set 2

1. What observations can be made from the two graphs with more data?
2. What questions cannot be answered?

Add Hourly Data

1. The graph made with many readings, one every hour during daylight, looks different from the first examples.
2. Examine the graph and answer question set 3.



[AERONET Reading - Every hour | Source AERONET (https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Aeronet3.png)]

Question Set 3

1. When did the smoke most likely pass through?
2. How are the two days different?
3. How are the two days similar?
4. Propose an explanation for these observations.
5. What is a possible advantage of having more frequent data observations than just one or two readings per day?
6. What is one possible problem that remains with this data, even when multiple readings are included?

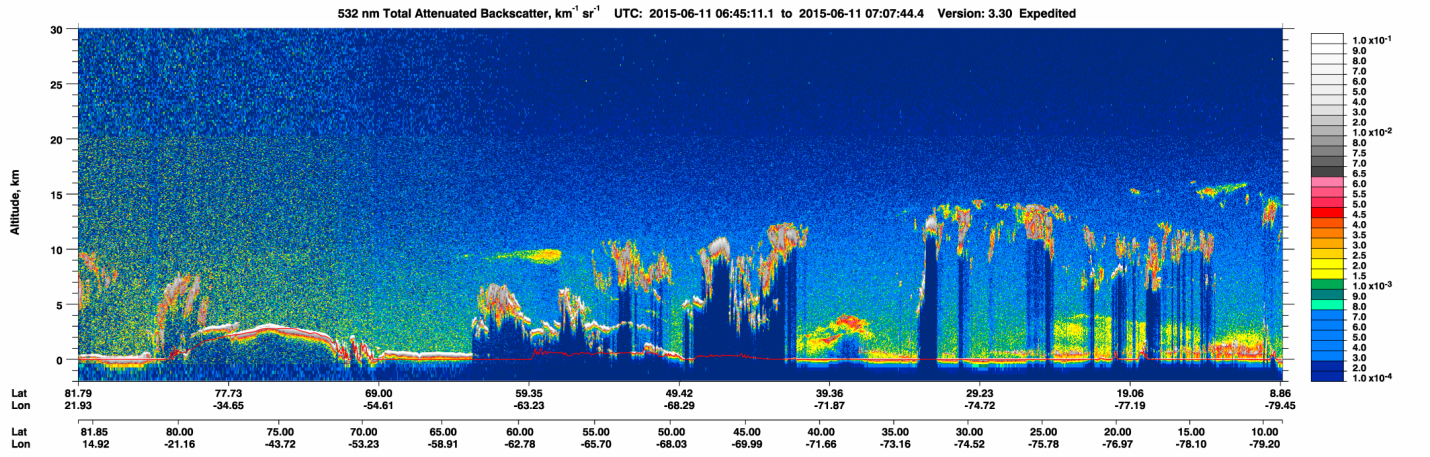
Event Duration

Incomplete data is always a challenge for scientists. Sensors and satellites always have some limitations. This is why a combination of tools are needed. Hourly data gives a more complete understanding of an event, allowing scientists to know if the event was short-lived or ongoing.

Question Set 4

1. Why would knowing if an air quality event, such as a fire or weather inversion is on-going be important?

A Different Data Source



[LIDAR Data from CALIPSO is another source of data, for clouds and aerosols |Source: CALIPSO | (https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Calipso%20image%206.11.2015.png)](https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Calipso%20image%206.11.2015.png)

1. This image is created from data collected very close to Hampton, VA at the same time as the graph data.
2. See the smoke?

    1. It is the bright, but lower, red and yellow colors on the right half of the image.
    2. Learn more about [CALIPSO Mission Overview]

Question Set 5

1. How does having more data build a more complete picture of an event?
2. How does having different sources of data help?
3. How do you think different types of data could have been used in monitoring the fires in 2022?

Answers:

Teachers who are interested in receiving the answer key, please complete the [Teacher Key Request and Verification Form]. We verify that requestors are teachers prior to sending access to the answer keys as we've had many students try to pass as teachers to gain access.

Sources:

1. Lightning strike numbers 'stupendously high'. (2022, July 6). Whitehorse Daily Star. Retrieved September 22, 2022, from https://www.whitehorsestar.com/News/lightning-strike-numbers-stupendous…
2. NASA Earth Observatory. (2018, December 5). Canadian Wildfires Produce River of Smoke. NASA Earth Observatory. https://earthobservatory.nasa.gov/images/86151/canadian-wildfires-produ…
3. Aerosol Robotic Network (AERONET) Homepage. Retrieved September 22, 2022, from https://aeronet.gsfc.nasa.gov/
4. CALIPSO Mission Overview. (2011, January 26). NASA. Retrieved September 22, 2022, from https://www.nasa.gov/mission_pages/calipso/mission/