

MY NASA DATA Lesson:

Tropical Atlantic Aerosols

Purpose:

Students will use real satellite data to determine where the greatest concentrations of aerosols are located during the course of a year in the tropical Atlantic region and their source of origin.

**Grade Level:** 8

Image courtesy NASA Visible Earth

Estimated Time for Completing Activity:

50 minutes

Learning Outcomes:

- Students will explore data and draw conclusions about aerosol transport.
- Students will learn about the radiation budget effects of aerosols.
- Students will consider explanations linking tropical Atlantic aerosols to Atlantic hurricane strength.

Prerequisite

- Familiarity with accessing websites on the Internet
- Familiarity with finding locations on a map using coordinates
- Familiarity with West African climate and geography.

Tools

- Computer with Internet access
- Map, Atlas or Globe

Vocabulary:

- [aerosol](#)
- [biomass burning](#)
- [MISR](#)
- [optical depth](#)

Lesson Links:

- [Live Access Server](#)
- [Geography of Africa](#)
- [African Monsoons](#)
- [Photo of West African Dust Storm](#)
- [Dust and the North African Climate](#)
- [Sahel Climate Map](#)
- [Sahel Vegetation Map](#)
- [Sahara](#)
- [NASA Image- African Biomass Burn](#)
- [Why Do We Care About Aerosols?](#)
- [Hurricanes and Aerosols](#)
- [What is a Cloud?](#)
- [Can We Control Hurricanes?](#)
- [Multi-angle Imaging Spectroradiometer \(MISR\)](#)
- [Aerosol Pollution Slows Winds and Reduces Rainfall](#)

Background:

The atmosphere is a mixture of gases including nitrogen, oxygen, carbon dioxide and other trace gases. Additionally, the atmosphere contains small, suspended liquid and particle matter called aerosols. Aerosols come from various sources, both natural and anthropogenic (man-made). Some examples are volcanic ash, dust, sand, sea salts, industrial pollutants and smoke from biomass burning.

Aerosols are important to study and monitor because they have direct and indirect effects on regional weather and global climate. Depending upon their exact nature, several radiation budget effects may occur. For instance, some aerosols can scatter back the sun's radiation to space (a cooling effect). Some can absorb radiation, keeping radiation from escaping to space (a warming effect). Some change cloud particle sizes, invoke chemical reactions, or even suppress cloud formation (modifying cloud radiative effects). The global balance between all of these effects is still being determined and is heavily debated in the field of Earth science.

There are several NASA satellite instruments currently monitoring the Earth's atmosphere to measure aerosols. The satellite does not directly measure the aerosol concentration, but rather the instruments will measure aerosol optical depth, or the extent that aerosols reduce the passage of sunlight through the atmosphere by scattering or absorption. The larger the optical depth, the less radiation reaches Earth's surface.

One of the questions that NASA scientists are trying to answer with data from the Aqua, Cloudsat, and CALIPSO satellites is what impact warm, dry, dusty air blowing out of the Sahara Desert might have on hurricane formation in the Atlantic. Does the dry air suppress hurricane formation, or does dust provide seeds for clouds, prompting storm formation? Together, the three satellites reveal humidity, aerosols (dust), temperature, and cloud structure within the layer of Saharan air, which allows scientists to map out these characteristics of the air mass in relation to where and when hurricanes form. By understanding where Saharan air is in relation to hurricanes, scientists can then observe what impact the air might have on storms. (From Hurricanes: NASA Missions to Study Hurricanes – The Greatest Storms on Earth).

In this lesson, you will be exploring real NASA satellite data from the Multi-angle Imaging Spectroradiometer (MISR) instrument to examine the transport of desert dust off the west coast of Africa. Desert dust warms the atmosphere regionally by absorbing radiation and suppressing storm cloud formation. See Lesson Links for MISR information.

Procedure:

Inquiry-based pre-activity:

Using the Live Access Server, explore the various parameters that are available in order to create a hypothesis that includes an 'if-then' statement. The hypothesis can pertain to the creation of aerosols in North Africa, North Atlantic hurricane generation, or changes in Atlantic Ocean Wind Speed.

MY NASA DATA Live Access Server Procedure:

1. Click on the link to the Live Access Server in the lesson links above.
2. Select 'Choose Dataset' if it is not already selected in the upper left corner of the page.

3. Select Atmosphere, Aerosols, Monthly Aerosol Optical Depth (MISR).
4. Above the map in the left hand corner of the screen, click on the double downward arrows, and select the region Equatorial Atlantic in the drop-down menu. Then select 'Update Plot' above the map.
5. Generate one image for each month of 2003 by setting the date to: Jan 2003 through Dec 2003. For each month, click on 'Update Plot' if this does not happen automatically.
6. Save each month's image to your computer. This can be done by clicking on 'Set Plot Options' from the top menu and then selecting 'GIF' from the drop down menu for 'Image Format' and then clicking on 'Ok'. Next click on 'Print' menu in the menu above the plot. This will open a second window with the GIF image of your plot. You can 'right click' or 'control click' on this image and 'save as' to save the image to your computer for later use.
7. Repeat this process for Oceans, Monthly Ocean Wind Speed Vectors to generate wind plots during the same months.

NASA Earth Observations primary procedure for the lesson:

1. Go to <http://neo.sci.gsfc.nasa.gov/Search.html> (For implementation on the MND site the first step might be to go the lesson link 'NASA Earth Observations' in a separate window)
2. Click on the 'Atmosphere' button below the world image on the NEO homepage.
3. Choose 'Aerosol Optical Thickness' from the available choices.
4. For this lesson you will be looking at separate color plots for each month in 2006 for the Equatorial Atlantic region of the globe.
5. To do this make sure to begin by finding January 1, 2006 00:00 through February 1, 2006 00:00 under the search results section of the page.
6. Once you have used the navigation arrows at the bottom of the list to locate your first month: January 1, 2006 00:00 through February 1, 2006 00:00, click on the date to reveal a drop down menu and select either 'View' or 'Open in Google Earth'. This will depend on the capabilities of your computer and the software that is loaded on it.
7. In order to look more closely at a region you can use the plus sign to zoom in and the minus sign to zoom out of a particular region. To pan around the map you can use the tool that looks like a hand to move around the map.
8. Another feature that you can utilize to look more closely at the map is the 'Download Options' found in the upper right hand of the screen to get a larger more detailed image of the time frame that you are studying.
9. Repeat steps 6-8 for each additional month for 2006 to be able to answer all of the questions that follow the Procedure section of the lesson.

NASA Earth Observations secondary procedure for the lesson (analyzing 3 images at a time):

1. Go to <http://neo.sci.gsfc.nasa.gov/Search.html> (For implementation on the MND site the first step might be to go the lesson link 'NASA Earth Observations' in a separate window)

2. Click on the 'Atmosphere' button below the world image on the NEO homepage.
3. Choose 'Aerosol Optical Thickness' from the available choices.
4. For this lesson you will be looking at separate color plots for each month in 2006 for the Equatorial Atlantic region of the globe.
5. To do this make sure to begin by finding January 1, 2006 00:00 through February 1, 2006 00:00 under the search results section of the page.
6. Once you have used the navigation arrows at the bottom of the list to locate your first month: January 1, 2006 00:00 through February 1, 2006 00:00, click on the date to reveal a drop down menu and select 'View'.
7. Click on 'Analyze this image' to add it to a queue that you will analyze after a three month block has been added to the tool.
8. This will allow you to look at three months worth of data next to each other.
9. Depending on the question below this tool will help you narrow your findings to come up with better answer.
10. Repeat steps 6-8 for each additional 3-month block for 2006 to be able to answer all of the questions that follow the Procedure section of the lesson.

Questions:

1. Which months had the greatest activity of aerosols off the west coast of Africa? What was the source of these aerosols?
2. Which direction is the wind pattern carrying the aerosols off the west coast of Africa? Explore Lesson Links for clues to aerosol direction.
3. If the aerosols continue to travel across the Atlantic Ocean, which land mass will they encounter first?
4. What do you think is the source of aerosols during September and October further south in the Equatorial Atlantic?

Extensions:

Refer to Lesson Links for more background information to assist with Extensions.

1. Hurricane season is during the months of June through November each year. Pick a year to study and find data on the aerosol content for the Caribbean during this time frame. Do you think aerosols played a role in where the hurricanes were able to form?
2. Find Near-Surface Air Temperature data in the Live Access Server. Do you see a relationship between this parameter and from the aerosol activity during the same timeframe? Repeat the Procedure steps for Oceans, Atmospheric Temperature, and Monthly Near-Surface Air Temperature to generate plots during the months of June through November.

Lesson plan contributed by Rex Roettger, Aguadilla, Puerto Rico

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