Seasonal Patterns of Aerosols

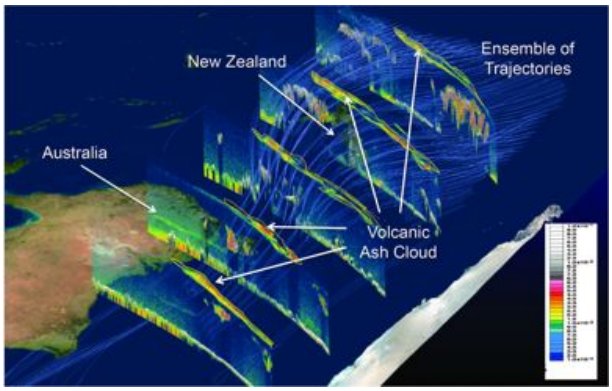

Image courtesy NASA- CALIPSO

Purpose:

In this lesson students will gain a better understanding of what an aerosol is and how they are measured. As the students work through the Live Access Server they will gain a better understanding of the range of measurements, and how aerosols impact the amount of light that reaches the surface of the Earth.

Grade Level: 7 – 12

Estimated Time for Completing Activity: 2 -3, 45 min class periods

Learning Outcomes:

- The learner will understand what is meant by aerosol optical thickness.
- The learner will identify high and low levels of AOD
- The learner will examine MISR data to look for patterns of seasonal aerosols
- The learner will understand how sky visibility is affected by aerosols

Vocabulary:

- aerosol
- aerosol optical depth
- satellite
- season
- sky visibility
- wavelength

Lesson Links:

- Aerosol Resource Page
- MISR webpage
- Night Sky Network
- NASA Earth Observatory Gbloal Maps
- Intro to LiDAR 3D
- NASA Earth Observatory on Aerosols
- Light Detection and Ranging
- Live Access Server
- GLOBE Aerosol Protocol

Background:

Aerosols are tiny particles floating around in air. You often cannot see these particles because they are so small. Some of these aerosol particles are naturally occurring, such as dust, sea spray, or volcanic ash, other aerosols are anthropogenic (generated by humans), these include car exhaust or soot from a stove burning. While these particles are small they can have a huge impact on Earths climate and humans health.

+ The Multi-angle Imaging SpectroRadiometer (MISR) instrument, launched on the Terra spacecraft on December 18, 1999, provides important data products that describe clouds and aerosols in the Earth's atmosphere and their effect on Earth's climate.. MISR is unique because it is an instrument that has a wide view, with 9 different cameras pointing in different directions. The cameras can take pictures with both visible and near-infrared light.

+ A common measurement of aerosols from satellites is Aerosol Optical Depth (AOD). This is a column measurement that reflects how much aerosols are in a column from the ground up through the atmosphere. Satellite measure ments of aerosols, called aerosol optical thickness, are based on the fact that the particles change the way the atmosphere reflects and absorbs visible and infrared light. An AOD of 0.1 or less indicates a very clear sky, whereas a value of .5 or higher indicates very hazy conditions.

+ Percent Transmission refers to the percentage of light that is transmitted through the atmosphere, according to this formula: percent transmission = 100 x e-a (where a is optical thickness at a particular wavelength). This calculation gives the percentage of light, at a particular wavelength, which would be transmitted through the atmosphere if the sun were directly overhead. For example, an optical depth of 0.10, the percent transmission is about 90.5 percent.

+ Appendix A:

Optical Depth	Percent Transmission
.10	90.5%
.20	81.9%
.30	74.1%
.40	67.0%
.50	60.7%
.60	54.9%
.75	47.2%
1.00	36.8%
1.25	28.7%
1.50	22.3%
2.00	13.5%
2.50	8.2%
3.00	5.0%

Procedure:

Student Introduction:

You are a researcher with NASA Langley Research Center, one of the instruments you work with is MISR. Your Project Manager has asked you to provide a summary on seasonal patterns of atmospheric aerosols so that you might be able to predict the best time of year to host a stargazing party. The Project Manager has told you that you will present the summary of your findings to your Research Team at the next scheduled meeting. You will need to identify aerosol and atmospheric related factors that affect stargazing so that you might be able to predict a time period that would be best for viewing stars.

As you begin to think about what information and data you will need to analyze, write down questions you think your Research Team may ask you to better prepare yourself.

You should be prepared to answer these questions when you present to your Team.

a. What is Aerosol Optical Thickness (AOT)?

b. What would a high value of AOT be? In other words, if the data indicated the value over a given region was .35, how would you explain what this means?

c. How many years of data are currently available from VIIRS? Is this enough to come to a conclusion? Why or why not?

d. How is sky visibility affected by aerosols?

Let's first explore certain features in the MY NASA DATA Live Access Server (LAS) that will help you better answer your questions. Below are techniques that will help you identify what parameters in the LAS you should be using and how to access particular plot types. However, you can certainly use other parameters and plot types to explain your answers to your team members.

1. Go to the Live Access Server. Link can be found in the Lesson Links above

2. Select the data set by clicking on Choose Dataset. Then click on Atmosphere, All Data, Aerosols and finally, Monthly Aerosol Optical Depth.

3. This dataset provides monthly data that has been averaged over several years. To get a better understanding of the patterns of aerosols that appear each year, create an animation of the aerosol optical depth maps.

4. Click the Animate button at the top of the map. Select the OK button without making any changes in the pop-up window that appears.

5. Now use the default time range that appears in the new window, and click Submit to create your new animation. Notice the patterns that appear often in the animation.

If you need to slow the animation down, reduce the speed at the bottom of the animation panel.

Note- You can compare plots using various methods. You could print various plots, save images and paste into one file for easy viewing, or use the Live Access Servers Compare feature located at the top of the tool bar. The compare feature allows the user to compare up to four plots at once.

Questions:

To help you prepare your summary of findings, answer the following questions:

1. Where in the world did you find the highest and lowest values (the extremes)? You may want to focus on regions of the world (such as Eastern U.S., Northwest Africa, and Southeast Asia) and track how aerosol concentrations change in each region throughout the year or data range.

2. Using the chart in appendix A above in the background section of the lesson, what is the percent transmission in the areas with the highest and lowest aerosol values?

3. How do high or low AOT values impact people on Earth in these regions you have identified?

4. Which areas see the greatest differences from season to season?

5. Are there any noticeable differences in any of the seasonal patterns in the data you selected? Why or why not?

6. Are these patterns different on different continents? Why or why not?

7. Do these patterns appear to remain consistent over different years? Why or why not?

Extensions:

1.How well do your results compare to these articles and visualizations?

a.Please refer to the lesson link on NASA Earth Observatory Global maps

b.Please refer to the lesson link on NASA Earth Observatory on Aerosols

2.Research why certain regions experience higher aerosol concentrations in different times of the year. What is the source of these aerosols?

Lesson plan contributed by Tina Harte, MY NASA DATA Team

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