Seasonal Patterns of Aerosols

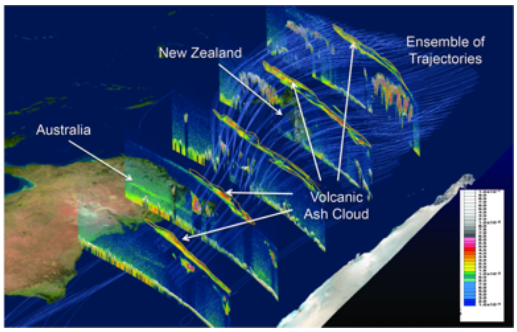

Image courtesy NASA- CALIPSO

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 CALIPSO 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
- CALIPSO 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, often times you 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 Cloud-Aerosol LiDAR and Infrared Pathfinder Satellite Observation (CALIPSO) satellite, launched on April 28, 2006, provides insight into the role that clouds and atmospheric aerosols play in regulating Earths weather , climate, and air quality. CALIPSO combines an active Light Detection and Ranging (LiDAR) instrument with passive infrared and visible imagers to probe the vertical structure and properties of thin clouds and aerosols over the globe.

+ 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 transmis sion 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 satellites you work with is CALIPSO. 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 CALIPSO? 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, Aerosols and finally, Monthly Average Aerosol Optical Depth (CALIPSO)
3. This dataset provides monthly data that has been averaged over several years. To get a better understanding of average patterns of aerosols, select Monthly Aerosol Optical Depth
4. Select Monthly Average Cloud Free Aerosol Optical Depth. This will provide AOD values for all aerosols measured by CALIPSO's instruments, including dust, smoke, etc. Cloud free means it only collected data when there were no clouds present between Earth's surface and the satellite.
5. Notice you can select data for each of the 12 months. Select various months and compare the color plots to better understand seasonal patterns of aerosols.

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.Select another data parameter such as Cloud Free or Dust and compare results.
3.Research why certain regions experience higher aerosol concentrations in different times of the year. What is the source of these aerosols?
4.Research how CALIPSO uses LiDAR technology to tell scientists about what's in the atmosphere. How can this technology impact our understanding of Earth? Watch these videos to learn more about LiDAR and to help answer the question:
a.Intro to LiDAR 3D found in the lesson links above
b.Launchpad: Light Detection and Ranging found in the lesson links above

Lesson plan contributed by Tina Harte, MY NASA DATA Team

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