



Analyzing Sun Photometer data to discover trends and to create educational activities for students



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Summary

This summer I participated in the Science Teachers and Researchers (STAR) Internship program where I was given the opportunity to work with NASA scientists at the Goddard Space Flight Center (GSFC) to observe the scientific process and to gain first hand research experience in order to help bridge the gap between classroom teachers and scientists.

Using data collected from sun photometers, I was able to generate a hypothesis and then analyze the data in order to draw a conclusion. Based on the data collected in various locations, I was able to find out that elevation might have an effect on the aerosol optical depth (AOD) in some places.

As part of the STAR program, I needed to find ways to connect the research done by scientists to classroom research and to devise a unit that would incorporate the research I've seen this summer.

In addition to analyzing data and creating a high school biology unit, I also shared my experience with the Global Learning and Observations to Benefit the Environment (GLOBE) program through a blog and, along with another STAR intern, created a web-quest activity to connect the climate-based protocols with climate change.

Background

The sun photometer data was collected and organized by the Aerosol Robotic Network (AERONET) program at NASA GSFC. These sun photometers measure AOD by looking at the sun using 8 different filters that take measurements at various wavelengths. The larger the AOD at a particular wavelength means that less of that wavelength is being transmitted to the Earth's surface. An optical depth 1 or greater indicates a hazy sky condition while an optical depth of less than 0.1 indicates clear skies.

This summer I decided to research whether elevation had any effect on the AOD value. I chose locations across the United States and others around the globe. In order to limit the amount of variables involved, I compared the AOD at locations along the East Coast, Midwest, and West Coast of the US. These locations also had a range of elevations:



FIGURE 1.

EAST COAST		MIDWEST		WEST COAST	
Location	Elevation	Location	Elevation	Location	Elevation
Wallops Island, VA	10 meters	Bondville, IL	212 meters	Fresno, CA	0 meters
GSFC, MD	87 meters	Konza, KS	341 meters	La Jolla, CA	115 meters
Egbert, Canada	264 meters	Maricopa, AZ	360 meters	Rimrock, ID	824 meters
Walker Branch, TN	365 meters	Sevilleta, NM	1477 meters	Railroad Valley Playa, NV	1435 meters

Results

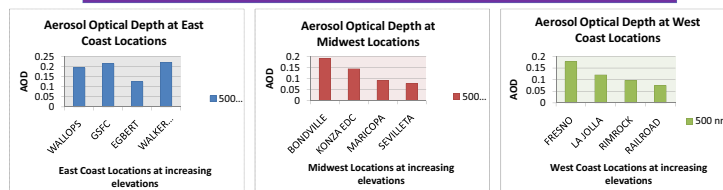


Figure 1.

Figure 2.

Figure 3.

As seen in Figures 2 and 3, as the elevation increases, the AOD value decreases but in Figure 1, the AOD values do not seem to be affected by elevation. Because the East Coast has a typically lower elevation level than the West Coast, other locations along the West Coast that had elevation levels more similar to the East Coast were analyzed. They can be seen below in Figure 4.

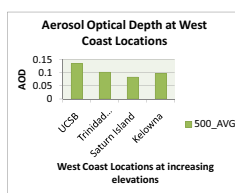


Figure 4.

West Coast	
Locations	Elevation
UCSB, CA	33 meters
Trinidad Head, CA	105 meters
Saturn Island, Canada	200 meters
Kelowna, Canada	344 meters

Figure 5.

The back trajectory of some locations were also seen to discover a reason for the lack of trend in the East Coast locations.

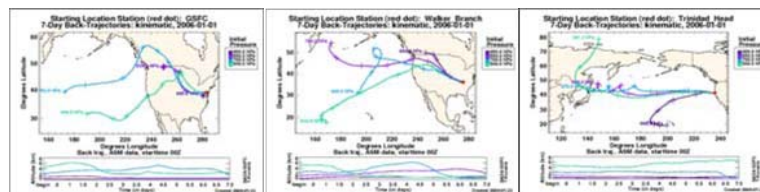


Figure 6.

Figure 7.

Figure 8.

Further Investigation

The next step in this investigation would be to see if there are any other relationships between AOD and elevation around the globe. Also based on the back trajectory information, there might be a relationship between the AOD levels and where the aerosols are originating from such as those that travel primarily over water vs. those that travel over land.

Relation to Education

Because the sun photometers are measuring the amount of radiation from the sun, I decided to write a unit on photosynthesis where I would discuss the importance of light to the Earth system. This unit would follow the 5E method and would also incorporate an open inquiry activity for the students to complete.

Lesson 1: What is light?

The students will be introduced to the concept of light and how it is broken down into multiple wavelengths. They will explore the colors of light by breaking it down using a prism and glasses of water.

Lesson 2: What is chlorophyll?

The students will learn about the structures that are involved in photosynthesis such as chloroplasts, chlorophyll, and thylakoids. They will also learn about the difference between absorption and reflection and will be able to explain why we see certain colors.

Lesson 3: "Photosynthesis, Let's Get Into This."

The students will learn about the stages of photosynthesis by listening to a "photosynthesis rap" and then analyzing the lyrics that explain the process of photosynthesis. They will also go through the motions of photosynthesis by participating in a role play activity.

Lesson 4: Journey to Help Washington

The students will complete an open inquiry lab activity to test how various factors may influence the rate of photosynthesis. Some factors they will be testing include light intensity, wavelength, and carbon dioxide levels.

Lesson 5: Importance of Photosynthesis

After learning about the method of photosynthesis, the students will research the importance of photosynthesis in scientific research. They will be using sources such as NOAA and NASA to discover how scientists use photosynthesis in their research.

Webquest Activity

Along with another STAR fellow, I also created a webquest activity that would require students to research climate change. This activity was created as a wrap up activity for the GLOBE program. We designed this activity for middle to high school students and used primarily NASA data as sources for the students.