

Homework  
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Due Tuesday, November 17, 2009

**Problem 1 (LIDAR)**

Go to the following web address:

```
http://www-  
calipso.larc.nasa.gov/products/lidar/browse_images/show_det  
ail.php?s=production&v=V3-00&browse_date=2009-04-  
15&orbit_time=17-38-07&page=1&granule_name=CAL_LID_L1-  
ValStage1-V3-00.2009-04-15T17-38-07Z.N.hdf
```

If you don't want to type all of this in, this assignment will be posted on my webpage. You can copy the web address from there.

Explain some of this data by answering the following question:

This data shows a lot of aerosols in different locations. Determine the source of these aerosols and explain how you know what the source is.

## Problem 2 (Sun Photometers)

**a.** In figure 1, you are given a Langley plot for the Mauna Loa observatory on August 7, 1999, which corresponds to Julian Day 219. (Julian Day tells you which day of the year you are in. For example, January 1 is Julian Day 1, and December 31 is Julian Day 365.)

Using the Beer-Lambert-Bouguer law

$$I = I_0 e^{-m\tau}$$

determine the optical depth  $\tau$  and solar irradiance  $I_0$  for each of the three wavelengths pictured.

**b.** These values of  $I_0$  you calculated will need to be corrected for the distance between the sun and the Earth, which is a function of the Julian Day. Calculate  $I_0$  at the top of the atmosphere (TOA) by using the formula

$$I_0^{TOA} = I_0^{m=0} \cdot r^2$$

where

$$r = 1 - \epsilon \cos[a(J - 4)]$$

$\epsilon$  is the eccentricity of the Earth's orbit and is equal to 0.01673.  $a$  is a constant equal to the frequency of the Earth's orbit, i.e.  $a = \frac{2\pi}{365.3} = 0.017201$ .  $J$  is the Julian Day on which these measurements were taken. (Remember to set your calculator to radians when you are calculating trigonometric functions!)

**c.** Figure 2 shows some of the different solar irradiance curves (different values of  $I_0^{TOA}$ ) that are commonly used in the literature. At 415 nm,  $I_0^{TOA}$  varies between 1.75 and 1.8  $\text{W m}^{-2}$ . At 500 nm,  $I_0^{TOA}$  varies between 1.85 and 2.1  $\text{W m}^{-2}$ . At 862 nm,  $I_0^{TOA}$  varies between 1 and 1.1  $\text{W m}^{-2}$ .

Use the Beer-Lambert-Bouguer law to answer the following question. Take these values as your values for  $I_0$ . Use values of  $I$  and  $m$  from the Langley plot I have provided. Now calculate  $\tau$  for each of the three wavelengths.

**d.** Discuss any differences you find between the values calculated in part c and the values obtained in part a. How would these differences affect your interpretation of a given situation you are trying to measure?

Figure 1

