METR 5223: Atmospheric Radiation

Direct and Indirect Solar Radiation

1:

Lecture for Spring 2009

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2:

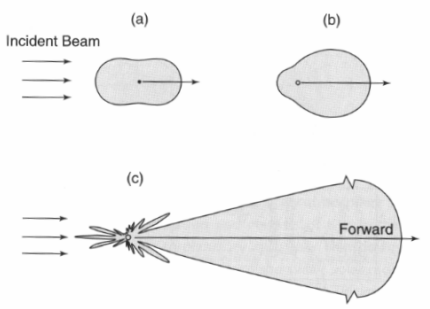
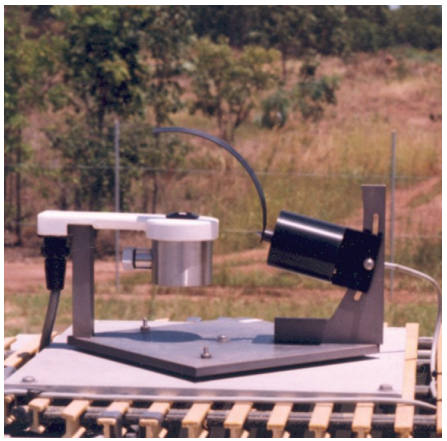


Fig. 4.12 Schematic showing the angular distribution of the radiation at visible (0.5 μm) wavelength scattered by spherical particles with radii of (a) 10^{-4} μm, (b) 0.1 μm, and (c) 1 μm. The forward scattering for the 1-μm aerosol is extremely large and is scaled for presentation purposes. [Adapted from K. N. Liou, *An Introduction to Atmospheric Radiation*, Academic Press, p. 7, Copyright (2002), with permission from Elsevier.]

3:

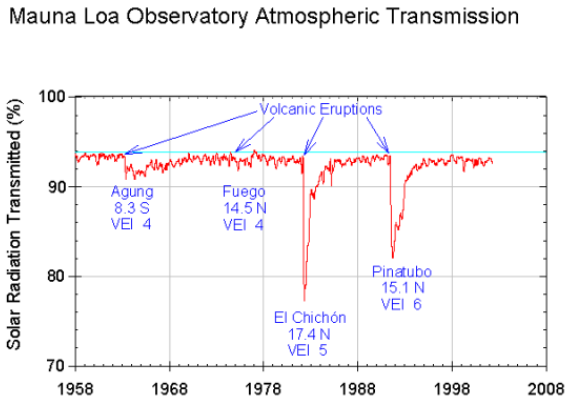


Multi-Filter Rotating Shadowband Radiometer (MFRSR)

4:

The MFRSR is an instrument that directly measures global and diffuse components of spectral solar irradiance. The direct normal component is calculated from the difference of the global and diffuse measurements. At the start of a measurement series, a global measurement is first taken. The shadowband is then rotated from the home position and stops in three positions before returning home. The first and third stops are just before and after shading the diffuser. At the second stop the diffuser is completely shaded. Measurements at the first and third stops are used to correct the error introduced by the shadowband shading a portion of the sky.

5:



Is this showing *direct*, *diffuse* or *global* radiation?

6:

Direct solar radiation should obey *Beer's Law*:

$$L_\nu(\chi_\nu) = L_\nu(0)e^{-\chi_\nu}$$

For the sun directly overhead, the surface value of L_ν is:

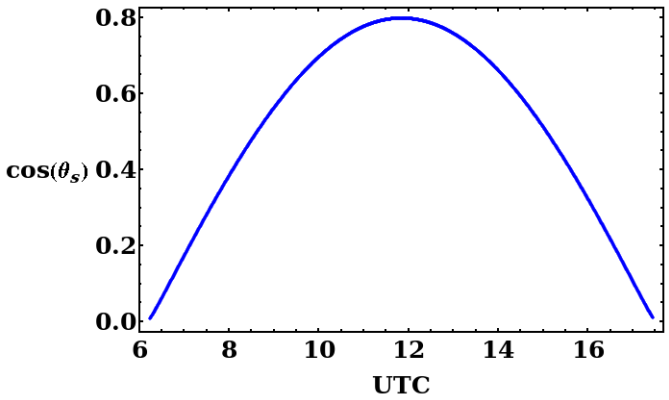
$$L_{\nu,s} = L_\nu(0)e^{-\chi_{\nu,s}}$$

For the sun NOT directly overhead

$$L_{\nu,s} = L_\nu(0)e^{-m\chi_{\nu,s}}$$

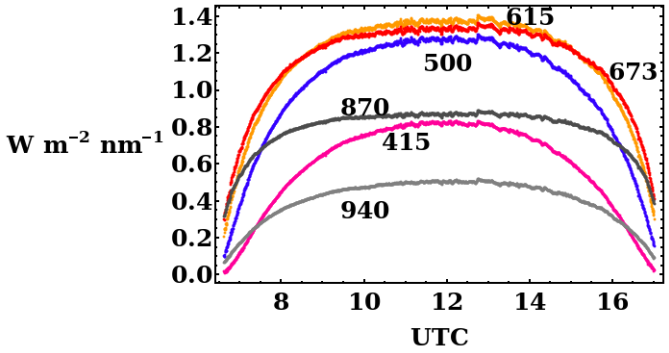
$$m = \frac{1}{\cos(\theta_s)} = \sec(\theta_s)$$

7:



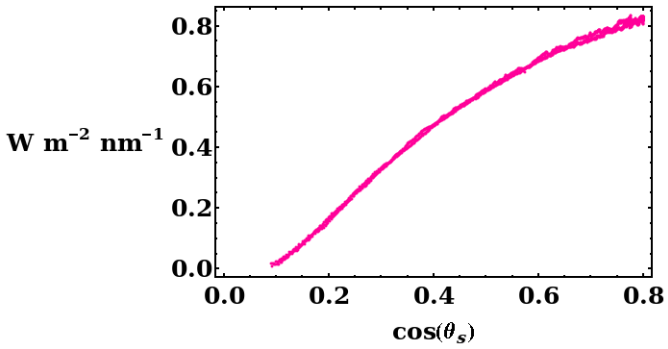
$\cos(\theta_s)$ as a function of UTC at Niamey, Niger. December 24, 2006.

8:



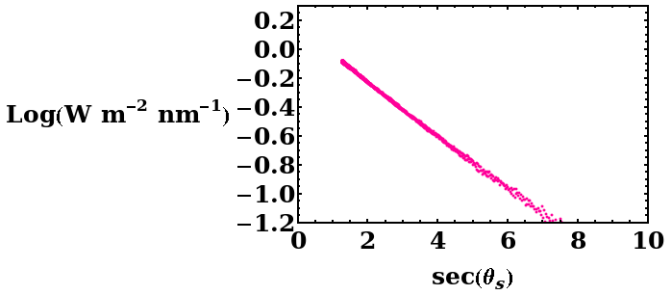
Direct $L_{\nu,s}$ as a function of UTC at Niamey, Niger. December 24, 2006.

9:



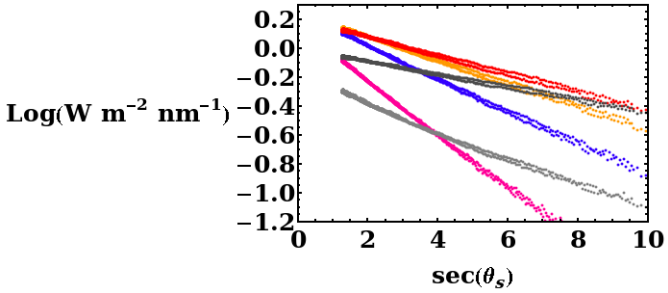
This is NOT a Langley plot.

10:



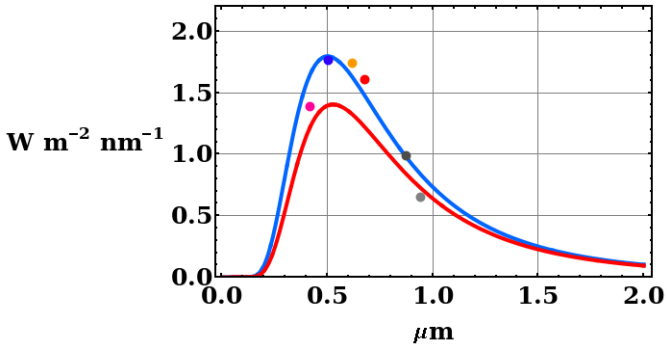
This is a Langley plot.

11:



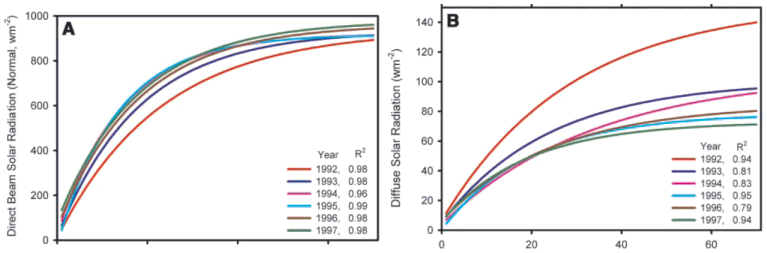
This is a Langley plot.

12:



$L_\nu(0)$ deduced from Langley plots. Compared with Planck function for 5777 K and 5500 K.

Direct Beam Solar Radiation Diffuse Solar Radiation



Regression between the cloudless solar radiation and the solar elevation angle for the 6 years (1992 to 1997) after the Mount Pinatubo eruption. At Albany NY.