

MSC 409 Spring 2006 HW #4
DUE APRIL 20 (Thursday)

1. Consider solar radiation with a zenith angle of 0° that is incident on a layer of aerosols with a single scattering albedo ω_0 of 0.85, an asymmetry factor $g=0.7$, and an optical thickness $\tau = 0.1$, averaged over the shortwave part of the spectrum. Assume a surface albedo of 0.15. Show the formulae you apply as well as numerical answer. This question is based on WH 4.42

- a. What fraction of the solar radiation is directly transmitted through to the surface ?
- b. What fraction of the direct solar beam reflected back to space by the aerosol layer ?
- c. What fraction of the direct solar beam is absorbed by the aerosol ?
- d. What fraction of the direct solar beam is reflected upward by the surface ?
- e. Of the answer to d. how much ends up getting reflected back to space ?
- f. Diagram the multiple scattering that occurs between the surface and aerosol layer and the portion that contributes to the total reflection back to space.
- g. If instead the solar zenith angle were 60° how would your answers to a.-f. change ?

2. Consider a marine cloud with droplets of radius 15 micron at a concentration of 10/cc. Assume an extinction efficiency of 2.

- a. What extinction does this correspond to ?
- b. What is the optical depth if the cloud thickness is 200 m ?
- c. How would your answers to a. and b. change if this were a (monodisperse) continental cloud with droplets of radius 5 micron at a concentration of 200/cc ?
- d. For the marine cloud, what are representative values of the single-scattering albedo ω_0 and asymmetry parameter g ?
- e. Given an ocean albedo of 0.06, what fraction of incoming radiation is ultimately reflected back to space and transmitted through to the surface ? Assume a solar zenith angle of 60° .
- f. What fraction of the downwelling solar radiation at the surface is from the direct solar beam, and what fraction is the diffuse contribution ?

Explain:

3. Clouds behave as blackbodies in the infrared, but are relatively transparent at microwave wavelengths.
4. The presence of cloud cover favors lower daytime surface temperatures and higher nighttime surface temperatures.
5. Temperature inversions tend to form at night immediately above cloud top.
6. Convection cells are often observed within cloud layers.