AT622 Practice Problems

Bring to my office sometime between Monday & Thursday and I evaluate your answers with you on the spot.

1. Derive equations for the upwelling radiance at the surface and downwelling radiance at the top-of-atmosphere for a two-layer atmosphere with zenith optical depths tau1 and tau2, and temperatures T1 and T2. Assume a general zenith angle of propagation theta. Let the surface temperature be Ts and assume a surface emissivity of unity. This may be adequate for ozone emission in the troposphere and stratosphere. Assume that the optical depths are 0.1 (lower) and 0.5 (upper), and temperatures of 260 K (lower) and 220 K (upper). Assume the surface temperature is 300 K. Plot the upwelling radiance as a function of view zenith angle theta.

2. Petty 8.8

3. Petty 8.10

4. Explain what a "weighting function" is. Explain why weighting functions for upwelling light at TOA vs. downwelling light at the surface at the same wavelength of light can sometimes have very different shapes, though sometimes they can have nearly identical shapes. What leads to this effect? It will be useful to think about the terms in the equation for the weighting function.

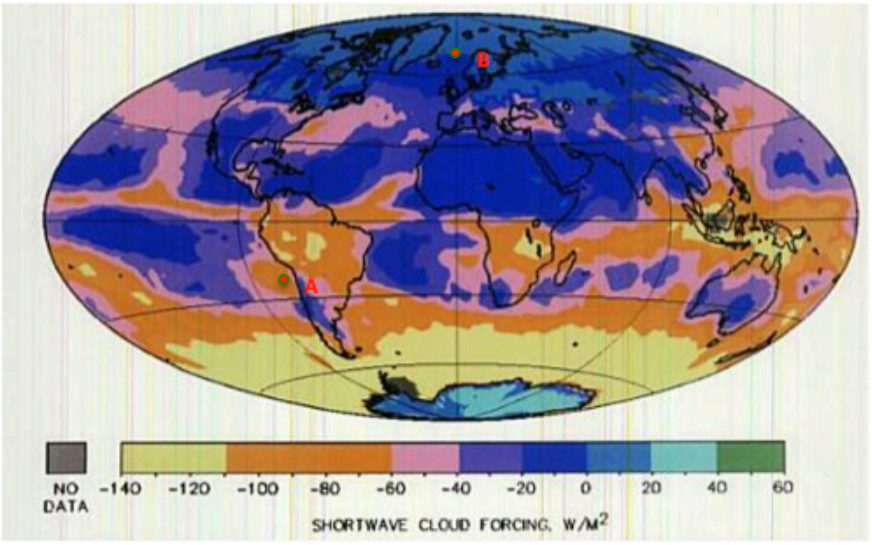
5. Using assumptions similar to those we made in class, derive the equations for the longwave Cloud Radiative Forcing of the surface+atmosphere (i.e., at TOA), and of the surface only (i.e., at the surface) for a cloud very close to the surface. (These equations are in the online materials –you should be able to match them). For the low cloud example given in the notes, compare the total CRF (at surface an TOA) for a very dark surface such as the ocean, vs. the case of a surface albedo of 0.5 (like a desert).

6. Petty 9.3

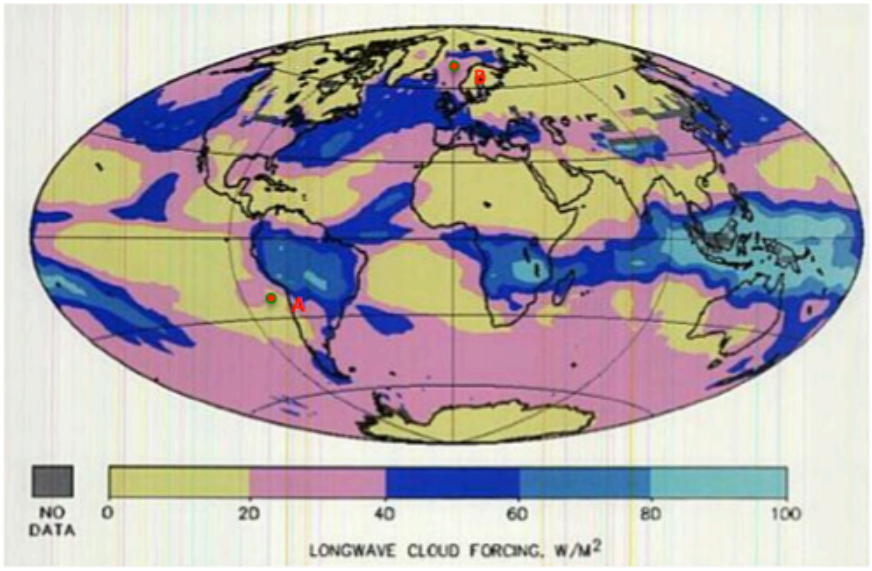
7. Sketch the three vibration modes of the CO_2 molecule. Which is expected to be least radiatively active and why?

8. The next page shows plots of *average* shortwave, longwave, and net cloud radiative forcing taken from as measured by the ERBE satellite in January of 1986 (i.e., averaged over the entire month). For the points marked "A" and "B", describe the cloud types that might be responsible for these forcings. Use the shortwave & longwave forcings to make your arguments.

SW Forcing



LW Forcing



Net Forcing