AT622 Practice Problems
Turn in by Monday April 6- I will correct & return by Wed April 8.

1. Derive equations for the upwelling brightness temperature T_B at the top-of-atmosphere for a two-layer atmosphere with zenith optical depths τ_1 and τ_2, and temperatures T_1 and T_w. Assume a general zenith angle of propagation θ. Let the surface temperature be T_s 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. You may assume a wavelength in the Rayleigh-Jeans regime for simplicity. Plot the upwelling brightness temperature as a function of view zenith angle θ. Explain the behavior you see, based on your equation.

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 and 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