ATMO 551a Homework 2 Due 9/12/08

As I mentioned in class, recommended educational viewing:
http://www.thedailyshow.com. Click on **full episodes**. Then click on the Sept 3, 2008 episode.

1. Pluto's orbit is far more eccentric than those of the major planets' orbits:
   Aphelion: 7,375,927,931 km
   Perihelion: 4,436,824,613 km
   a. Determine the solar flux (watts/m^2) at each of these distances.
   b. Assume the albedo is 0.7 in both cases. Determine the radiative equilibrium temperature at both distances.

2. In the first figure in the 9/5/08 notes, the IR radiative flux from Earth's atmosphere into the surface is 324 watts/m^2.
   a. Based on the Stephan-Boltzmann law, what is the temperature of the atmospheric level that is radiating into the surface?
   b. Assuming the Earth's surface temperature is 288 K and the atmospheric temperature decreases vertically at a rate of 6.5 K/km, at what atmospheric altitude is the IR radiation into the surface coming from ?

3. The outgoing IR radiation to space of 235 watts/m^2 is composed of 3 terms: 165 watts/m^2 from the atmospheric gas, 30 watts/m^2 from the atmospheric clouds and 40 watts/m^2 from the surface.
   a. Take the atmospheric portion: 165 + 30 = 195 watts/m^2. Based on the Stephan-Boltzmann law, what is the temperature that is radiated from?
   b. Assuming the same atmospheric temperature structure as in the previous problem, what altitude in the atmosphere is this being radiated from?
   c. Assume that increasing CO_2 in the atmosphere causes the atmospheric portion of the IR watts/m^2 to decrease by 4 watts/m^2, how much cooler is the new radiating temperature?
   d. How much higher is the new radiating altitude than the original?

4. Assuming the vertical temperature gradient remains at 6.5 K/km, how much must the surface temperature increase to bring the Earth back into equilibrium?

SHOW ALL WORK!!