ESS11: CLIMATE CHANGE AND POLICY

Homework # 2

(due Tuesday - 3 February)

1. The effective "color" of the blackbody radiation curve is described by the wavelength of peak light intensity:

$$\textit{peak-wavelength}\ (\text{microns} = \text{micro-meters} = 10^{-6}\text{m}) = \frac{2897}{T(^{\circ}K)}$$

(a) If the sun has a surface temperature of 6000°K, what is its peak wavelength?
(b) If the Earth has an emission temperature of 273°K (freezing point of water), what is the peak wavelength of this terrestrial infrared radiation?
(c) A toaster element heats up to "red hot", assuming its peak wavelength is 0.9 microns, what is its temperature?

2. A simple climate model for a planet is the energy balance model:

$$T_e^4 = C \times \frac{(1 - albedo)}{D^2}.$$

where T_e= the effective temperature of the planet (for Earth = 255 K),
albedo = the fraction of sunlight reflected (for Earth = 0.30),
D = distance from planet to the sun (for Earth = 1 astron. unit),
and *C* is a constant.
Calculate the change in effective temperature of the Earth as it goes from perihelion (D=0.983 a.u.) in January to aphelion (D=1.017) in July. (Hint - you can either calculate the constant above using the Earth values in the first part of the problem or you can take the ratio of two equations.) (N.B. In solving for T^4, you can take two successive square roots with your calculator, example, $T^4 = 81 \rightarrow T^2 = 9 \rightarrow T = 3$)

3. Describe in 2-3 sentences how greenhouse gases warm the surface of the Earth.

4. In a weightless (i.e., no gravity) space ship, is there a pressure of the gas in the balloon? Why?

5. How does the air temperature change in the first 10 km of the atmosphere? How many degrees (°C) does it change by going up every 1 km?