Meteo 466-- Homework #3

Due: Fri.., Feb. 3

1. Earth, Venus, and Mars have planetary albedos of 0.3, 0.8, and 0.22, respectively. Venus orbits at 0.72 AU and Mars at 1.52 AU. Calculate the solar flux incident on Venus and Mars, using the inverse square law to scale from Earth's flux. Now, calculate the effective radiating temperatures, T_e, for all three planets. Do you see anything surprising about these values? Given that their respective surface temperatures are 288 K (Earth), 730 K (Venus), and 218 K (Mars), calculate the magnitude of the greenhouse effect on each planet. How can one explain the differences between planets?

   Data: Stefan-Boltzmann constant: $\sigma = 5.67 \times 10^{-8}$ W/m^2/K^4
   Solar constant for Earth: $S_0 = 1370$ W/m^2

2. Mars' atmosphere has a surface pressure of roughly 6 mbar, and it is composed of 95% CO_2, by volume. By comparison, Earth's atmosphere has a surface pressure of 1.013 bar and a CO_2 mixing ratio of 380 ppmv. Which planet has a greater column abundance of CO_2, and by how much? Remember from Homework 1 how to calculate column abundances.

   Data: Mars' surface gravity $g_M = 3.73$ m/s^2
   Earths' surface gravity $g_E = 9.81$ m/s^2

3. Solar luminosity is estimated to have been about 30% lower at the time when Earth formed, around 4.6 b.y. ago. If Earth's albedo and atmospheric greenhouse effect were the same as today, what would its surface temperature have been? Do you think it was actually this cold?