Phys 24
Homework 5
Due at or before the beginning of class, Thursday Oct. 29

Hand in your own *individual* answers to each of the questions below. In addition, be sure that your *group* hands in an electronic document with your answers (and supporting plots) for the questions in the El Niño exercise we worked on in class on Thursday Oct. 22. Only one document per group needs to be handed in for those.

Solutions to homework problems should always clearly show how you arrived at your answer (your calculations and an explanation of your reasoning), not just state the answer itself. If you use information from sources other than class notes, be sure to cite where the information comes from.

1. During the 11-year solar activity cycle, the solar constant goes from about 1360 W/m^2 at solar minimum to 1361 W/m^2 at solar maximum.

    a. How much extra radiative forcing is there at the peak of the cycle compared to the minimum? (Careful – it's not 1 W/m^2!)

    b. If the Sun stayed at that maximum, how much would the equilibrium temperature of the Earth rise?

    c. Why don't we observe the temperature of the Earth to go up and down in response to the Sun's activity cycle?

2. A doubling of carbon dioxide in the atmosphere corresponds to a radiative forcing of about 4 W/m^2. To what value would the albedo of the Earth need to change (from its current average value of 0.3) to completely offset the warming effects of doubling CO_2 ?

3. We discussed in class how the slow evolution of the Earth's orbit (in particular the eccentricity of the orbit, and the direction the axis is tilted) leads to changes over time in Earth's climate. Draw a diagram showing the Sun, the Earth, and the Earth's orbit. Remembering that somewhat cooler summers (relatively speaking) in the northern hemisphere are a key factor in eventually leading into an ice age, construct the diagram so that it corresponds to the point in this long orbital evolution cycle that yields this outcome. Show and label the Earth in both its (northern hemisphere) winter and summer positions in the orbit, and explain in words why the drawing you made leads to the desired result of cooler northern summers. (If you want, you could make a second diagram showing a contrasting configuration to help explain this. If you do, be sure to label each one clearly.)