PROBLEMS – PHYSICS OF CLIMATE

Due: 15 September 2008
There are 2 problems. You are welcome (in fact encouraged) to consult with each other (as well as me) if you have difficulty working on these, but you must each hand in your own answer set. Please turn in your work via email to gutowski@iastate.edu. To help me spot it in my Inbox, please have the subject line read:
Subject: Physics of Climate, Problem Set 1

1. Following on our class discussion, let's use our understanding of radiative balance to estimate the temperatures of various planets and dwarf planets. For this calculation, it is important to note that the intensity of radiation from the sun decreases with the *square* of distance from the sun. At the orbit of the earth (1 Astronomical Unit from the sun), assume the solar energy flux = 1360 W-m^{-2}. For the earth's albedo, radiative balance led to an average outgoing flux of 238 W-m^{-2} and a radiative temperature of 255 K.

Fill in the average outgoing flux and radiative temperatures for these objects orbiting the sun:

Planet	**Distance from sun [A.U.]**	**Albedo**	**Outgoing radiation [W-m^{-2}]**	**Radiative temperature [K]**
Earth	1.00	0.30	238	255
Jupiter	5.20	0.51		
Saturn	9.54	0.50		
Uranus	19.18	0.66		
Neptune	30.06	0.62		

Dwarf Planet	**Average dist. from sun [A.U.]**	**Albedo**	**Outgoing radiation [W-m^{-2}]**	**Radiative temperature [K]**
Pluto	39	0.5		
Quaoar	42	assume 0		
Sedna	90	0.2		

2. Jupiter actually emits somewhat more than it absorbs, so it is not in pure radiative balance. What might be the source of this additional energy for emission?