Name:

Student ID:

ATOC 1060: Our changing environment

Homework assignment 2

The greenhouse effect

Due: 1:45 pm (end of class), Thursday 24 September 2009

We know that the amount of energy reaching Earth from the sun is related both to the temperature of the sun, and the distance between Earth and the Sun. We also know that the amount of energy leaving earth is related to Earth's temperature. As such, if these energy fluxes are balanced we can find the radiative equilibrium temperature.

1a) Making use of the inverse square law, compute the solar constant for each planet. (Fill in the table) *Hint, all calculations can be relative to Earth.*

1b) Compute the radiative equilibrium temperature for each planet. (Fill in table) (*Hint, you can check your calculation be recalculating the values in the table for Earth*)

1c) Using your calculated temperature and the observed surface temperature calculate the strength of the greenhouse effect as the temperature difference. (Fill in table)

Planet	***Observed surface temperature (K)***	***Distance from sun (10^9 m)***	***Albedo***	***a) Solar constant (W/m^2)***	***b) Equilibrium temperature (K)***	***c) Temperature difference (K)***	***Surface pressure (hPa)***
Mercury	440	58	0.11				~ 0
Venus	737	108	0.65				9300
Earth	288	149	0.31	1361	254	34	1000
Mars	208	249	0.15				6
Jupiter	163	779	0.52				n/a
Saturn	133	1434	0.47				n/a
Uranus	78	2873	0.51				n/a
Neptune	73	4495	0.41				n/a
Pluto	48	5870	0.60				0.0003

(Note Pluto is no longer considered a planet!)

Stefan-Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ $W/m^2/K^4$

Hint: Reread page 38, 41, 42 and 43 of the textbook. Also, the "fourth root" is just the square root of the square root. i.e. $T = \sqrt{\sqrt{T^4}}$

2) Which planet has the strongest greenhouse effect? _____

3) Which planet has the weakest greenhouse effect? _____

4) What does the surface pressure tell you about the atmosphere?

5) By looking at the surface pressure of terrestrial planets and Pluto, can you conclude the strength of the greenhouse effect is related to surface pressure? Why?
(*Note, gas giants do not have a surface, so surface pressure is not meaningful*)

6) Explain what will happen to the surface temperature if the chemical composition of a planet's atmosphere changes (say, adding CO_2 to the earth's atmosphere).

7) If the chemical composition of a planet's atmosphere changes (as in 7), explain how would the radiative equilibrium temperature will change. (*Hint: this is a trick question*)

End