Physics 595CL – Homework 1

1) For Earth climate "Model 2", derive the following:

$$F_a - (1 - \mathcal{T}_{sw})F_0 = F_g - F_0 = (1 - \mathcal{T}_{lw})F_g - F_a$$

Explain how each of the three terms above may be taken as a measure of the green house effect, and find the common numerical value, based on the assumptions of Model 2 (see page 7 of the textbook).

2) Compare the ground temperatures for "Model 2" and "Model 3" of the Earth climate system. Which is larger? Compare the temperature T_a of the atmosphere for Model 2 with T_{trop} of Model 3 for the temperature of the Troposphere. Which is larger? Give a physical explanation for your answers.

3) The albedo for Venus is 0.77 and and its average surface temperature is $735K$. Venus has an average distance from the Sun of 0.72 AU (the distance from the Sun to the Earth is 1 AU). Assume that the Sun is a point source which radiates power isotropically.

a) Use "Model 1" without an atmosphere to find the "effective" emitting temperaurure of Venus.

b) Now consider a a model with N layers of atmoshere. Each layer is completely transparent to shortwave (solar) radiation and completely absorbing of longwave IR radiation as in the figure. Show that the ground (surface) temperature T_g is given by

$$T_g = (N + 1)^{1/4}T_e$$

where T_e is the effective temperature.

c) Find the number of layers needed in the model to get the observed surface temperature of Venus.

4) Andrews 2.2

5) Andrews 2.3