Homework 2

Due: March 9

Problem 1 (10 Points)

Instruction: to compute Planck function go to

http://irina.eas.gatech.edu/EAS8803_Spring2016/PlanckFunction.htm

Derive the asymptotic limit of the Blank function for small wavelengths and estimate its accuracy at several different temperatures.

Problem 2 (30 points**)**

The HITRAN database contains information on all gaseous species that are of importance to radiative transfer in the atmosphere. Between 691 cm^{-1} and 693 cm^{-1}, CO2 has two lines with the following parameters from HITRAN:

Line center, ν_0 (cm^{-1})	Line strength, S (cm/molecule)	Air-broadened half-width, α_0 (cm^{-1})	Temperature coefficient , n
691.972498	9.167E-20	0.0684	0.78
692.129032	4.010E-21	0.0686	0.78

a) Calculate and plot the absorption coefficient k_ν for these CO2 lines. Consider the Lorentz line shape. What is the relative contribution of each line to the monochromatic absorption coefficient at 692.0 cm^{-1}?

b) Consider a 1 km thick atmospheric layer at standard pressure and temperature. Calculate and plot the CO2 monochromatic optical depth and CO2 transmission function for this layer between 691.0 cm^{-1} and 693.0 cm^{-1}.

c) Perform the above calculations but for a 1 km thick later with P = 0.5 bar. Assume that the CO2 amount remains the same. Explain the differences in transmission functions calculated for (b) and (c) cases.

Problem 3 (20 points**)**

The spectral transmission in the 708 to 724 cm^{-1} range from space to 18 km is 0.765, while from 5 to 4 km it is only 0.425, even though these two paths contain the same absorber amount of CO2. Explain this difference in spectral transmission in terms of the behavior of molecular absorption lines.

Problem 4 (40 points**)**

Calculate the upwelling radiance at $\mu = 0.6$ for the spectral band 980-1100cm^{-1} in a subarctic winter atmosphere. This spectral region is band 12 in the Fu&Liou k-distribution model (see Table in Lecture 9), which is the 9.6 μm ozone band.

Treat ozone layer as an isothermal layer with a temperature of 217 K. The ozone absorber amount is 0.01 kg/m^2. Assume that surface emits as a blackbody at a temperature of 257 K. Water vapor absorption can be ignored.

The k-distribution parameters from Fu&Liou model are

j	Δg_j	k_j m^2/kg
1	0.45	4.2
2	0.30	41.6
3	0.20	238
4	0.04	1299
5	0.01	4073