12.815 Remote Sensing Exercise

Part 1:

A NOAA satellite radiometer is being used to observe the latitudes around 15°S in April. Radiances are measured at two infrared frequencies (695 and 709 cm^{-1}) at which CO_2 is the principal absorber. From theoretical considerations it is deduced that the weighting function for the 695 cm^{-1} channel has a peak at about the 150 mb pressure level whereas the 709 cm^{-1} channel weighting function peaks around 400 mb. The following four spatially and temporally coincident satellite radiances and radiosonde temperatures are available for April 15, all in totally cloud-free regions.

	Frequency (cm^{-1})	Radiance (erg.cm^{-2}.sec^{-1}.ster^{-1}.(cm^{-1})$^{-1}$)	Pressure (mb)	Temprature (K)
1.	695	38	150	212
	709	68	400	259
2.	695	33	150	206
	709	61	400	252
3.	695	35	150	208
	709	65	400	256
4.	695	36	150	209
	709	64	400	255

Deduce empirically the inversion matrix (C in pg. 17 of Remote Sensing notes) and use this matrix to compute the temperatures at 150 and 400 mb on April 15 over a nearby oceanic region (for which no radiosondes are available) where the observed radiances (in the same units as above) are 37 at 695 cm^{-1} and 70 at 709 cm^{-1}. Assume that a high level thin cirrus cloud with optical depth $\tau = 0.01$ was actually present over the latter oceanic region causing the observed radiances from this region to be 1% less than the ones for a clear atmosphere. Compute the temperatures which would result if the cirrus cloud were not present and hence the error due to the presence of the cloud.

Part 2:

Run the PCModWin model for a Tropical atmosphere in Radiance mode to stimulate the satellite observations above. (On Card 1 – Model Atmosphere, set "Output File Options" to "Cloud/Rain profiles and Data to FILE8". This output is placed in the MODOUT3 File.) Run it for a spectral resolution of 10 cm^{-1} covering the spectral region from 600 – 725 cm^{-1}. How do the radiance values compare with the results above? Take a look at the "Transmission To Begin" column of the MODOUT3 output. This gives the spectral transmission from each layer of the atmosphere to space. By subtracting the values of adjacent layers (higher layer minus lower layer), you can get the change in transmission at successive altitudes. Since the altitudes are separated by 1 km (from the surface to 25 km altitude), these values are directly equal to the weighting function expressed as dt/dz. At what altitude is the peak of this weighting function at 695? At 709? How do these results relate to the weighting functions in Part 1 and how would you explain any differences? Take a more detailed look at the weighting function output as a function of wavenumber and suggest a series of 6 frequencies for possible temperature sensing of the entire atmosphere.