ATOC/ASTR 5560   Lab 4   Solutions
September 21, 2001

The purpose of this lab is to make your own simple line-by-line model and compare results with LBLRTM.

You will need the following files on nit:

`/home/rt/lbl/mylbl.f`	*line-by-line model Fortran program*
`/home/rt/lbl/runmylbl`	*script for running mylbl.f*
`/home/rt/lbl/runlblrtm`	*script to run LBLRTM*
`/home/rt/atmos/mcatmmls.dat`	*midlatitude summer standard atmosphere file*
`/home/rt/lbl/plotlbl.pro`	*IDL plotting file*
`/home/rt/lbl/lbl_read.pro`	*IDL file for reading LBLRTM output*

1. *Look over the* `mylbl.f` *program to see how it works.*
   Notice the method used to calculate the absorber amount in molecules/cm^2.
   What method is used to compute the partition function?

   The mixing ratio of water vapor and ozone is interpolated between levels to get the layer average. The gas mixing ratios are converted to absorber amounts in molecules/cm^2 by multiplying by the number of dry air molecules/cm^2. The gas law is used to get the number of moles per volume, which is then multiplied by the height of the column and Avogadro's number to get the number of air molecules in a column.

   The partition function is calculated with a cubic polynomial equation in temperature. The coefficients for the polynomial are stored for each molecular species and isotope.

2. *Put in the Fortran code for line strength, line halfwidth, etc. to compute the optical depth spectrum. You only have to add code to the section after comment "*`Code the line strength and line shape stuff here`*".*
   You can compile mylbl.f with `pgf77 -O2 -o mylbl mylbl.f`*.*

   See the solution code at `/home/rt/lbl/mylblsol.f`.

3. *You will test your line-by-line model using the P branch of the 15 μm CO_2 band. Compute the optical depth spectrum from 625 to 665 cm^{-1} at 0.002 cm^{-1} resolution using the* `run-mylbl` *script. Compute the LBLRTM reference optical depth spectrum using the* `runlblrtm` *script.*
   First compute the optical depth spectrum for the 1.0 to 0.0 km layer in the midlatitude summer atmosphere. Write down the absorber amount in molecules/cm^2 for H_2O and CO_2.
   Compare the mylbl and LBLRTM spectra with the `plotlbl.pro` *IDL script.*

4. *When you think you have your line-by-line model working, plot the 0-1 km layer comparison using the optical depth ratio. The ratio won't be exactly 1, but it should be close at most wavenumbers.*
   The few large up/down spikes in the ratio spectrum are due to the "pressure induced line shift" that we are not modeling.

5. *Now compute optical depth spectra with LBLRTM and* `mylbl` *for the layer from 17 to 16 km (same MLS atmosphere and spectral region).*
Make the comparison plot between LBLRTM and `mylbl`.
Explain the differences in the optical depth spectra between the 0-1 km and 16-17 km layers. What are those extra lines that appear in the 0-1 km spectrum?

The extra lines in the 0-1 km layer are due to water vapor, which has very low abundance at 16 km.

The CO_2 lines in the 16-17 km layer are much narrower than those in the 0-1 km layer due to reduced pressure broadening (100 mb versus 1000 mb). The peak optical depths are similar however, because the higher line center mass absorption coefficient is offset by the reduced absorber amount. The absorber amount in a 1 km layer is proportional to density (which is almost proportional to pressure). For the low pressure case, between the main lines you can see weak lines due to other isotopes of CO_2.