Menzel / Revercomb / Antonelli
Lab Questions for Remote Sensing Seminar
Maratea, Italy
22-31 May 2003
Lab on high spectral resolution IR data

Exercise 1

Open Matlab and load the file *Exercise1* contained in the CD 2. Type *whos* from prompt. The *lines* structure contains the line by line calculations for 6 different absorption gases (H_2O, O_3, CO_2, CH_4, N_2O, water vapor continuum) in units of mW/ster/cm^{-1}/m^2. The *case1* and *case2* structures contain observed high spectral resolution spectra (in mW/ster/cm^{-1}/m^2) and the corresponding wavenumber scale (in cm^{-1}).

1. Plot the spectrum case1 [plotSpectrum(case1)] and, by over imposing the line by line calculations [help addLines; addLines(lines,1)], identify the spectral regions where each absorption gas is active.

2. Try also to identify lines that are not due to any of those 5 molecular species.

3. Look at the observed spectrum. What is the temperature difference for on-line off-line spectra at 735 cm^{-1} for this scene? What is the temperature difference for on-line off-line spectra at 720 cm^{-1} (at the Q branch of the CO_2 absorption band) for this scene? What does this imply about the 720 cm^{-1} weighting function with respect to the 735 cm^{-1} weighting function?
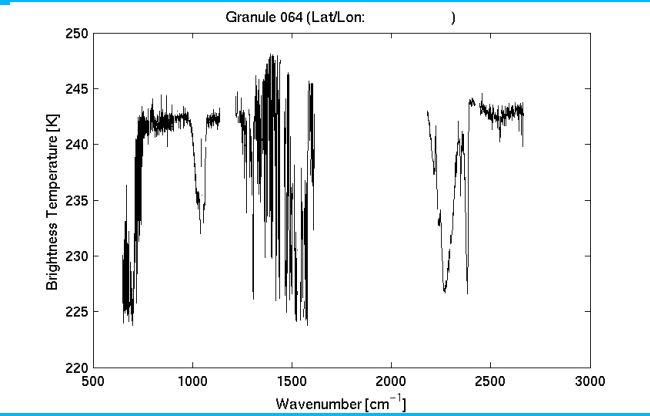
4. Redo 1 to 4 for the case2 spectrum. Is there any difference in your results? If yes, could you guess what those differences are due to?
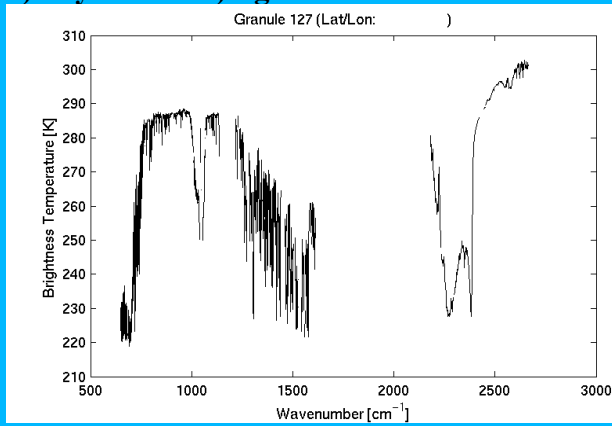
Exercise 2

5.Look at the following spectra, verify if one or more of the multiple choises are correct, and explain why (a copy of the plots can be found on CD 2 in the directory Ex2).
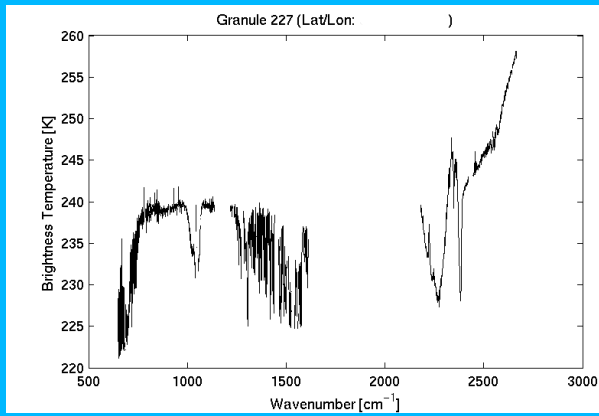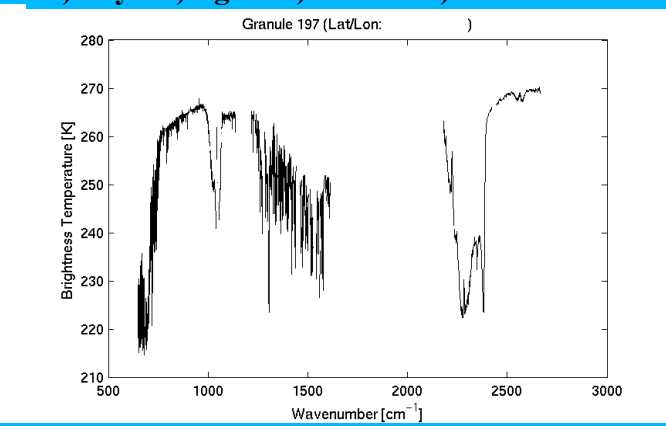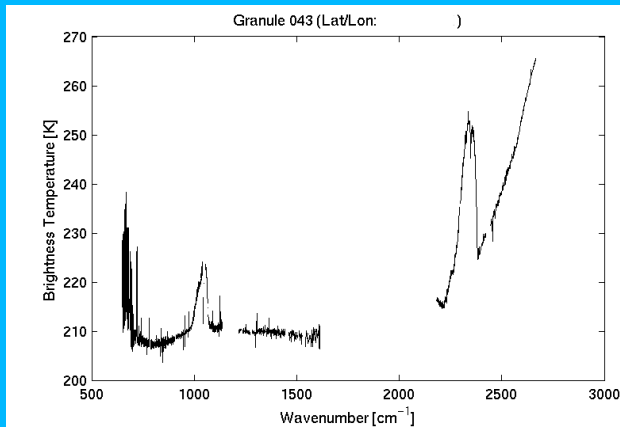

a) day   b)night
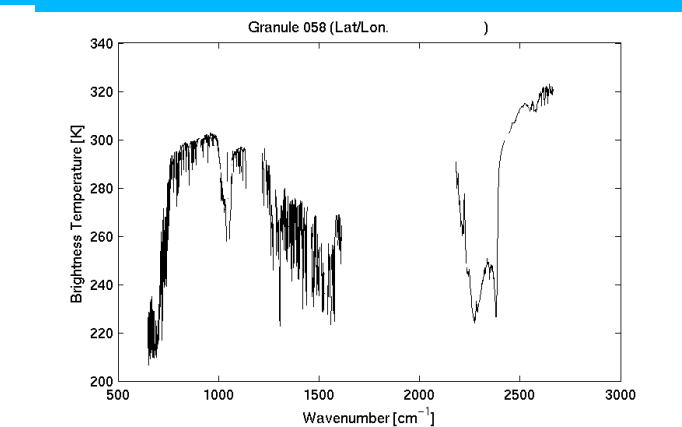

a) day   b)night   c) desert   d) ice/snow

a) day   b) night

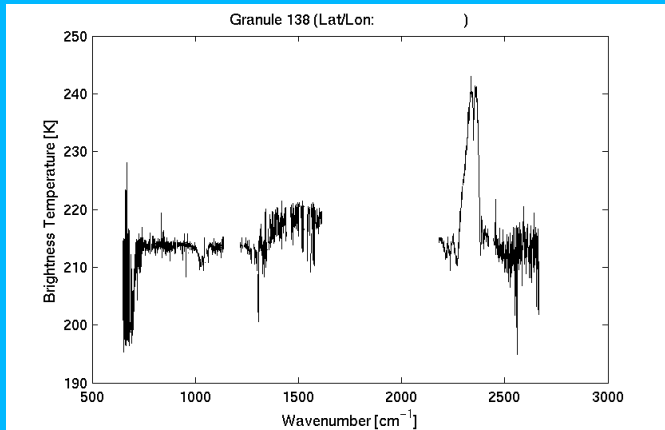**a) land   b) ocean**

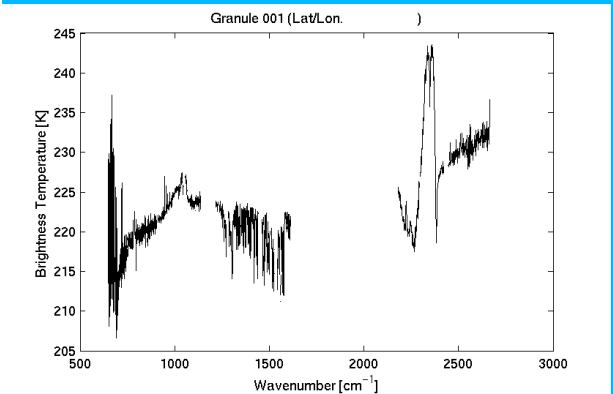
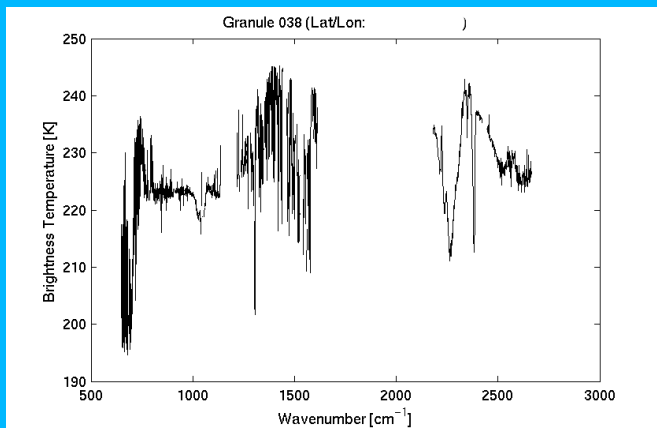**a) desert   b) ocean   c)cloudy**

a) day   b) night   c) desert   d) ocean
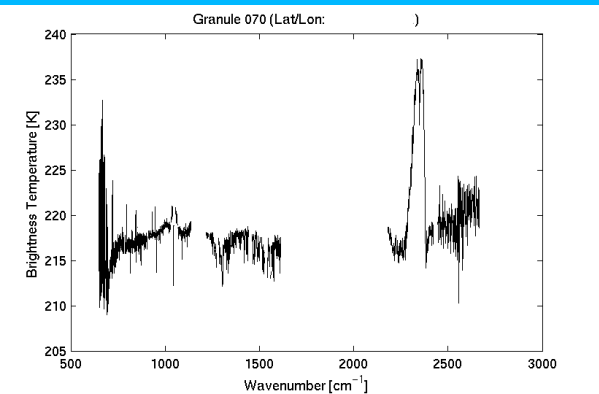
a) ocean   b) cloudy   c) snow/ice d) desert
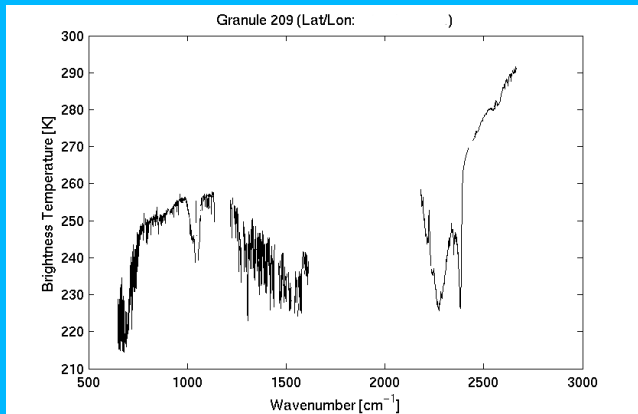

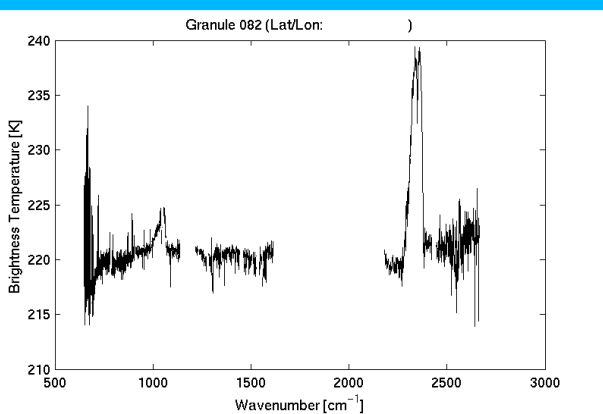a) day   b) night c) desert   d) cloudy

a) cloudy   b) desert c) ocean   d) ice/snow
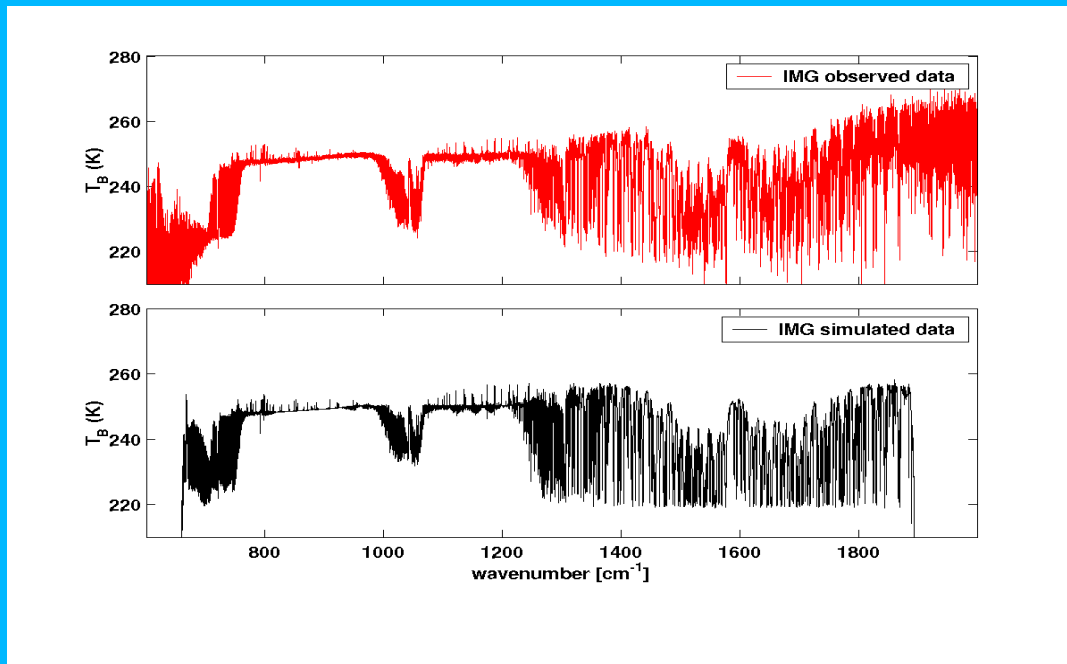

a) land   b)desert   c) ice/snow   d) ocean

a)day   b) night   c) low clouds   d) high cirrus

a) day   b)night c) ocean   d) cloudy

Exercise 3

6.The observations in the top panel of this figure were collected by IMG over Alaska. The spectrum in the lower panel was simulated from a radiosonde lauched in proximity of the observed FOV. The spectra show a clear signature of an atmospheric inversion, can you identify the signature? Can you explain why the inversion causes this unique signature in the spectrum?

7. From the matlab prompt descend in the directory Ex3 on the CD number 2 and run exercise3.m. This matlab script will plot the IMG data at a resolution of 0.1 cm-1, and it will allow you to calculate and display the same data at different spectral resolutions. At which resolution does the inversion signature disappear? Would have Modis been able to detect the inversion?

Exercise 4
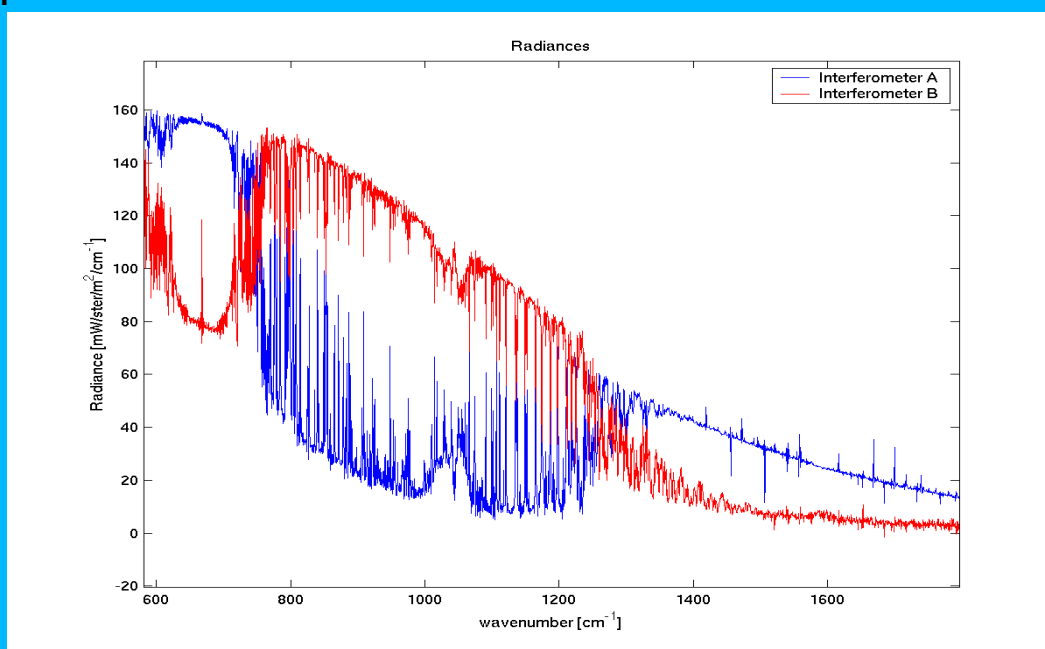
8. The observations in this figure were collected by two different interferometers looking at the same atmospheric column at the same time. Could you explain why they differ?

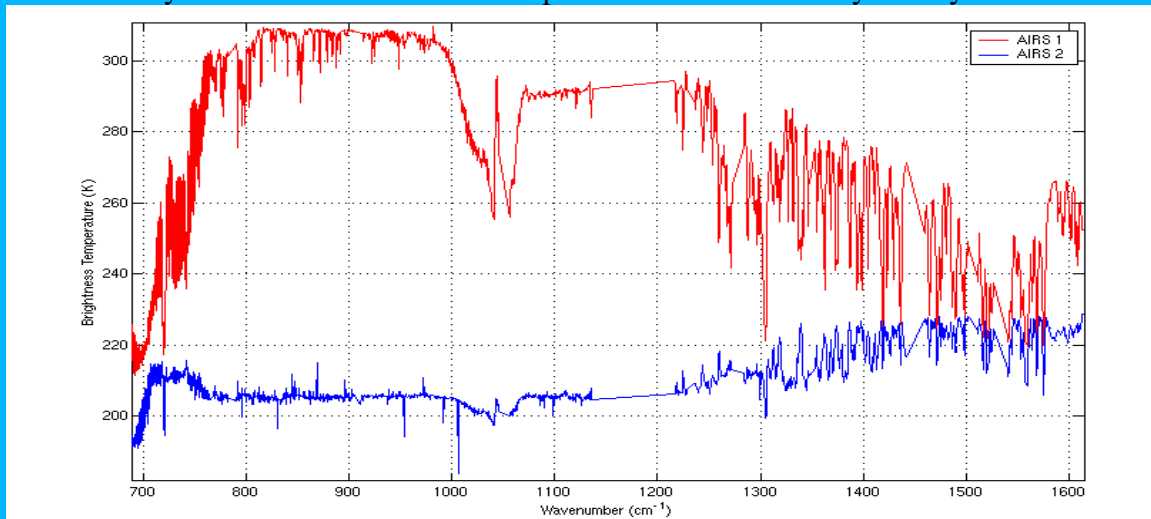9. Is there any evidence of a low-level temperature inversion? Why or why not?

10. The observations in this figure have been collected by the AIRS in different days and at different times. Could explain the they look so different?

11. There is any evidence of temperature inversion in the observations?

12. One of the observations shows a large difference between 8 and 12 microns, might that be related to any surface properties? If yes which one?

Exercise 5

Open Matlab and from the directoru Ex5 run the *Exercise5* application. This programs allows you to visualize the weighting function for each spectral channel. Convince yourself that moving in the wavenumber scale actually corresponds to a vertical scanning of the atmosphere.

13. Derive the weighting functions for the LW channels and plot all of them as function of pressure.

14. Plot a couple of weighting functions between 700 and 760 cm^{-1}, could you derive the value of the temperature lapse rate from the data visualized by the application?

Exercise 6

Open **airatee** from matlab (CD number 2 into Airs/Mfiles). Click on *Load Data -> Channel Properties* and select the channel property file: channelPropsV6_6_7.m. This file contains all the information about reliable and non reliable AIRS channels. Now click on *Load Data -> AIRS data* and load the file: AIRS.2002.10.28.123.L1.AIRS_Rad.v2.6.10.3.A02302200913 (with no extension). A new window will pop up asking you to enter a range of wavenumbers. Try to enter 833 cm^{-1} and 1440 cm^{-1}. If the computer starts paging too much kill the application and start over using a smaller range. Once the data are loaded in memory a new window pops up, use this window to select a single wavenumber (the scene will be visualized at this wavenumber). Click *Select Wavenumber* and then click on the spectrum

to select the desired wavenumber. Click the OK button. Now the scene is displaied (upside down). Click on *Settings -> Flip ->Flip u/d* (and also *Flip l/r*). Now the AIRS granule should appear correctly oriented.Using **airatee** try to repete some of the operations you did for Lab 1 with **manatee**. Describe the differences between the results obtained from the observations collected by MODIS at high spatial resolution and AIRS at high spectral resolution.

15.Using the same software of exercise 5 and airatee can you estimate the altitude of the volcano plume?
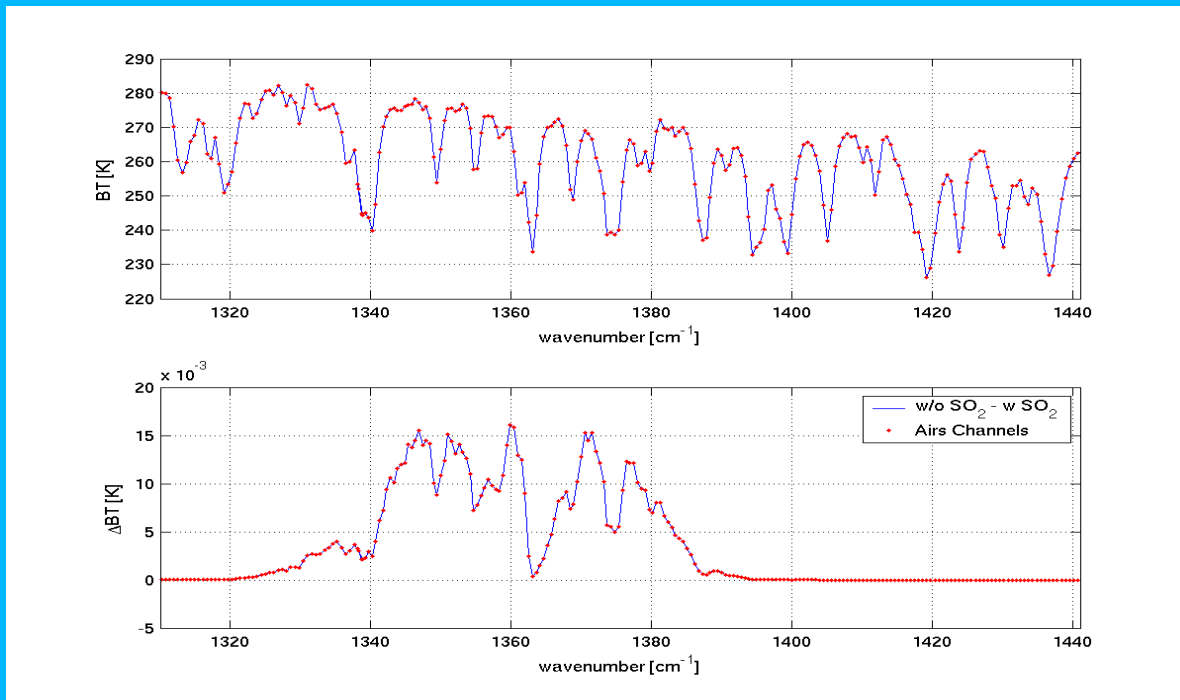
The top panel of this figure shows one simulated AIRS spectrum in the region that goes from 1320 cm^{-1} to 1441 cm^{-1}. The bottom panel shows the differences between the simulated AIRS spectrum with and without SO_2.

16. Using the menu bar select a region over Sicily (including Mount Etna) and select the *Scatter Plot* function. The difference between AAAA.A and BBBB.B wavenumber can be used to detect SO_2. Determine the optimal values for A and B and map this difference (A-B) to the X axis. If we had to detect the volcanic plume from AVHRR we would have used the difference between 833.3 and 909.0 wavenumber. Map this difference to the Y axis and get a scatter plot. After getting the scatter plot, use the *pseudochannel* button to get color maps for X and Y. How do the two figures compare? (if you do not have enough memory to load the spectral range between 833 and 1440 cm^{-1}, do the exercise in two steps loading into memory smaller ranges).

17.Now select a single spectrum over the smoke plume, you should be able to identify a peak around 1227.3 wavenumbe. Select the difference between 1123.0 and 1227.3 wavenumber, and map it to the Y axes keeping the differece between 1372.3 and 1439 on the X axes. Get a scatter plot and the color maps (with the *pseudochannels* function). Explain the differences between the colormaps with the help of the scatter plot.

18.Map the difference (1123.0 - 1227.3) – (1372.3 – 1439) to the X axis and 907.68 to the Y axis. Get a scatter plot and a colormap for the X axis. Try to describe and explain what you observe in the

colormap with the help of the scatter plot.
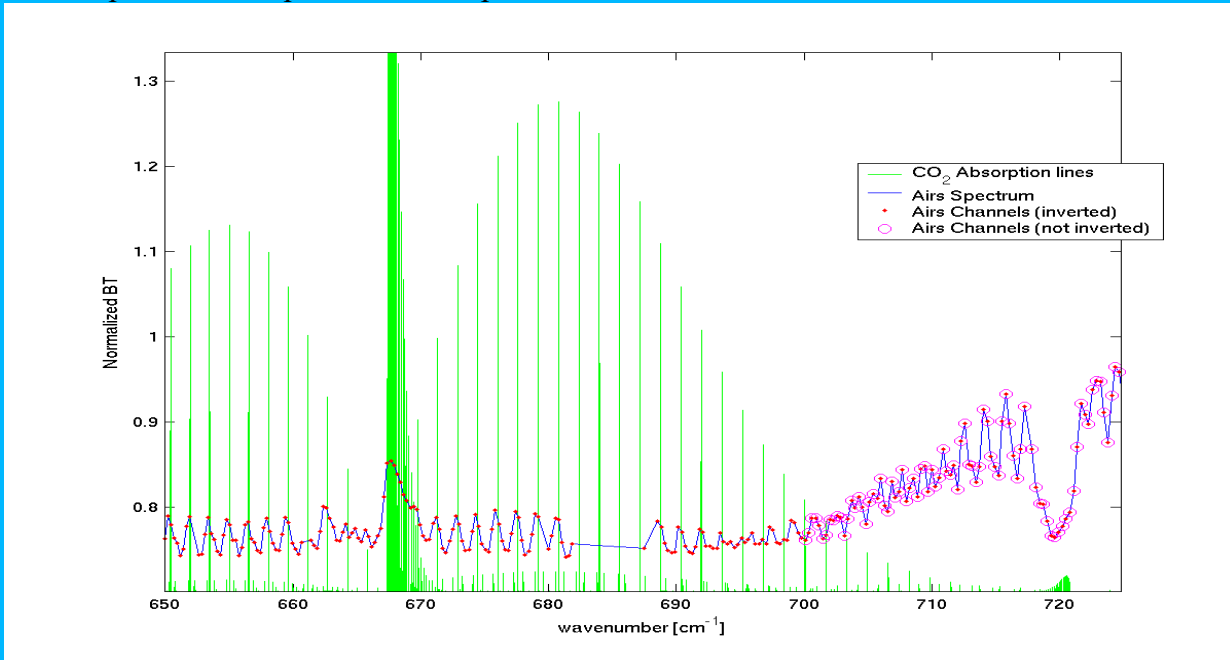
19. This plot shows an AIRS normalized specctrum (blue) along with the CO2 lines (green). In the spectral regions where the red dots indicate the AIRS channel the online channels are warmer than the offline channels, can you explain why? In the spectral region where the magenta circles indicate the AIRS channels the on-line channels are colder than the off-line channels, what is the difference between the two spectral regions.

20. Using airatee plot a colormap of the tropopause temperature for the granule over Italy.
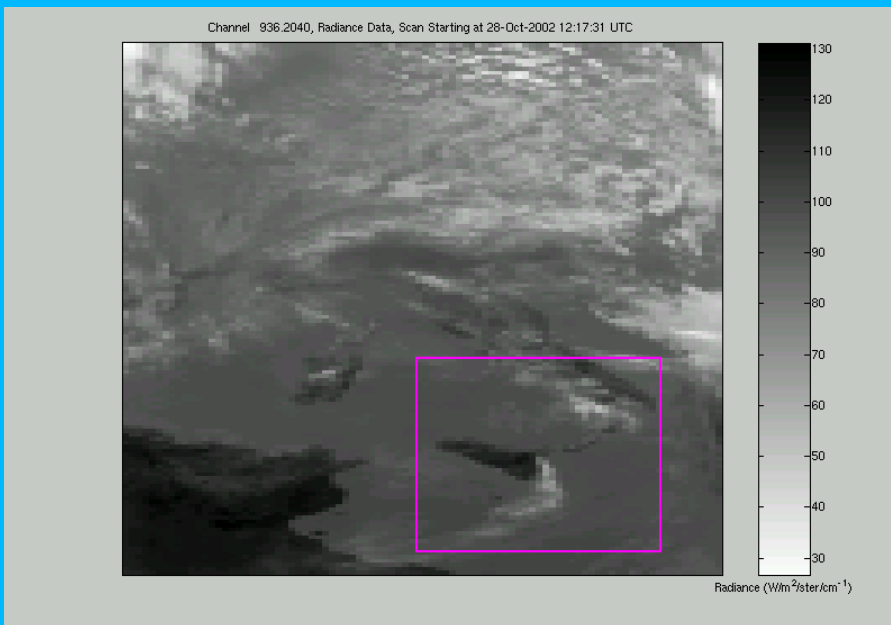
21. Clicking on the *Select -> Region* select this region and create a scatter plot of 1123 cm-1 – 1227 cm-1 (on the X axis) and 833 cm-1 on the Y axis. Can you explain the shape of the scatter plot? What do the tails represent?