

Figure 1: High resolution atmospheric absorption spectrum and comparative blackbody curves

1. Open **Hydra** and load the file: AIRS.2005.08.28.103.L1B.AIRS\_Rad.v4.0.9.0.G05241172839.hdf. Under **Start** open the **MultiChannel Viewer** and the following should appear (see Figure 2).

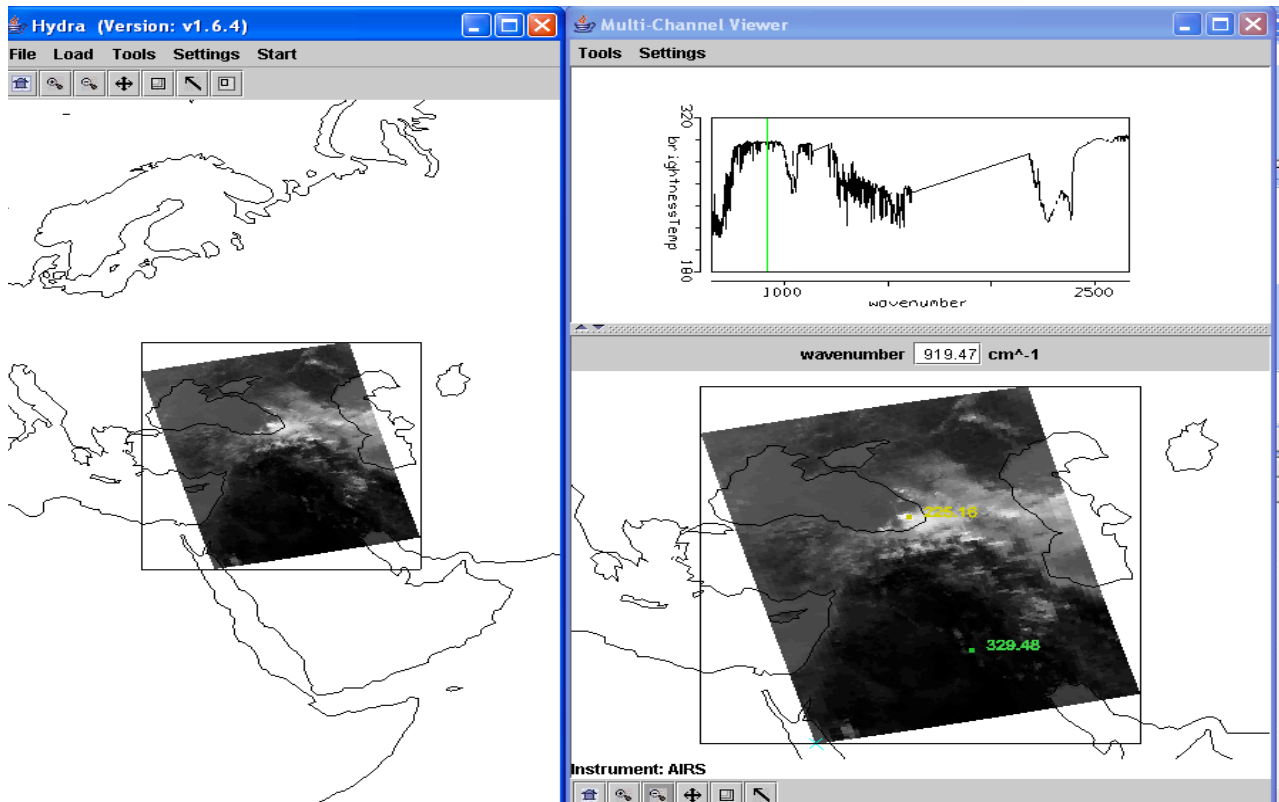
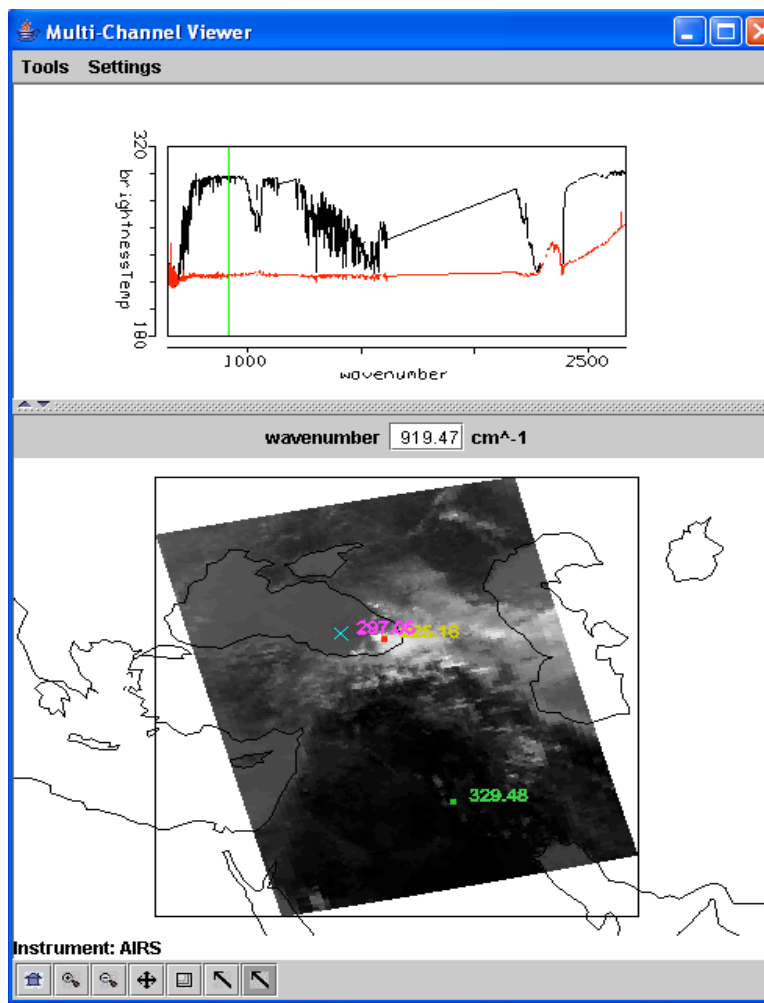


Figure 2: Hydra display of AIRS data showing BT spectra from warmest pixel and IRW image over the Black and Caspian Seas on 28 August 2005.

1a. Explore the image to view spectra measured in various pixels. To do this click on the arrow icon in the tool bar at the bottom of the MultiChannel Viewer and move the cursor around the image slowly, watching the spectra change from pixel to pixel. View a spectrum over the Black Sea in clear skies and locate the CO<sub>2</sub>, O<sub>3</sub>, and H<sub>2</sub>O absorption features. Now view a spectrum in the clouds at the eastern edge of the Black Sea. The absorption features have been severely diminished. Why? The BT at shorter wavelengths is now increasing as wavelengths decreases. Why?

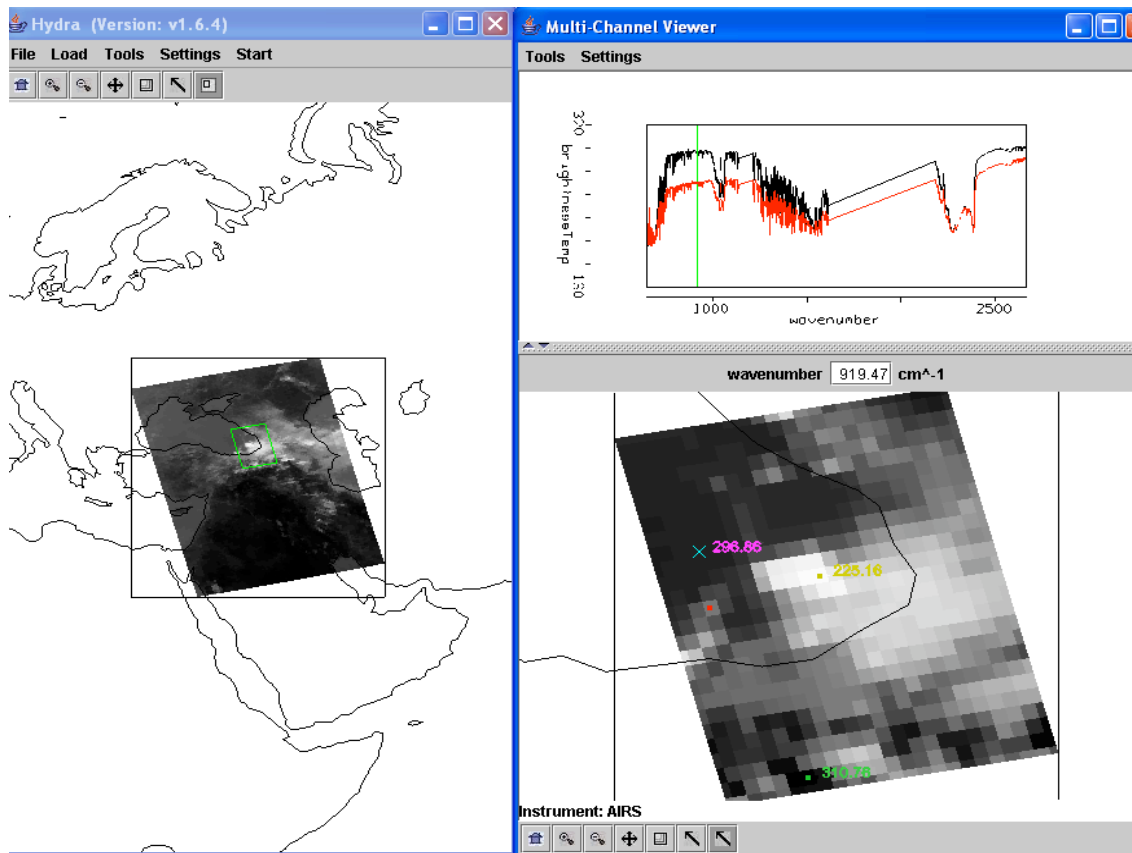
1b. Engage the reference spectrum icon (look under **Tools** and find **Reference Spectrum** and click on). Show both the spectra from 1a simultaneously by engaging the arrows in the bottom tool bar (Figure 3). Why is the spectrum from the cloudy field of view showing very little change in brightness temperature as a function of wavenumber?



**Figure 3:** MultiChannel Viewer display with reference spectrum on showing cloudy and clear sky spectra over the Black Sea

2. Zoom in on the spectra at 690 cm<sup>-1</sup> where the clear and cloudy spectra begin to separate (click on the zoom icon third from the right on the toolbar at the bottom and click and drag over the desired part of the spectra). Plot spectral band images at 700 and 690 cm<sup>-1</sup> and save on a ppt. Clouds are evident in one image but not the other. Explain why in the notes.

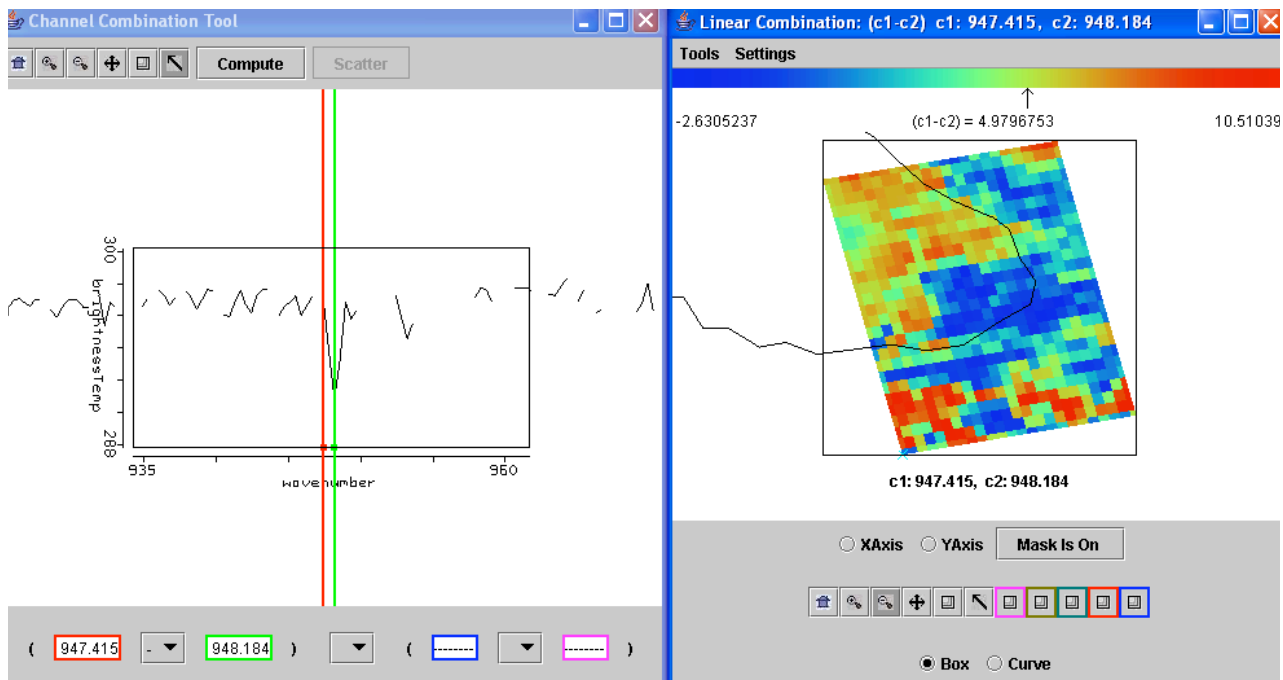
3. Restore the full spectra (click on the left icon on the toolbar at the bottom and click over the spectra). Go back to the Hydra main window and display the eastern portion of the Black Sea at full resolution (see Figure 4). Compare the spectra for a clear pixel and a pixel covered by thin cloud. What does the infrared window portion of the spectrum look like?



**Figure 4:** MultiChannel Viewer display of full resolution AIRS data showing partly cloudy and clear sky spectra over the Black Sea

4. Engage **Linear Combinations** (under **Tools**) to open the Channel Combination Tool display. What is the temperature difference for on-line off-line spectra at  $735\text{ cm}^{-1}$  for this scene? What is the temperature difference for on-line off-line spectra at  $720\text{ cm}^{-1}$  (at the Q branch of the  $\text{CO}_2$  absorption band) for this scene? What does this imply about the  $720\text{ cm}^{-1}$  weighting function with respect to the  $735\text{ cm}^{-1}$  weighting function?

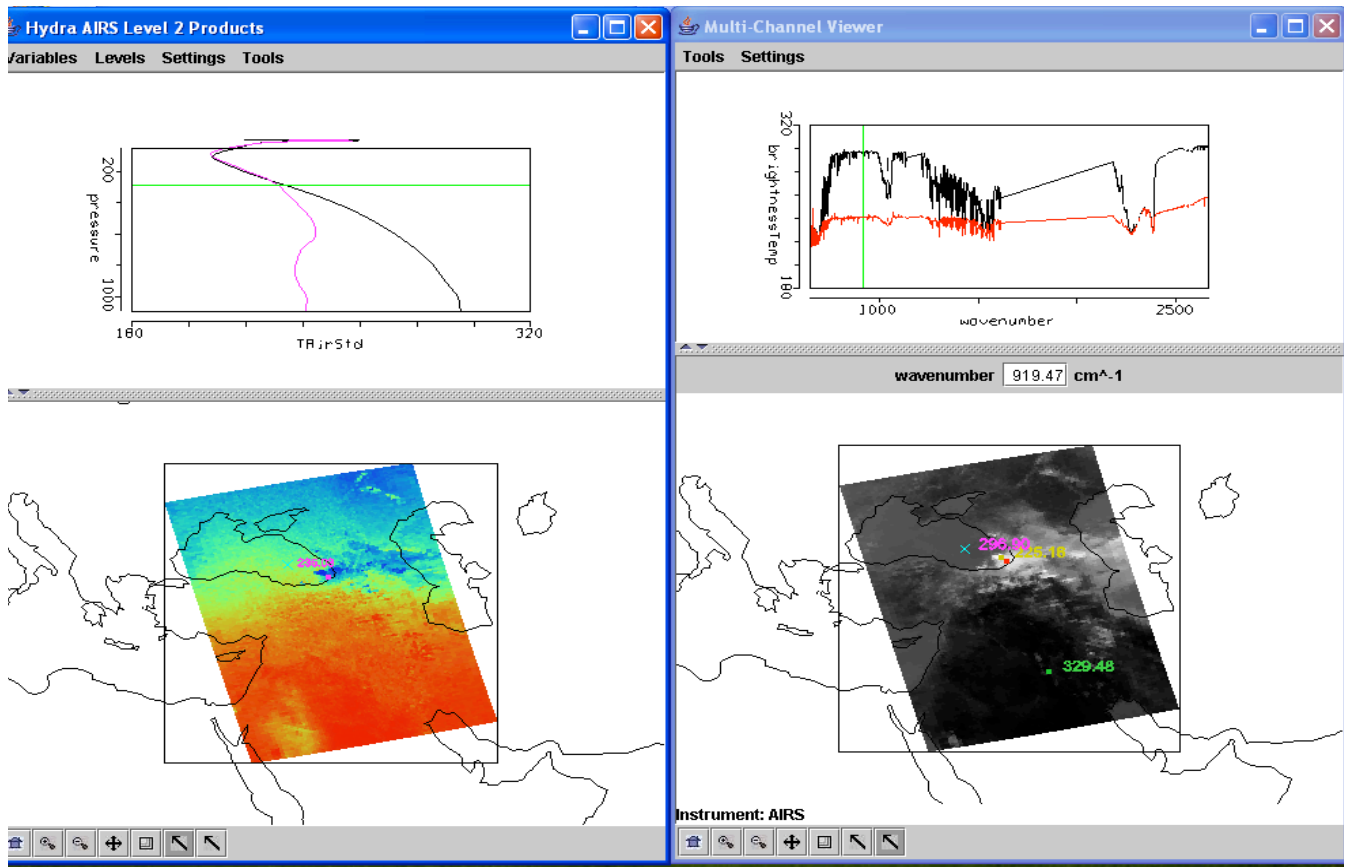
5. Calculate the BT difference on and off a  $\text{H}_2\text{O}$  absorption line in the infrared window region (e.g. try  $947.4$  minus  $948.2\text{ cm}^{-1}$ ). Color display the difference image (see Figure 5). What is the range of values in the scene? Differences in the eastern Black Sea are smaller than differences further west; what does this tell you about low level moisture? Explain.



**Figure 5:** Channel Combinations display of BT947.4 minus BT948.2.

6. Keep the *MultiChannel Viewer* with the reference spectrum open. Using Hydra again load the AIRS retrievals for this scene found in AIRS.2005.08.28.103.atm\_prof\_rtv\_npc030.hdf (leave the Multichannel Viewer with the AIRS data open). Under *Variables* select *Air Temperature Profiles* and under Tools turn *Reference Profile* on. In Multi-Channel Viewer, using the arrows in the bottom tool bar select one FOV directly in the cloud in their eastern Black Sea and another FOV nearby in clear skies.

6a. Observe the characteristic spectral signature of an opaque cloud in the Multi-Channel Viewer (see Figure 3). Now observe the temperature profiles for the two FOVs in the Hydra AIRS level 2 Products Window (see Figure 6). What can you infer about the height of the opaque cloud? Why? Inspect the temperature retrieval image for various pressure levels (in the Hydra AIRS level 2 Products Window use the first arrow in the bottom tool bar to move the horizontal green line to different pressure levels); the pressure level where the retrieval field shows large contrast over the cloud is indicative of its height.

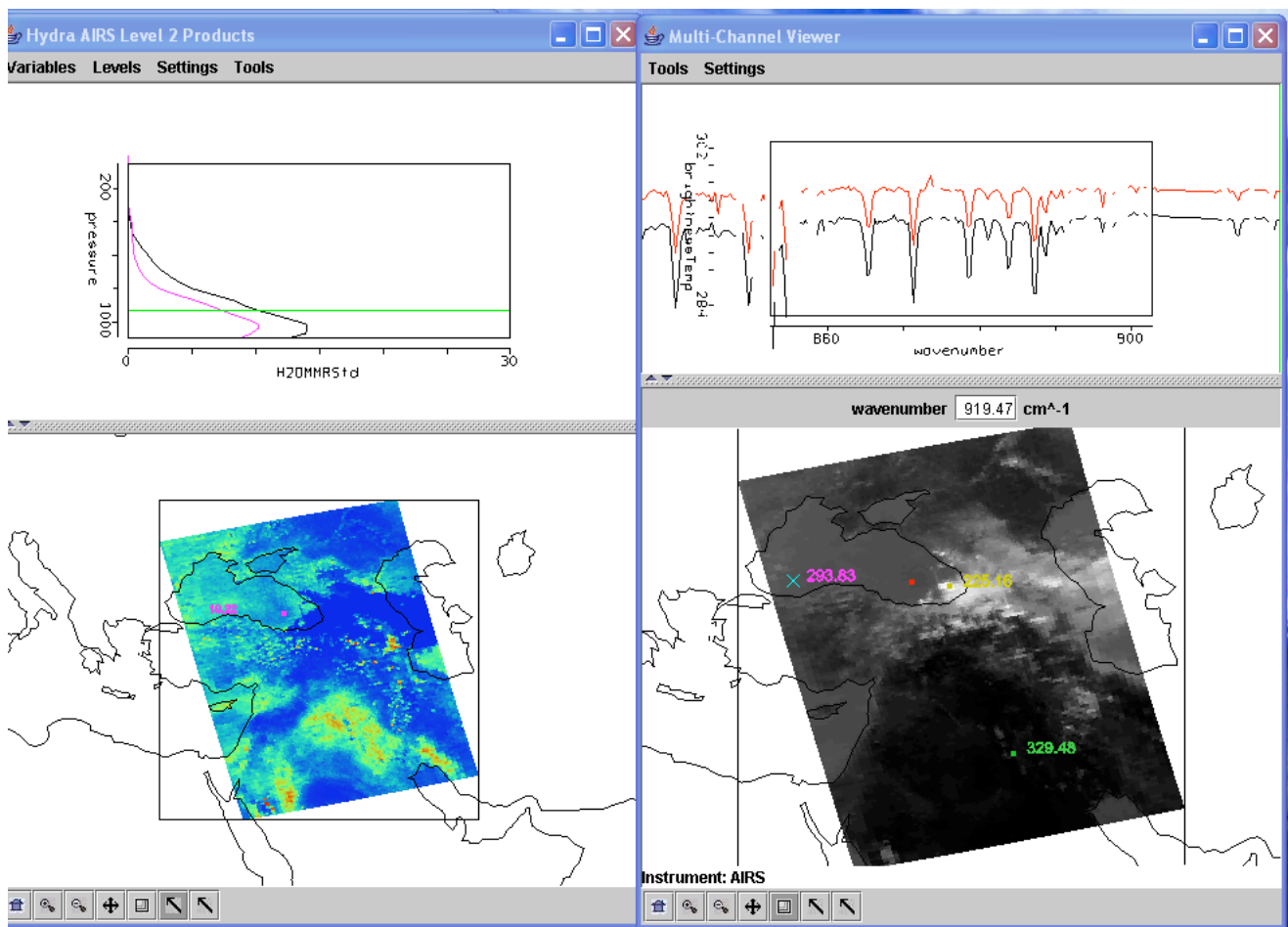


**Figure 6.** (right) MultiChannel Viewer display with reference spectrum on showing cloudy and clear sky AIRS spectra over the Black Sea. (left) AIRS temperature profile retrievals in clear and cloudy FOVs and the 300 hPa temperature retrieval field for the granule.

1b. Explore the spectra and the inferred height of several other clouds in the scene. Record their location and your estimate of their height.

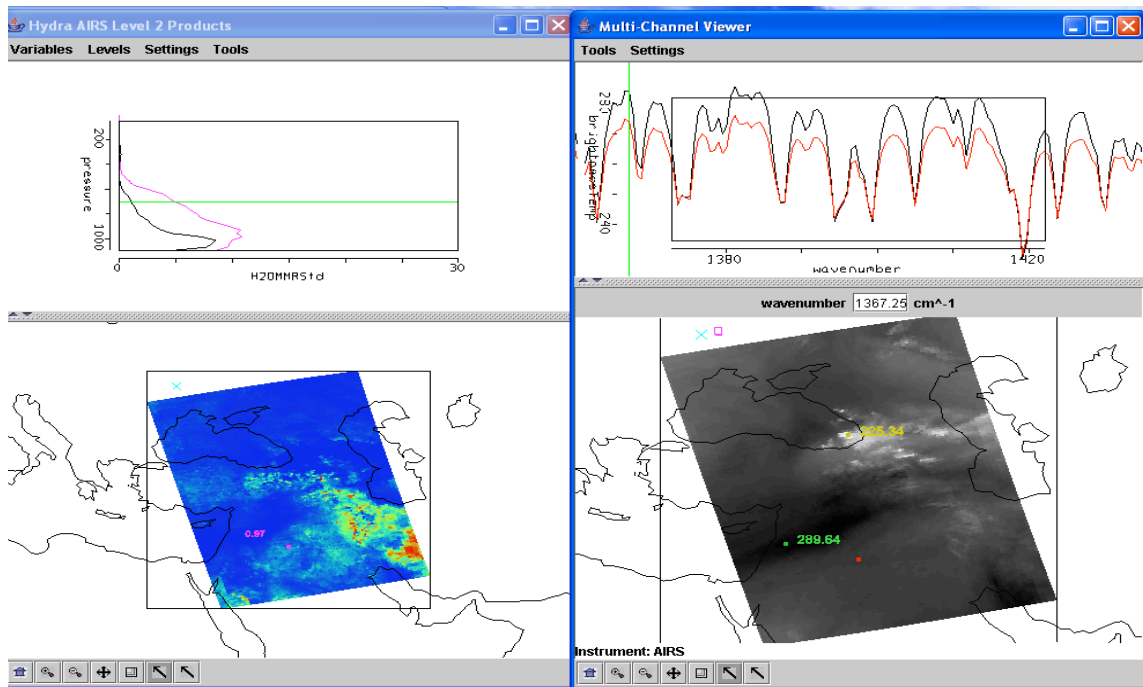
7. In the Hydra AIRS level 2 Products Window, under *Variables* select *Water Vapor Profiles*.

7a. Inspect the moisture retrieval image for 900 hPa. The western Black Sea appears to have more low level moisture than the eastern part. In the Multi-Channel Viewer display two spectra, one for a FOV in the moister region and one in the drier region. Zoom in on the two spectra at 870  $\text{cm}^{-1}$  (click on the icon third from the right in the bottom tool and then click and drag over the appropriate part of the spectrum – repeat until full resolution of the absorption lines in the IR window are apparent). You should have something that looks like Figure 7. Does the on-line off-line brightness temperature difference in this part of the spectrum agree with the inference from the retrieval field? Explain?



**Figure 7.** (right) MultiChannel Viewer display with zoom in on IR window spectra near 870 cm<sup>-1</sup> over FOVs in eastern and western Black Sea. (left) AIRS water vapor profile retrievals in the two selected FOVs and the 900 hPa water vapor retrieval field for the granule.

8. Repeat your investigation of atmospheric water vapor by displaying 1443 cm<sup>-1</sup> measurements in the Multi-Channel Viewer. There is a dry band south of the Black Sea. Display the spectra and the water vapor profiles in and out of the dry band. Zoom in on the spectra between 1380 and 1420 cm<sup>-1</sup>. See Figure 8. Does the on-line off-line brightness temperature difference in this part of the spectrum agree with the inference from the retrieval field? Explain?



**Figure 8.** (right) MultiChannel Viewer display with zoom in on H<sub>2</sub>O spectra between 1380 and 1420 cm<sup>-1</sup> over FOVs in and out of the dry band south of the Black Sea. (left) AIRS water vapor profile retrievals in the two selected FOVs and the 700 hPa water vapor retrieval field for the granule.