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Lab 5 – Exploring Spectral Properties of Clouds, Moisture, and Volcanic Ash Sensed with AIRS
March 2006

1. Open **Hydra** and load AIRS.2005.08.28.103.L1B.AIRS_Rad.v4.0.9.0.G05241172839.hdf. Under **Start** open the **MultiChannel Viewer**. Engage the reference spectrum icon (look under **Tools** and find **Reference Spectrum** and click on). 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 the eastern Black Sea and another FOV nearby in clear skies.

1a. Observe the characteristic spectral signature of an opaque cloud in the Multi-Channel Viewer (see Figure 2 of Lab4). Now observe the temperature profiles for the two FOVs in the Hydra AIRS level 2 Products Window (see Figure 1). 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.

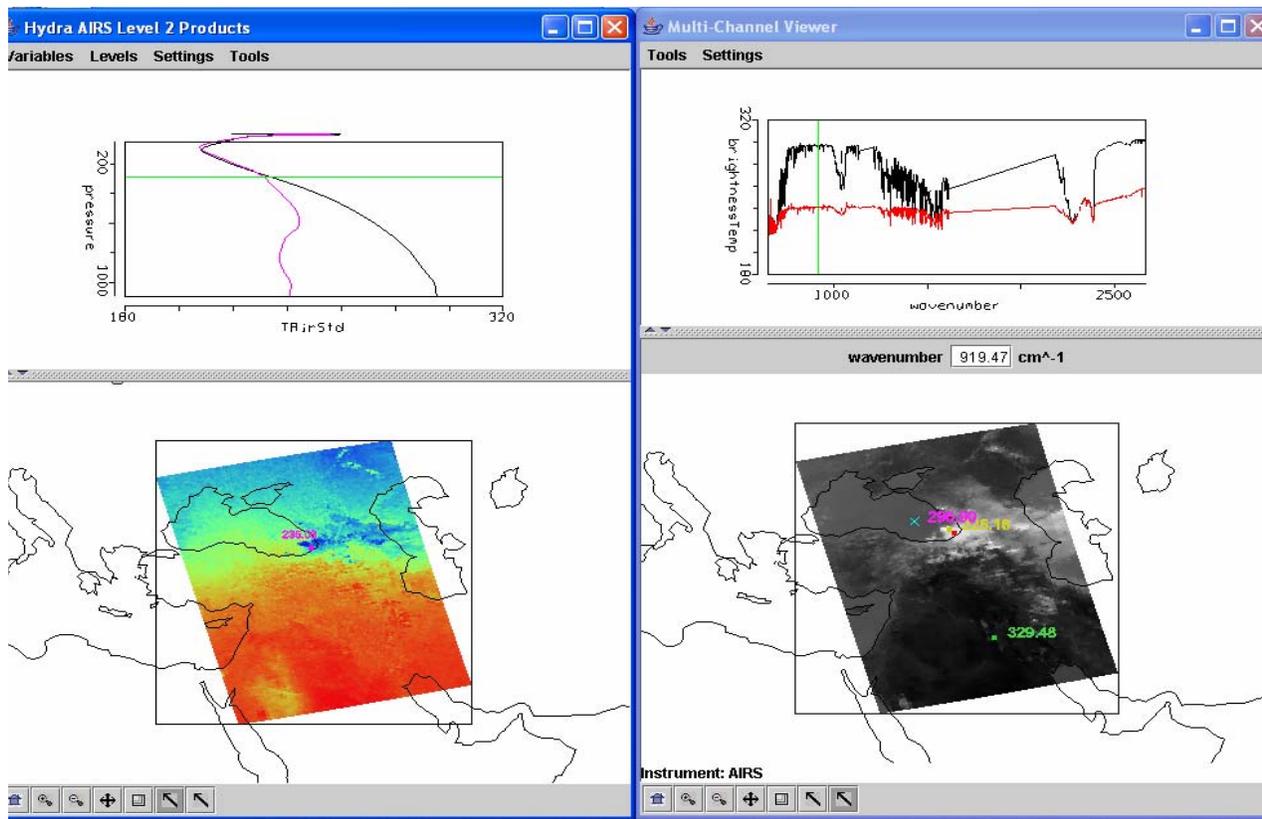


Figure 1. (right) MultiChannel Viewer display with reference spectrum on showing cloudy and clear sky AIRS spectra over the Black Sea. (left) AIRS temperature profile retrievals in clear and cloudy FOVs and the 300 hPa temperature retrieval field for the granule.

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

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

2a. 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 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 2. Does the on-line off-line brightness temperature difference in this part of the spectrum agree with the inference from the retrieval field? Explain?

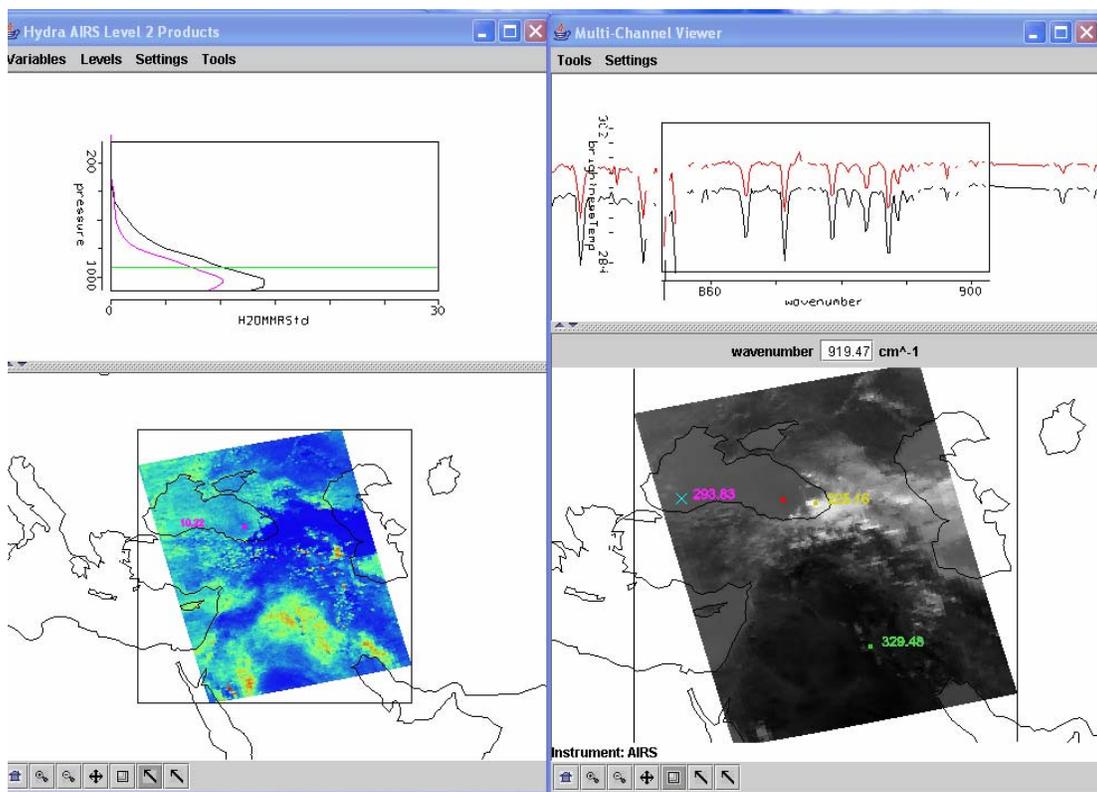


Figure 2. (right) MultiChannel Viewer display with zoom in on IR window spectra near 870 cm⁻¹ over FOVs in eastern and western Black Sea. (left) AIRS water vapor profile retrievals in the two selected FOVs and the 900 hPa water vapor retrieval field for the granule.

3. Repeat your investigation of atmospheric water vapor by displaying 1443 cm⁻¹ 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⁻¹. See Figure 3. Does the on-line off-line brightness temperature difference in this part of the spectrum agree with the inference from the retrieval field? Explain?

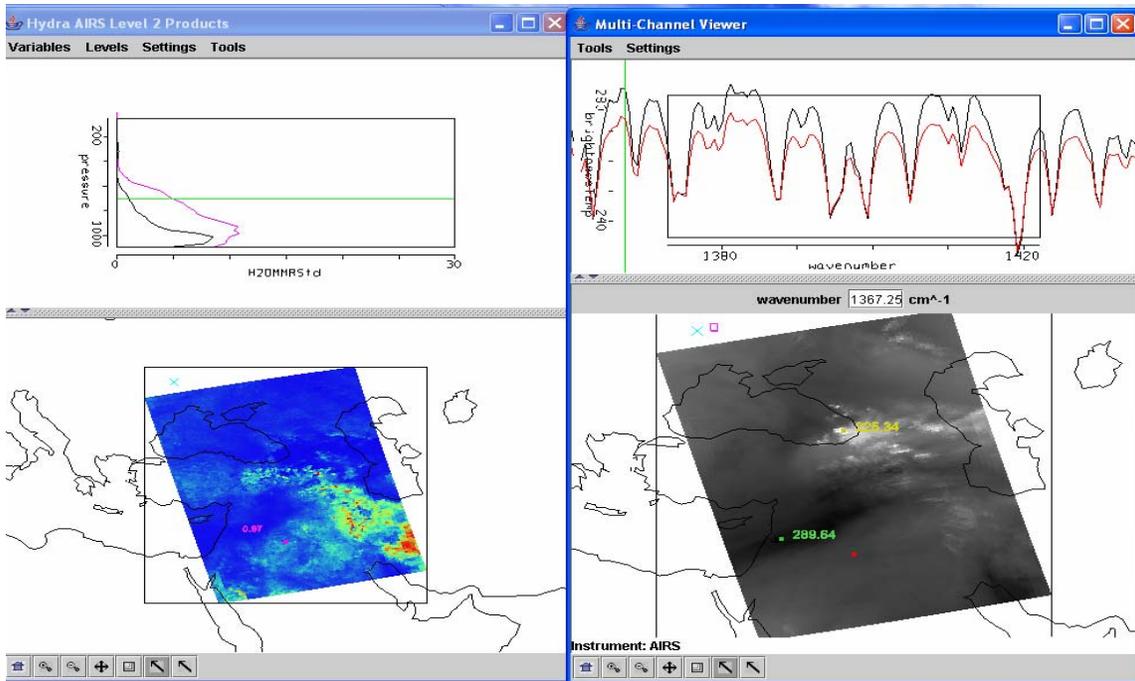


Figure 3. (right) MultiChannel Viewer display with zoom in on H₂O spectra between 1380 and 1420 cm⁻¹ over FOVs in and out of the dry band south of the Black Sea. (left) AIRS water vapor profile retrievals in the two selected FOVs and the 700 hPa water vapor retrieval field for the granule.

4. Using **Hydra** load AIRS.2002.10.28.123.L1.AIRS_Rad.v2.6.10.3.A02302200913.hdf. This granule includes the eruption of Mount Etna on 28 October 2002 (see Figure 4a).

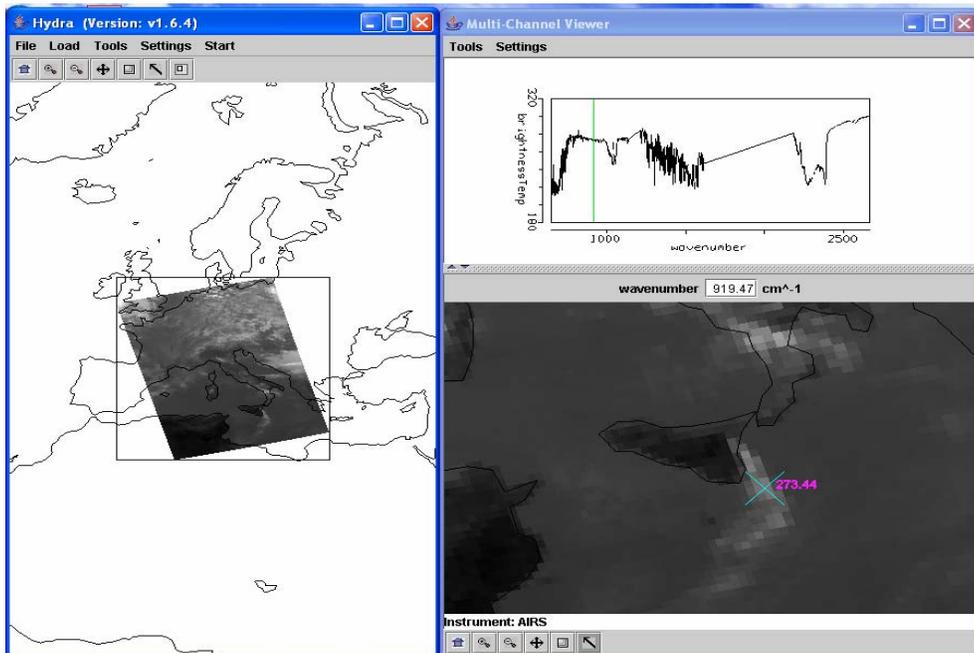


Figure 4a. AIRS measurements over eruption of Mount Etna on 28 October 2002

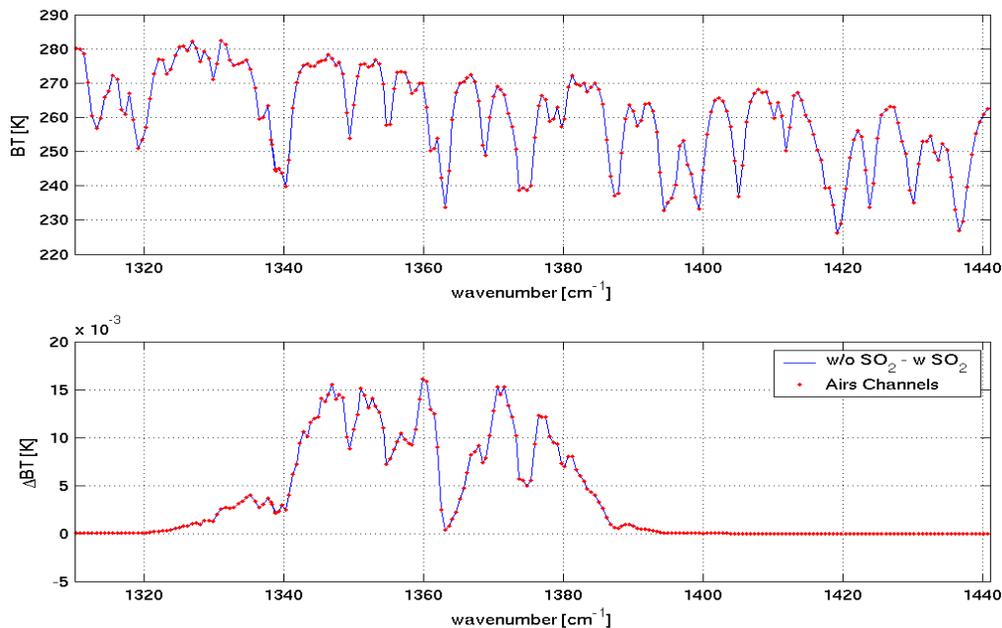


Figure 4b. (top) Simulated AIRS spectrum from 1320 cm⁻¹ to 1441 cm⁻¹. (bottom) Differences between the simulated AIRS spectrum with and without SO₂.

4a. Using *Scatter Plot* plot the difference between AAAA.A and BBBB.B wavenumber that can be used to detect SO₂. Determine optimal values for A and B and map this difference (A-B) to the X axis. With AVHRR we would have used the difference 833.3 minus 909.0 cm⁻¹. Map this difference to the Y axis and get a scatter plot. After getting the scatter plot, get color images for X and Y. How do the two figures compare?

4b. Select a single spectrum over the smoke plume. Identify a peak around 1227.3 cm⁻¹. Select the difference between 1123.0 and 1227.3 wavenumber, and map it to the Y axes keeping the difference between 1376.886 and 1414.008 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.

4c. Map the difference [(BT1123.0 – BT1227.3) – (BT1376.886 – BT1414.008)] 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.

4d. Using Hydra load AIRS.2002.10.28.123.atm_prof_rtv_npc030.hdf which contains the AIRS retrievals for this scene (leave the Multichannel Viewer with the AIRS data open). Under *Variables* select *Air Temperature Profiles*. Under Tools turn *Reference Profile* on. In the Multichannel Viewer turn *Reference Spectrum* on also. Using the arrows in the bottom tool bar select one FOV directly in the ash plume and another FOV nearby in clear skies. Observe the characteristic spectral signature of ash in the Multi-Channel Viewer. Observe the temperature profiles for the two FOVs in the Hydra AIRS level 2 Products Window. What can you infer about the height of the ash plume? 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 ash plume is indicative of its height.

5. Consider the AIRS measurements in the CO₂ region of the spectrum (see Figure 4). In the spectral regions where the red dots indicate the AIRS channel the on-line channels are warmer than the off-line 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.

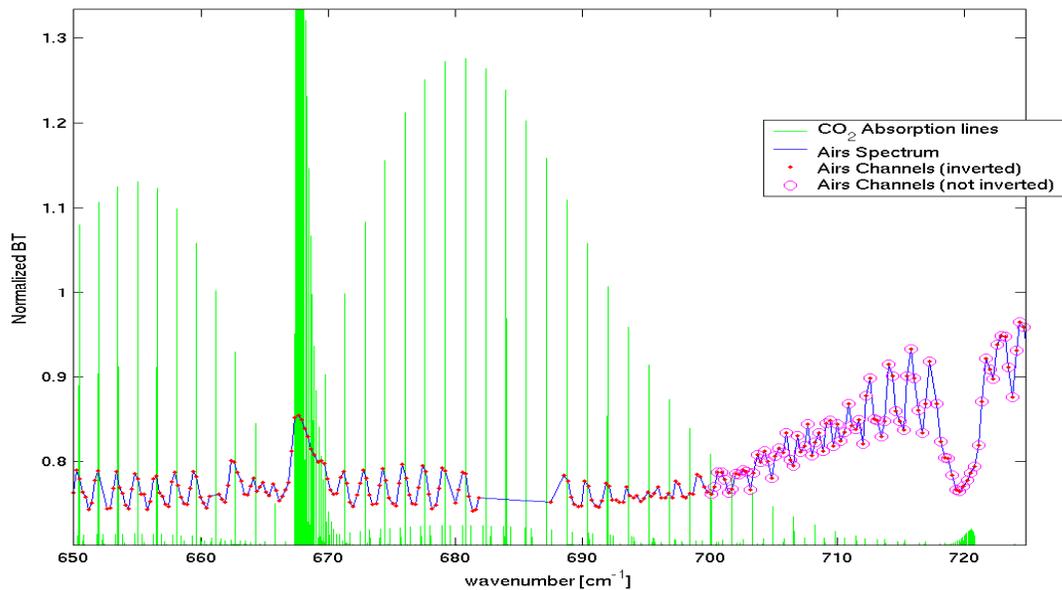


Figure 4. AIRS normalized spectrum (blue) and locations of CO₂ lines (green).

5a. Using Hydra plot a colormap of the tropopause temperature for the granule over Italy.

5b. 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?