Menzel / Antonelli
Lab 2 – Analyzing MODIS data viewing land, ocean, and atmosphere
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Table: MODIS Channel Number, Wavelength (μm), and Primary Application

| Reflective Bands			Emissive Bands		
1,2	0.645, 0.865	land/cld boundaries	20-23	3.750(2), 3.959, 4.050	sfc/cld temp
3,4	0.470, 0.555	land/cld properties	24,25	4.465, 4.515	atm temperature
5-7	1.24, 1.64, 2.13	"	27,28	6.715, 7.325	water vapor
8-10	0.415, 0.443, 0.490	ocean color/chlorophyll	29	8.55	sfc/cld temp
11-13	0.531, 0.565, 0.653	"	30	9.73	ozone
14-16	0.681, 0.75, 0.865	"	31,32	11.03, 12.02	sfc/cld temp
17-19	0.905, 0.936, 0.940	atm water vapor	33-34	13.335, 13.635	cld top properties
26	1.375	cirrus clouds	35-36	13.935, 14.235	cld top properties
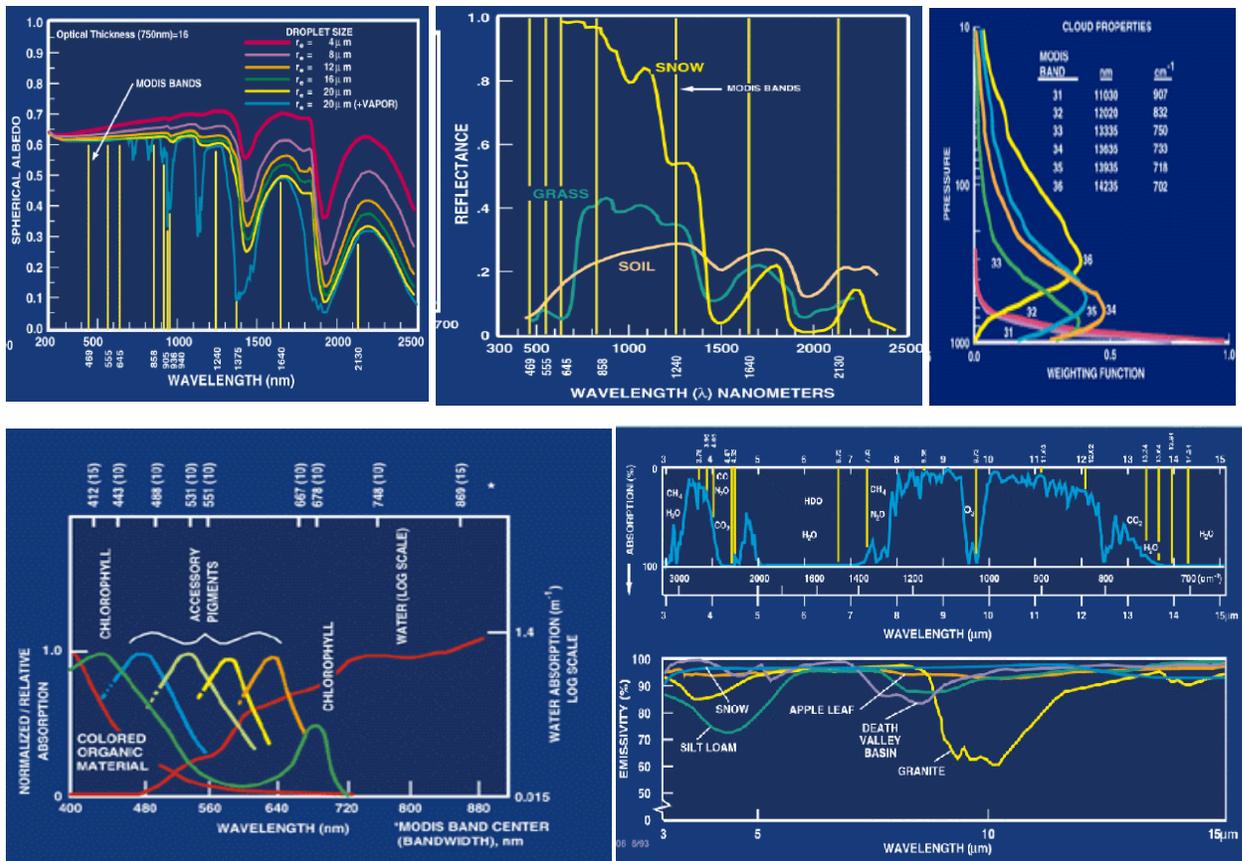
Figure 1: Spectral signatures from land, ocean, and atmosphere

1. Use Hydra to analyze the scene over Italy on 29 May 2001 detected by MODIS (find MOD021KM.A2001149.1030.003.2001154234131.hdf and load it into Hydra). Browse through the scene in several different wavelengths in the Multi-Channel Viewer window. Look at the scene both in BT and radiances (use BT > radiance under *Settings*):

1a. Verify that for infrared window channels the surface features are distinguishable while for absorption channels they are not.

1b. Look at clouds, ocean, and vegetated surfaces in different reflective bands. For each type (by selecting a single Field Of View) describe the changes in reflectance for different channels (top panel of Multi-channel viewer window).

1c. Demonstrate some of the spectral signatures indicated in Figure 1. In each case identify which spectral signature you are demonstrating.
      i. Look at snow in the Alps in 0.65 and 1.6 μm.
     ii. Look at vegetation in France in 0.65 and 0.86 μm.
    iii. Look at near shore waters in 0.55 and 0.45 μm.
    iv. Look at ocean waters in 11 and 13.9 μm

2. Use **Linear Combination** combine spectral bands to explore the vegetation index that is based on the relatively low leaf and grass reflectance from spectral bands below 0.72 μm and relatively high reflectance from spectral bands above.

2a. Construct a pseudo image of normalized vegetation index [Band 2 (0.86μm) – Band 1 (0.65μm)] / [Band 2 (0.86μm) + Band 1 (0.65μm)]. Can you discriminate regions with some vegetation from those with little? What are the NDVI values in regions without significant vegetation; what are they in vegetated regions?

2b. Create an image of Band 31 (11.0 μm) using **Compute**. Map the NDVI values from 2a on the Y axis (by clicking the Y axis button) against Band 31 (11.0 μm) on the X axis (by clicking the X axis button). Click on the scatter button to open a scatter plot window. Select different regions in the scatter plot window (see Figure 2) and look at the corresponding points in the linear combination windows.
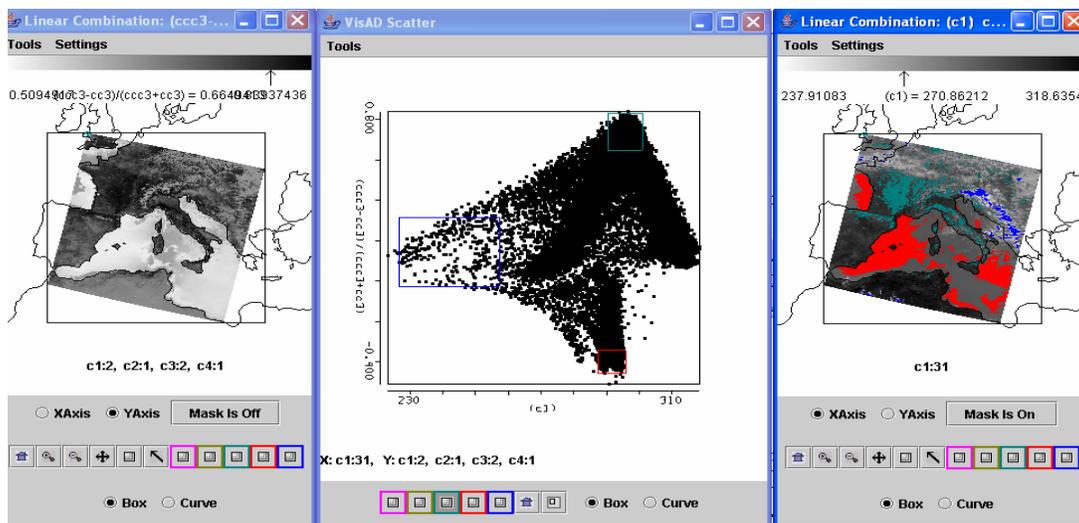

Figure 2: Scatter plot of NDVI (left image & y-axis) versus BT11 (right image & x-axis)

3. Select a region in the northern part of the Adriatic Sea (outlined approximately by green box) within the Hydra window. Now select Band 9 (0.45 μm) in the Multi-Channel Viewer and display the reflectance image.
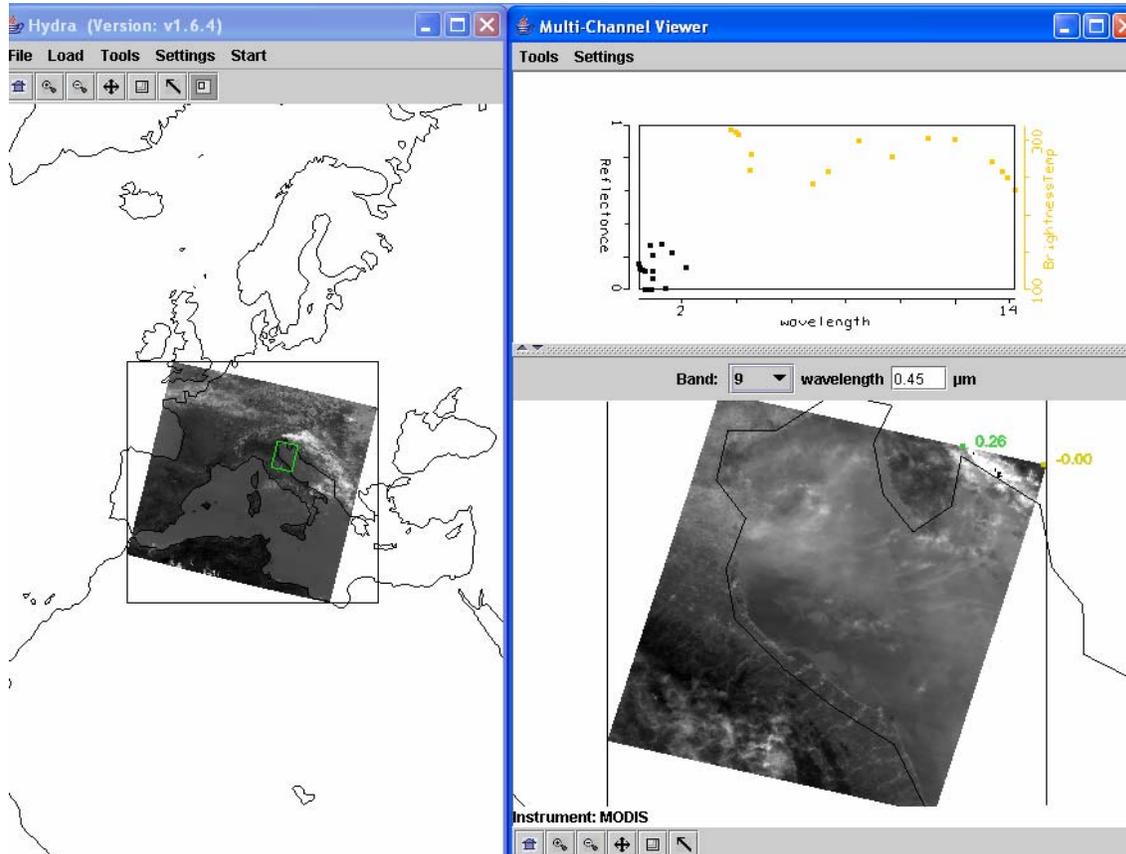

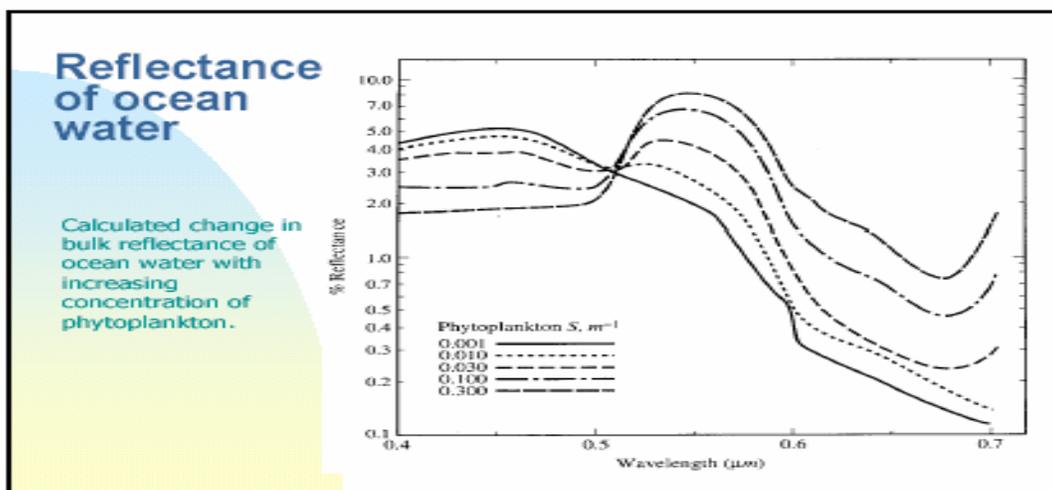**Figure 3:** Northern Adriatic shown in phytoplankton sensitive Band 9.

Figure 4: Reflectance of ocean water with increasing phytoplankton.

3a. Construct a pseudo image of [Band 12 (0.56µm) / Band 9 (0.45µm)]. Using Figure 4 explain why higher values of this ratio should indicate water regions with more phytoplankton from those with little? What is the likely source of the high phytoplankton plume entering the Adriatic?

3b. Create a pseudo SST image of [2*Band 31 (11.0 µm) – Band 32 (12.0 µm)] using *Compute*. What is the range of SST values in the northern Adriatic?

3c. Map the phytoplankton values from 3a on the Y axis (by clicking the Y axis button) against the SST from 3b on the X axis (by clicking the X axis button). Click on the *Scatter* button to open a scatter plot window. Select different regions in the scatter plot window and look at the corresponding points in the linear combination windows. Are high concentrations of phytoplankton associated with warmer or colder waters? Explain.

4. In the Hydra main menu load MODIS measurements of a volcanic eruption of Mt Etna on 28 October 2002 (MOD021KM.A2002301.1215.003.2002302200901.hdf). Select a region to focus on the eruption (see Figure 5).

4a. Plot Band 31 (11 µm) on the X-axis and [Band 31 (11 µm) minus Band 32 (12 µm)] on the Y-axis and show the scatter plot. Observe that the volcanic ash produces negative temperature differences (between 0 and –6 C) in the split window. Show that the denser ash produces the larger differences by highlighting different negative split window values in the scatter plot with different colors (using the tool bar at the bottom of the scatter plot window) for every two degrees (e.g. box -6 to -4 C with red, box -4 to -2 C with green, and box -2 to 0 C with purple). Will negative split windows always depict only volcanic ash? Explain.
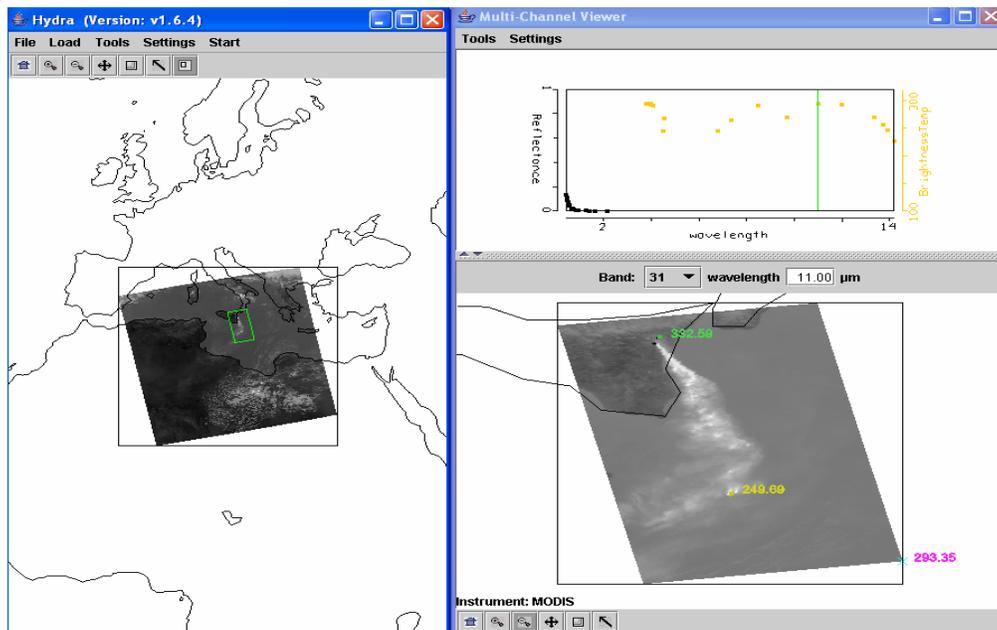

Figure 5: Mt Etna eruption on 28 October 2002