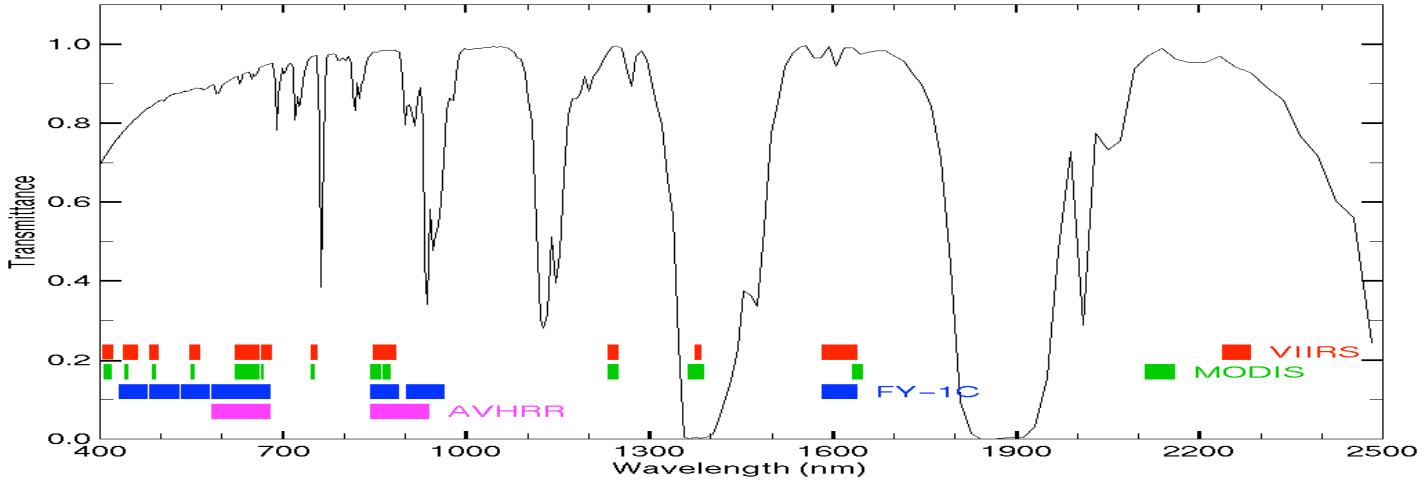
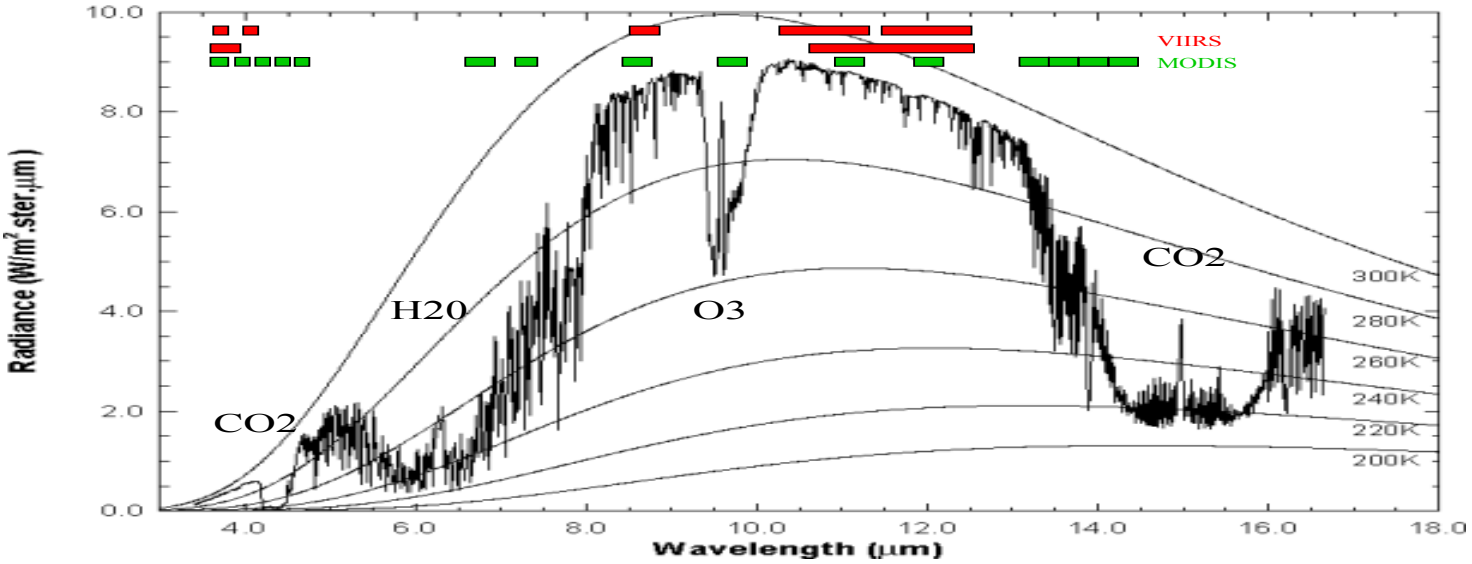
Labs in Tokyo
Menzel

Lab 1 – Using HYDRA2 to Inspect Multispectral Remote Sensing Data

Table: MODIS Bandl 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 temperature
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 temperature
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 temperature
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





Inspect the scene over Italy on 29 May 2001 detected by MODIS using HYDRA (see the attached instruction sheet explaining how to run HYDRA). After engaging HYDRA, the HYDRA window will appear (Figure 1). To load a MODIS Level-1B 1KM file from disk, click on "file" and select "Files" and fnd the file to be loaded (e.g., MOD021KM.A2001149.1030.005.2007054003907.hdf). When the file is loaded, an image of the 11 μm radiances appears, as shown in Figure 2.

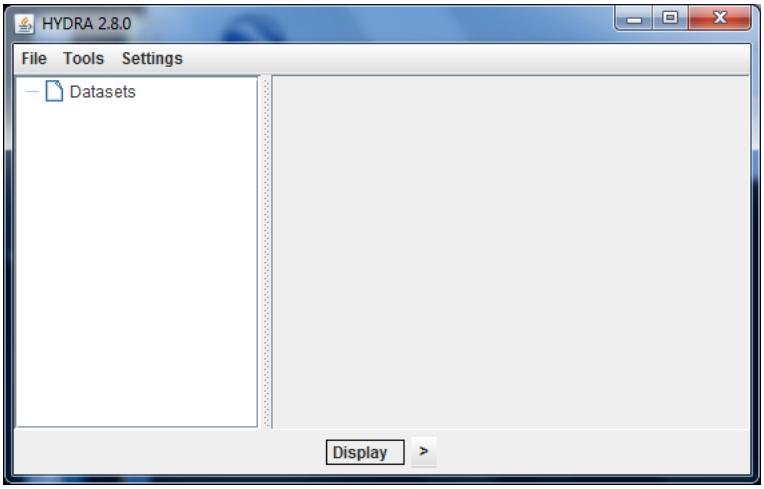


Figure 1: The HYDRA window.

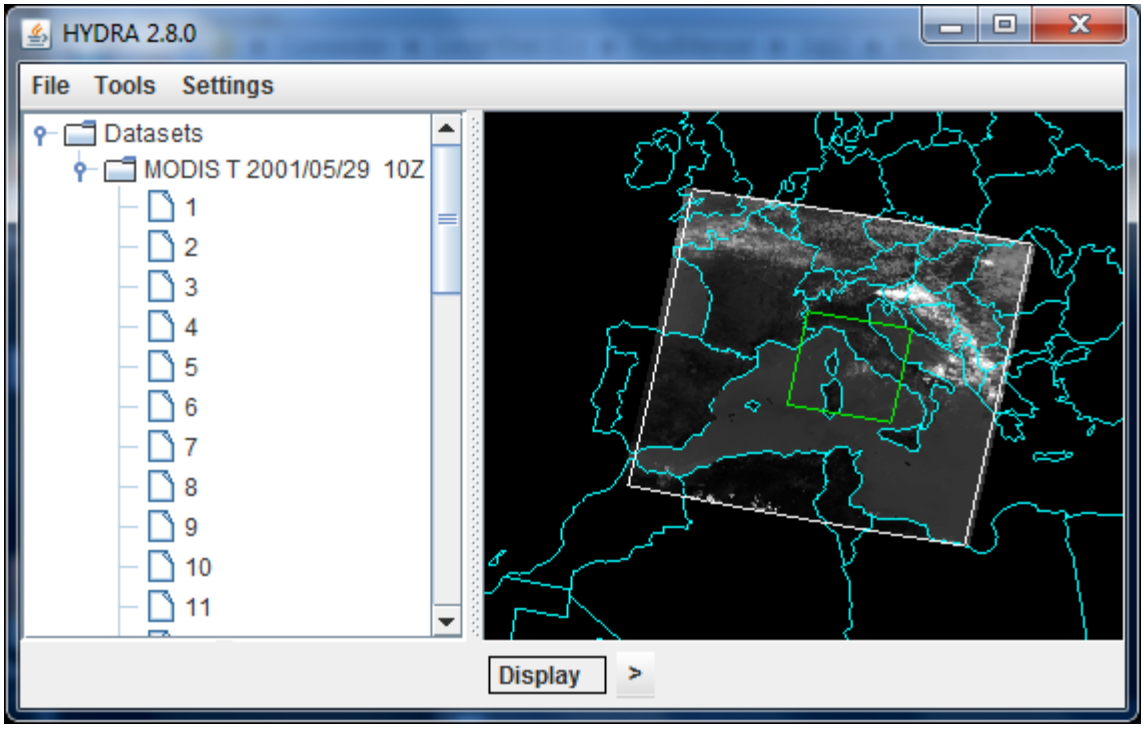


Figure 2: HYDRA window with a MODIS L1B 1KM file loaded.

1. Get familiar with the Display command. After clicking on **Display**, Band 31 (11 μm) is automatically displayed.

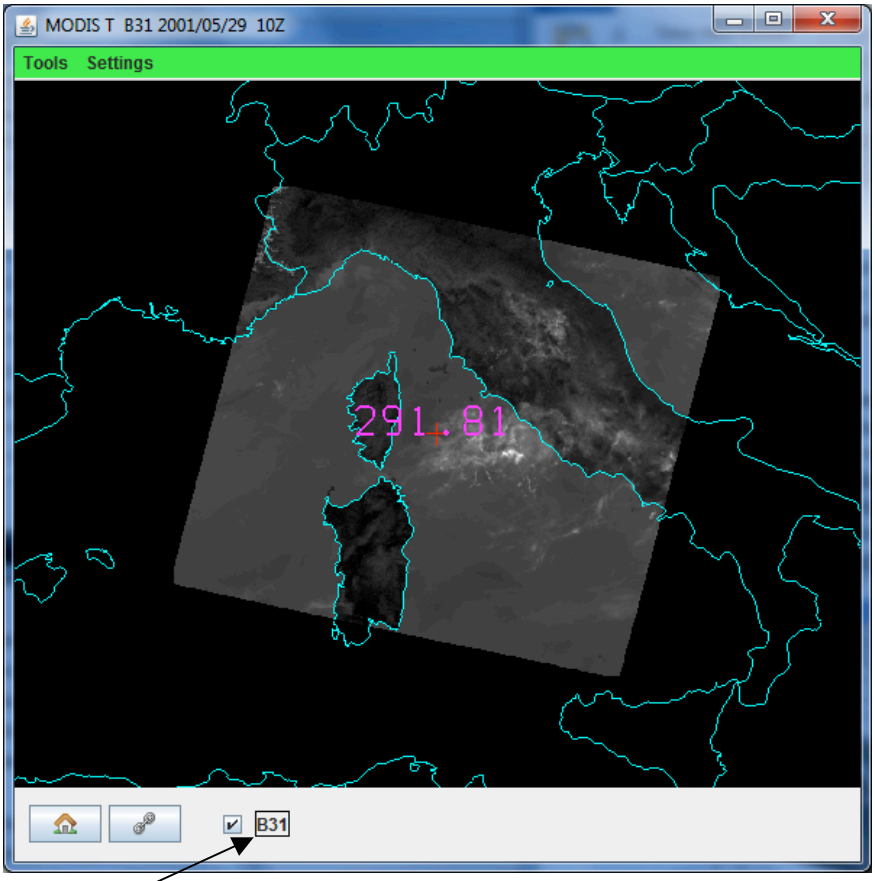
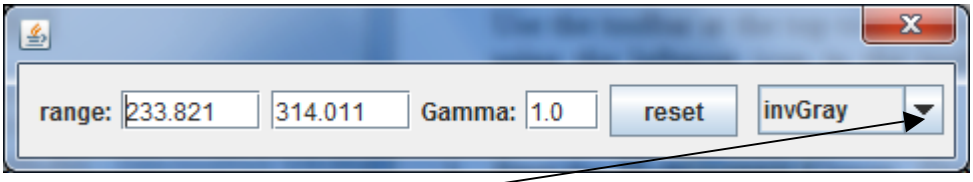


Figure 3. Display of Band 31

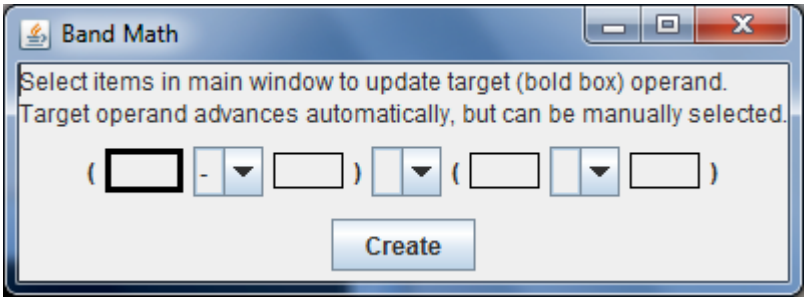
2. Try different black and white enhancements by adjusting the range (click on Band number "B31").



Then switch from invGray to Rainbow. Try different color enhancements. Zoom in and out using shift/right-click/drag. Close the Display.

3. Create another display with the box further north and zoom in on the clouds east of the Alps. Now open another display selecting ***Band number*** 20 (3.8 μm). Note how much warmer the 3.8 μm brightness temperatures are than those for 11 μm. What can be responsible for this? Create an image of 3.8 μm brightness temperatures allowing the range of values to span 250 to 310 K. Do the same for Band 31 (11 μm). Create a power point slide with the two images side by side. Note how the clouds appear to be much larger in the 11 μm image.

4. Start the ***Band Math*** by clicking on ***Tools*** in the main HYDRA window. The following display will pop up.



Fill in Band 20 minus Band 31 (click on the box and then on the Band you wish to place in the box. Also insert the mathematical function you wish to engage). Zoom in on the shoreline in western Italy. Compare the brightness temperature differences in some locations near the shoreline (over land and sea) in northwestern Italy. Note the patches where the 3.8 μm brightness temperatures are much greater than those for 11 μm. What could be causing this?

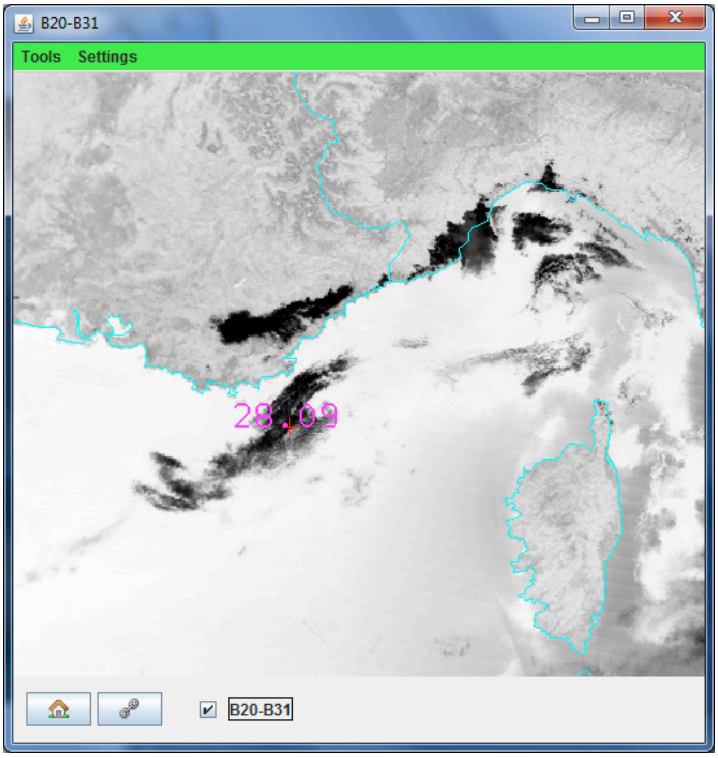


Figure 4: FourChannelCombine display of Band20 minus Band31.

5. Open a new display of Band 20 that includes most of the MODIS granule. Use ***Transect*** (under ***Tools***) in the 3.8 μm image to create a transect going through clouds, sea, and desert (see Figure 5). What are the min and max brightness temperatures encountered. Open another display of Band 31 and do the same for 11 μm. Discuss the difference.

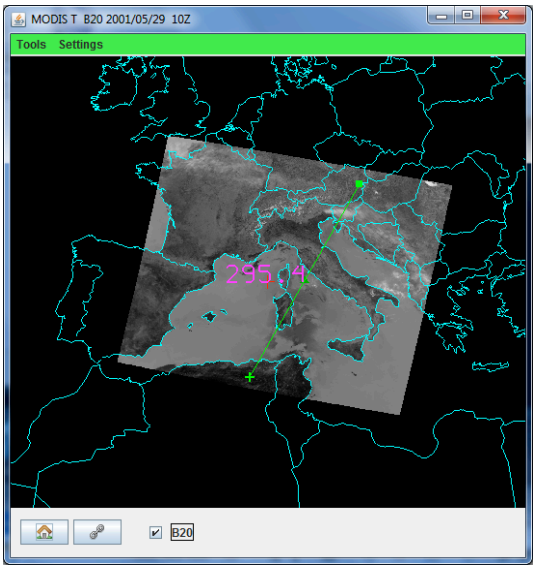


Figure 5: Brightness temperature transect of line over Band 20 image.

6. Open a new display for Band 1 of 0.55 μm reflectances. Hang on to the display of Band 31 with the 11 μm BTs. Click on ***Scatter*** under ***Tools*** to generate a scatter plot (the first image clicked will be on the x-axis and the second image clicked will be on the y-axis). Shows points then switch to density. Look at the stats. Using the color areas boxes (or curves to encircle areas) to highlight pixels in the scatter plot and find where they are located in the images. Save your scatter plot and associated images on a power point slide. Explain high / low reflectances and cold / warm BT combinations in the notes section of the powerpoint slide.

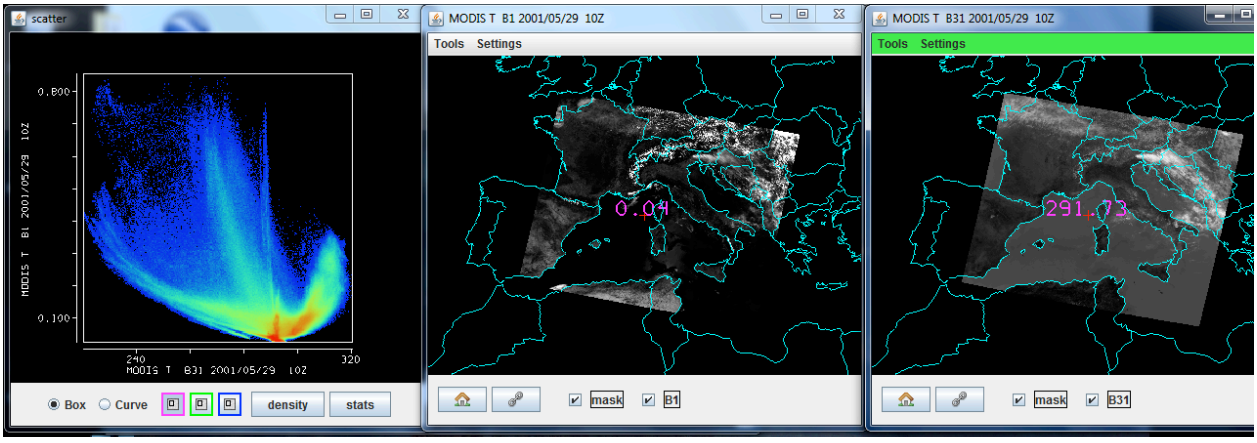


Figure 6: Scatter plot of vis on y-axis and IRW on x-axis

7. Using the ***Band Math***, create an image of the difference of 3.8 μm minus 11 μm brightness temperatures. Display the difference image in color. Use the color range to enhance features in various regions. Save this on a power point slide. Suggest three causes for the large differences for these two window spectral bands? Explain.

Summary of HYDRA 3.6 Commands

In all windows

Shift-right click-drag to zoom in image within display

Right click-drag to move image or roam within display

In HYDRA window (see Figure A1)

Under File, select the VIIRS directory (a VIIRS folder) or File(s) (MOD02 or MYD02 for MODIS, AIRS for AIRS, SCRIS for CrIS, SATMS for ATMS) that is to be studied. (1) For VIIRS and MODIS, file selection will result in a listing of spectral bands available, an image of the IR window with coastlines, and a default subset of the granule that will be displayed in a new window upon clicking on display. The subset of the image can be adjusted with a right click and drag. The spectral band can be changed with a left click on another choice. (2) For CrIS, AIRS, and ATMS, a new window opens showing the spectral band brightness temperatures and a spectral window image showing the data coverage. Left click a drag on the green line in the top display to change the spectral band displayed below.

Left click on spectral band desired (default is IR window)

Left click-drag to highlight subset of image for display

Left click on Display at bottom to create a new image in window #1. Once Window#1 is established you can choose to replace the image in Window#1, to overlay a another image in Window#1, or to open a new Window#2 by using the arrows next to the Display command.

Tools/RGB Composite will open new a box where you have to select the R, G, and B spectral bands desired by left clicking on the color and then on the spectral band. When all three have been

selected, left click on Create in the RGB Composite window to establish the RGB image. Left click on Display in the main HYDRA window to open a new window wherein the RGB image is displayed.

Tools/Band Math will open a new display where you have to select two, three, or four spectral bands that you wish to combine with + , -, x, or / operations. Spectral bands are selected by left clicking on the spectral band and then the appropriate box in the Band Math equation. After selecting the desired Band Math click on create and the pseudo image dataset will appear under Combinations in the main HYDRA window. Click on Display to see the Band Math result in a new Window.

In Window and Band Math Display (see Figure A2)

Left click-drag to move cursor within display

Left click on bottom left icon (house) to restore original display

Left click on bottom box (indicating band number) to open range, gamma, reset, and B&W vs color options (see Figure A3)

> Range can manually set BTmin (rmin) and BTmax (rmax). Range entries can be typed in to enhance low or high reflectances or BTs or they can be set by right click and sliding the top of the green bars in the reflectance/BT histogram. For the VIIRS DNB try very small values for your initial min to max range
>
> Gamma can be adjusted to stretch the dynamic range. It is a non-linear mapping from color to value. For infrared, color_value = BT**gamma. For visible, when gamma = 0.5, this is the square root enhancement popular with VIS.
>
> Reset restores the dynamic range to the min and max values in the display.

Color options include inverse gray (BTmax is black, BTmin is white), gray, rainbow (BTmax is red, BTmin is blue), and inverse rainbow. Contrast from white to black (or blue to red) can be adjusted in the range.

When overlays exist in a window, display can be moved from one overlay to another by clicking on the arrow at bottom of window. The check next to the band (or Band Math) identifier controls whether that image is contained in the loop controlled by the arrow at the bottom of the window. An overlay can be removed by clicking on the red circle to the right of the band identifier. (see Figure A4)

When two displays are open, toggle on link button in lower left to link zoom and roam in two displays (default is to have the windows linked)

After engaging Tools/Transect, one can left click-drag to change end point of the transect. Note that Transect can be opened in several windows simultaneously. (see Figure A5)

To engage Tools/Scatter, left click on Tools/Scatter in a first window to establish the x-axis and then left click on Tools/Scatter in a second window to establish the y-axis of scatter plot. The scatter plot will appear in a separate display. Two windows are necessary; Scatter is not properly initiated when using the overlay from one window alone.

Under Settings, options include coastlines (toggle for on and off), min/max display (toggle for on and off), probe readout (toggle for on and off for numerical value at cursor location), and color scale (toggle for on and off of numerical values associated with the colors in the display)

In Scatter Display (see Figure A6)

Selecting purple, green, and blue points (with box or curve) in the scatter window will show the associated pixels in the two image windows; conversely selecting pixels in either image window will show the associated points in the scatter window.

Left click on the points box (bottom of scatter window) to create density scatter plot; toggle back and forth between points and density

Left click on stats to see stats for purple, green, and blue selections.

Under Settings, Background Color allows selection of white or black background for the scatter plot and Axes allows resetting of x- and y-axes.

In AIRS, CrIS, or ATMS SDR (Sensor Data Record) Display

Select the file(s) to be displayed (AIRS for AIRS, SCRIS for CrIS, SATMS for ATMS)

Move the green line in the spectrum (left click drag) to change the spectral band displayed below.

When viewing the AIRS/CrIS/ATMS spectrum, zoom using shift- left click–drag. Restore to full spectrum using control-left click.

When viewing AIRS/CrIS/ATMS spectral band image left click drag to move cursor within image (note if VIIRS data over same area is open then cursor will move in both VIIRS and CrIS/ATMS images; same for AIRS and MODIS)

Click on Tools to have the option for Transect, Scatter, and FourChannelCombine. In FourChannelCombine the colored lines have to be moved (left click drag) to the desired wavenumber (GHz). Expanding beyond two spectral bands is initiated by completing the mathematical operator desired in the FourChannelCombine equation.

When viewing AIRS or CrIS profile retrievals (temperature, water vapor, and ozone can be found under the parameter), transect and scatter (under Tools) can be used in the same way as before.

In the AIRS or CrIS Retrvl Display left click and drag on the green line in the vertical profile to change the altitude of the parameter being displayed.

The red cursor in the CrIS Retrvl Display will move in synch with the red cursor in CrIS or VIIRS or ATMS spectral band displays; the blue cursor moves independent of any cursor in the other images.

Under Settings, in addition to the usual options, under Spectrum the background color can be switched from black or white.

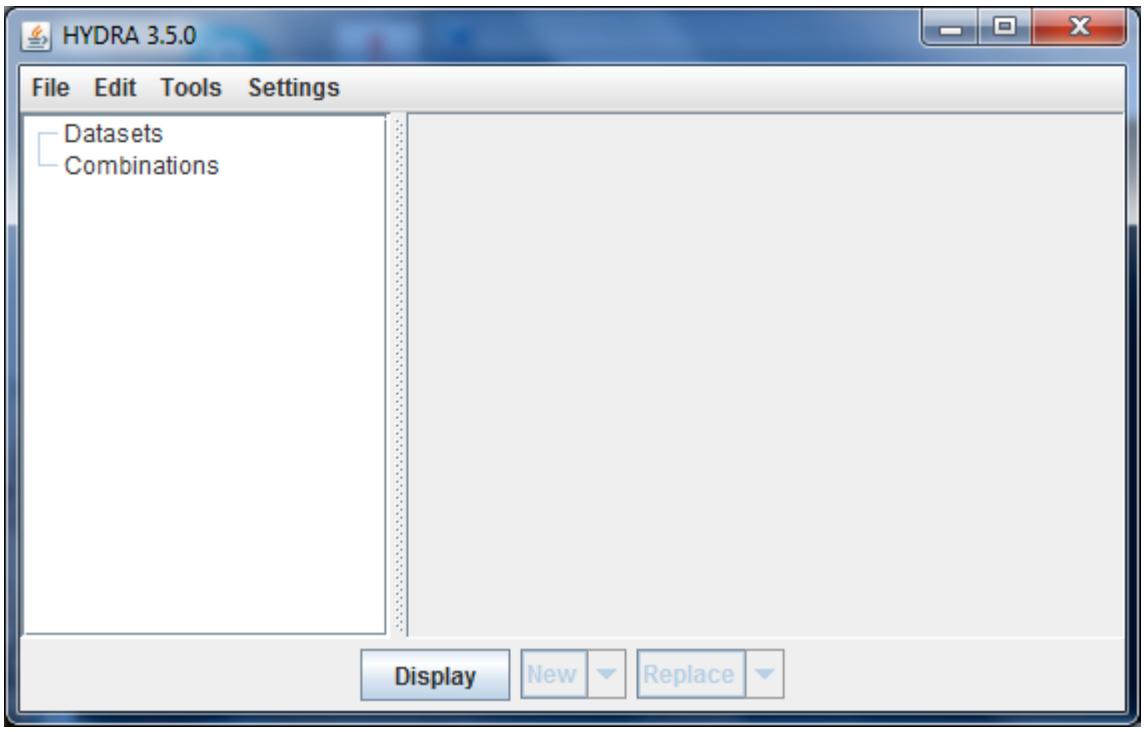


Figure A1: The HYDRA window before data set selection.

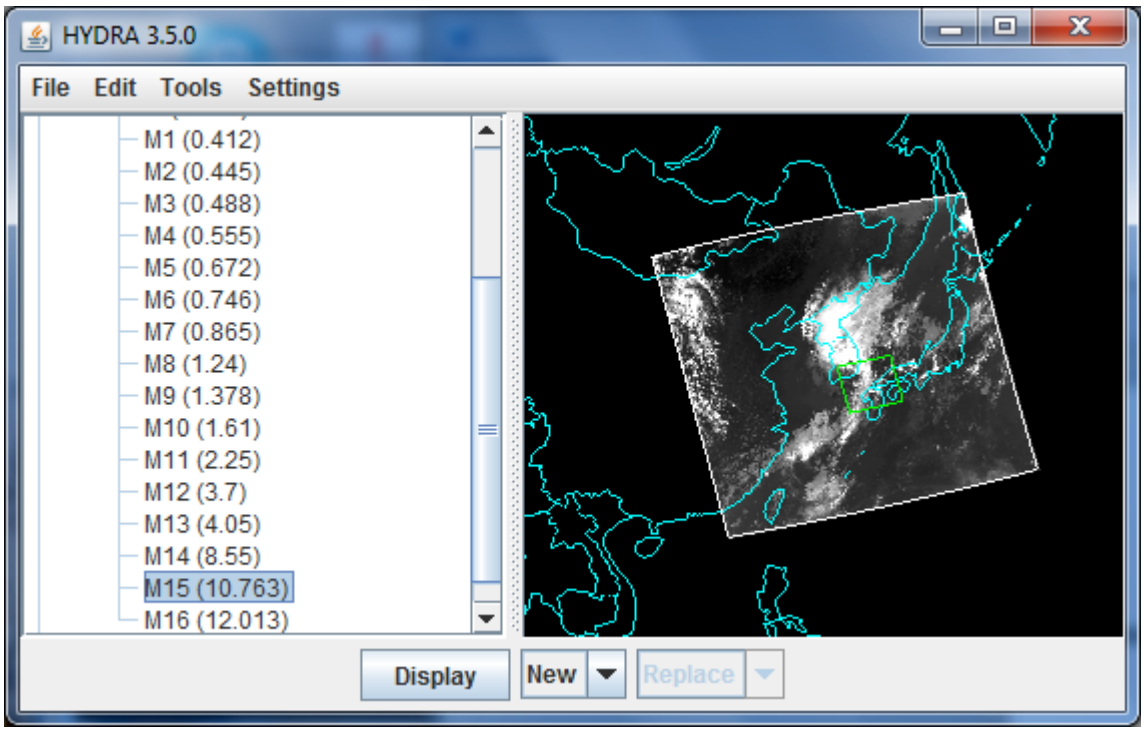


Figure A2: HYDRA window after selection of VIIRS data from 422 UTC on 30 August 2012 over Korea.

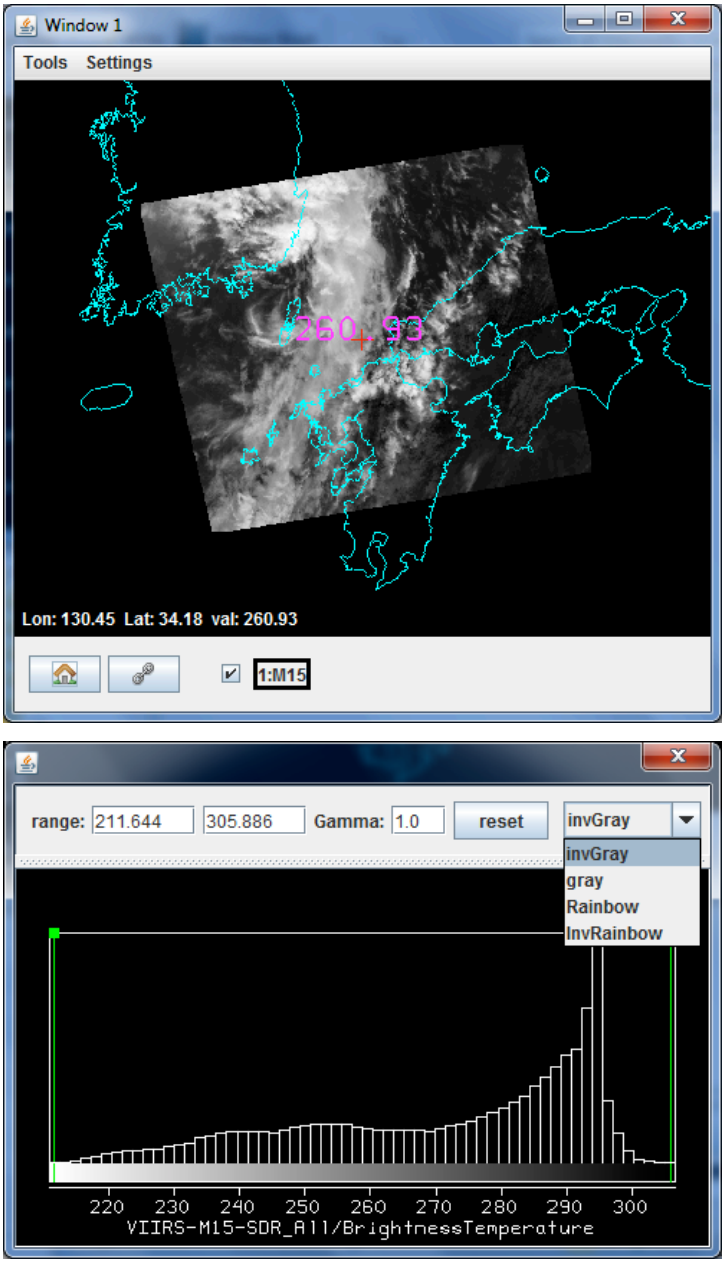


Figure A3: Image enhancement options opened by clicking on the box at the bottom of the window indicating the spectral band. Range entries can be typed in to enhance low or high reflectances or BTs or they can be set by right click drag on the top of the green bars in the reflectance/BT histogram. Reset restores the dynamic range to the min and max values in the display. Color options include inverse gray (BTmax is black, BTmin is white), gray, rainbow (BTmax is red, BTmin is blue), and inverse rainbow.

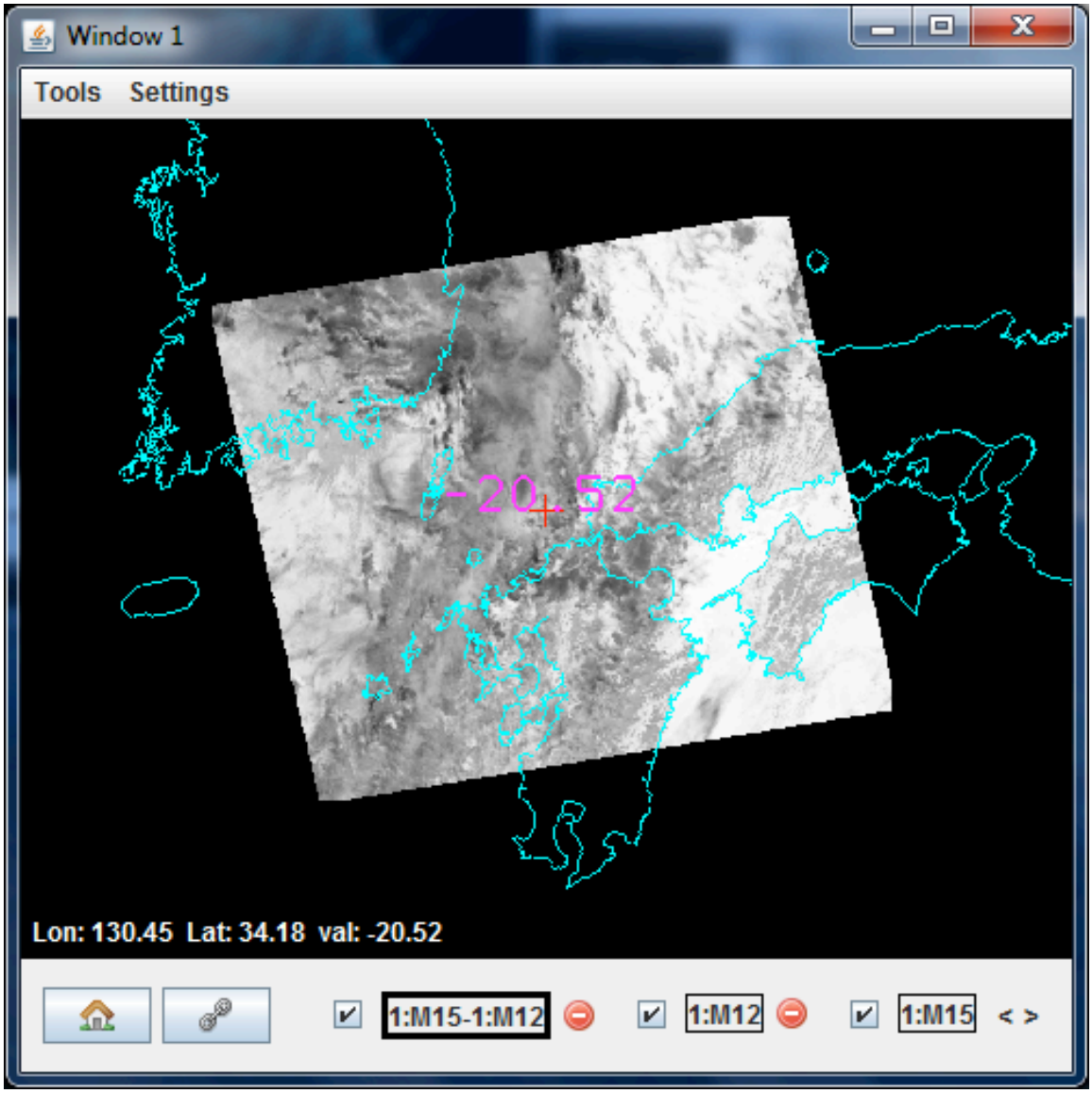


Figure A4: Window with overlay of three VIIRS brightness temperature images (BT(M15) at 10.8 μm minus BT(M12) at 3.7 μm, BT(M12) at 3.7 μm, and BT(M15) at 10.8 μm). The bold outline indicates which of the overlays is on display. When overlays exist in a window, the display can be moved from one overlay to another by clicking on the arrow at bottom right of the window. The check next to the band (or Band Math) identifier controls whether that image is contained in the loop controlled by the arrow at the bottom of the window. An overlay can be removed from the window by clicking on the red circle to the right of the band identifier.

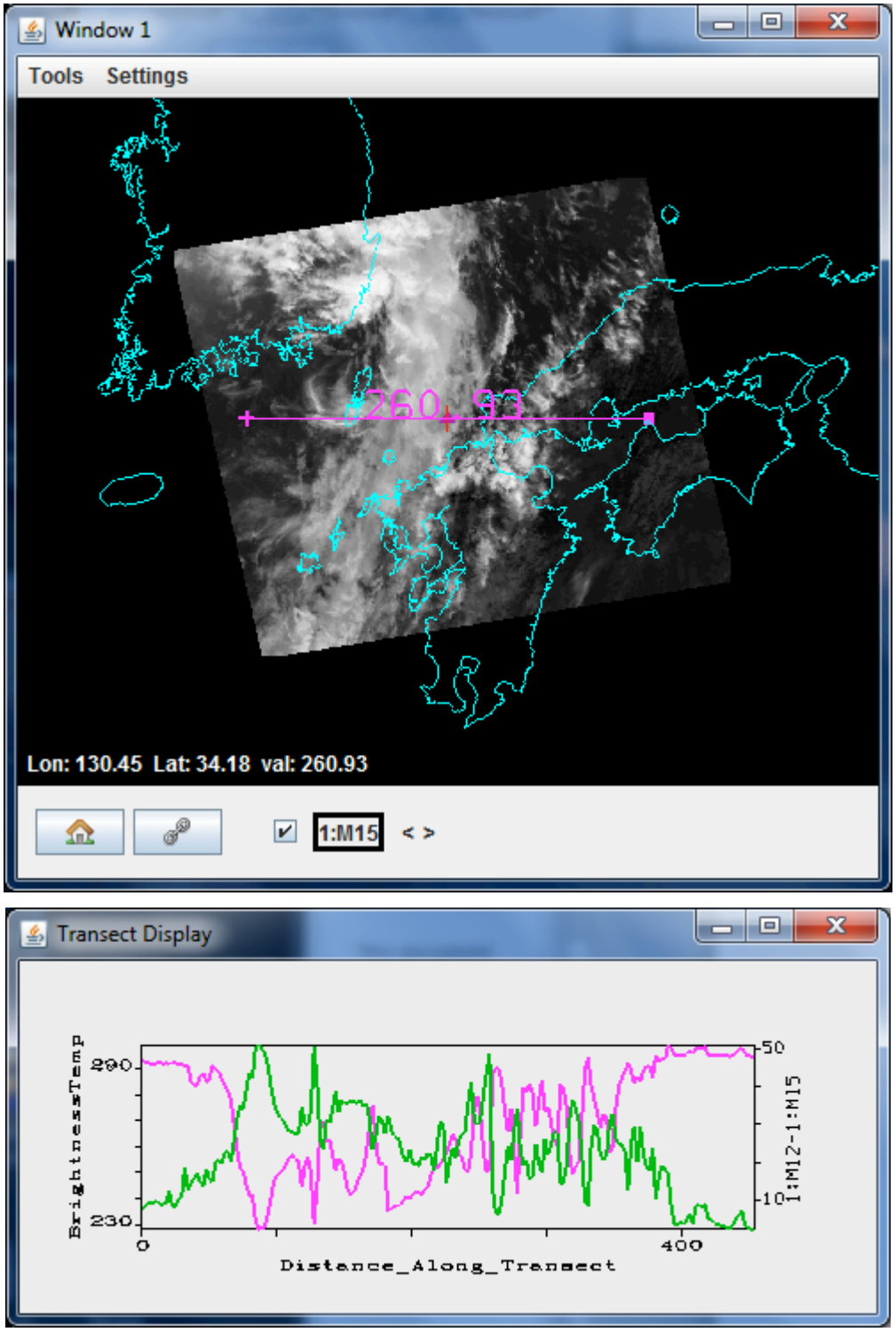
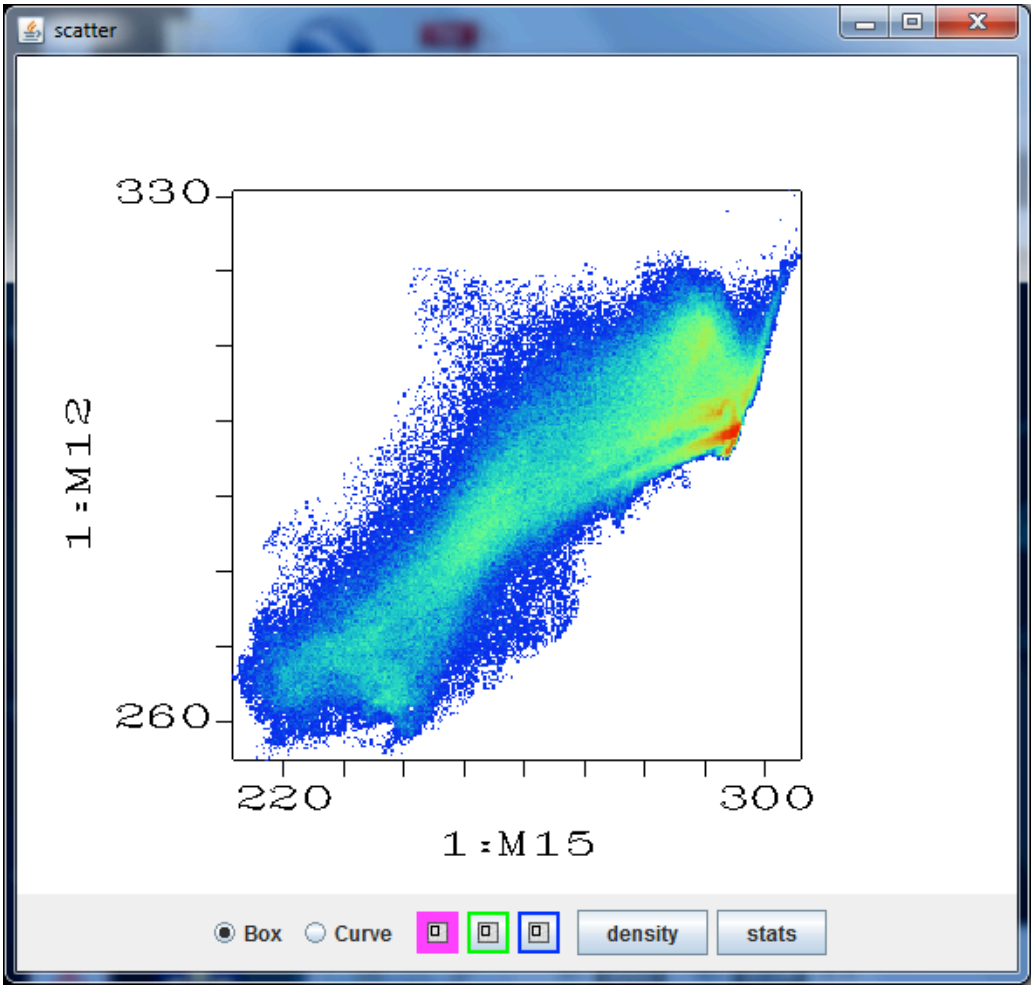


Figure A5: Transect Display of BT(M15) shown in the purple plot and [BT(M12)-BT(M15)] shown in the green plot for M12 at 3.7 μm and M15 at 10.8 μm. The reflected solar contributions often make BT(M12) greater than BT(M15).



Scatter Statistics

Stats Parameter	NPP VIIRS 1:M15 2012/08/30 04:22Z	NPP VIIRS 1:M12 2012/08/30 04:22Z
Maximum	305.89	330.77
Minimum	211.64	254.83
Number of points	592620	592620
Mean	272.28	294.40
Median	279.88	298.07
Variance	475.31	173.39
Kurtosis	-0.71587	-0.06323
Std Dev	21.80	13.17
Correlation	0.84746	
Difference Maximum	-1.427	
Difference Minimum	-78.91	
Difference Mean	-22.11	
Area [km^2]		

Figure A6: (Top) Scatter window (in density mode) showing BT(M15 or 10.8 μm) on x-axis versus BT(M12 or 3.7 μm) on y-axis. Red points show highest occurrence and blue points show least. (Bottom) Scatter statistics for the pixels shown in the scatter plot.