Lab Session 1: MODIS Instrument Characteristics

1. Load the Terra MODIS scene of the Western Australian coast collected on 30 May 2002 at 0240 UTC by selecting 'File, Open Image File' in the main ENVI menu. The image is stored on disk in

D:\WASTAC\Southwest_WA\MOD021KM.A2002150.0240.img

Familiarize yourself with the 'Available Band List' tool by loading and examining the various MODIS spectral bands. Note that in the sample datasets, bands 1-19 and 26 are in reflectance units (dimensionless), and bands 20-36 (not including band 26) are in brightness temperature units (Kelvin). Select different parts of the scene by left-clicking and dragging the rectangle in the Scroll window to a new area. Select different areas to zoom by left-clicking and dragging the rectangle in the Image window. Start the 'Cursor Location / Value' tool by selecting 'Tools, Cursor Location/Value' in the image window.

(a) What are typical reflectance values in band 1 over dark ocean, land, and bright cloud?
(b) What are typical brightness temperature values in band 31 over the same features?

2. Load band 31 for display, and enhance the image by selecting 'Enhance, [Image] Linear 2%' in the Image window. Band 31 is used for many applications including cloud detection, and sea surface temperature.

(a) What are the lowest and highest values in band 31 over the entire scene, and where do they occur?
(b) Which three reflective solar bands (1-19 and 26), and which three thermal emissive bands (20-36) appear to have the worst noise or striping artifacts?

3. Load band 27 for display. Band 27 is used in cloud detection and also to derive upper tropospheric humidity (UTH). Briefly describe regions and features in the image that appear to be casued by

(a) atmospheric conditions
(b) instrument artifacts such as detector imbalance, bad detectors, and mirror side differences

(use the Zoom window and 'Cursor Location / Value' tool to identify individual detector numbers)

4. Display a vertical profile of the band 27 image by selecting 'Tools, Profiles, Y Profile' in the Image window. Center the Image window at around line 1050 in the scene.

(a) What is the approximate peak to peak noise (in Kelvin) due to striping?

Reset the range of the plot x-axis by selecting 'Edit, Plot Parameters' in the Vertical Profile plot window, and enter 1000 to 1100 as the range for the x-axis (hit Enter after typing each number', then hit 'Apply'.

(b) Does the striping pattern appear to be consistent in the profile plot?
(c) How would you correct the image (i.e., remove the striping) if

- the detectors are out of balance with each other
- one detector is behaving unpredictably
- all detectors are biased with respect to truth?

5. Load band 31 for display. Center the area in the Image window just south of Shark Bay. Move the Zoom window selector to an area over the water that is fairly uniform. Enhance the image by selecting 'Enhance, [Zoom] Linear 2%' in the Image window. This should stretch the image over a narrow range of values. Move the Zoom window selector to a region that looks uniform (i.e., a minimum of surface features). Start the Region of Interest (ROI) tool by selecting 'Tools, Region of Interest, ROI Tool' in the Image window. In the ROI tool window, select 'ROI_Type, Rectangle'. Now left click, drag, and right click to select the uniform area in the Image window. You should end up with an ROI with between 1000 and 2000 points. Press 'Delete' in the ROI window if you are not happy with the region selected. Now view statistics for the ROI by selecting 'Options, Stats for All Regions' in the ROI tool window. You should see a report showing the minimum, maximum, mean, and standard deviation for all bands within the ROI.

(a) Which three reflected solar bands (1-19 and 26) are the noisiest (i.e., highest standard deviation)?
(b) Which three thermal emissive bands (20-36) are the noisiest?
(c) Do the noise estimates correspond to your initial impressions from part 2 of this exercise?

6. Load band 8 for display. Band 8 is used for ocean color retrievals. Note how this band saturates over bright targets such as clouds or deserts (saturated pixels are set to a value of –1.0 in this dataset).

(a) What is the approximate reflectance at which band 8 saturates?
(b) What is the approximate saturation reflectance in bands 9, 12, 13, and 16?

7. Load the Terra MODIS scene of Tropical Cyclone Sam off the Western Australian coast collected on 30 May 2002 at 0240 UTC. The image is stored on disk in

D:\WASTAC\TCSam_WA\MOD021KM.A2000343.0210.img

Load band 4 for display, and center the Image window over the eye of the cyclone. Band 4 is used for making true color composite images.

(a) Do you see any evidence of saturation in this band?
(b) What is the approximate reflectance at which band 4 saturates?
(c) What impact would the saturation in band 4 have on true color images, if bands 1/4/3 are used for red/green/blue?

8. Load band 31 for display. Note how dark regions in the image correspond to cold cloud tops (infrared images are sometimes displayed with the grayscale color table reversed so the clouds are white).

(a) What is the coldest brightness temperature you can find over a cloud top?
(b) What is the temperature contrast (range) between the eye of the cyclone and the surrounding eyewall?

(c) Why the eye is so much warmer than the eyewall?
(d) Why might the clouds in the eyewall be so cold?

9. Start a second display window by selecting ‘Display #1, New Display’ in the Available Bands List, and load band 6 in the Display #2 Image window. Band 6 is used for discriminating water vs. ice particles. Now select ‘Tools, Link, Link Displays’ in the Display #2 Image window. In the ‘Link Displays’ dialog, select ‘Link Size / Position, Display #1’ and hit ‘OK’. Now you can left click on either Image window, and ENVI will display the other MODIS band. Flick bands 31 and 6 on and off in one of the Image windows, and note the correspondence between the cloud features in the two bands.

(a) Do the darker clouds in band 6 have any correspondence to the same clouds in band 31?
(b) From the appearance of the clouds in band 6 and band 31, how might you discriminate between ice vs. water clouds?