

Hampton University Direct Broadcast Polar Orbiter Workshop

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8 June 2017 Lab 2 Part 4: Investigating VIIRS and MODIS Fire Detection Capabilities

1.1. Use Hydra to open the VIIRS directory from the daytime pass of 7 April 2012. Select the directory and click on **Choose**. Select the North Florida region as shown in Figure 1 and display the M-Band 15 (10.7 μm) data at full resolution.

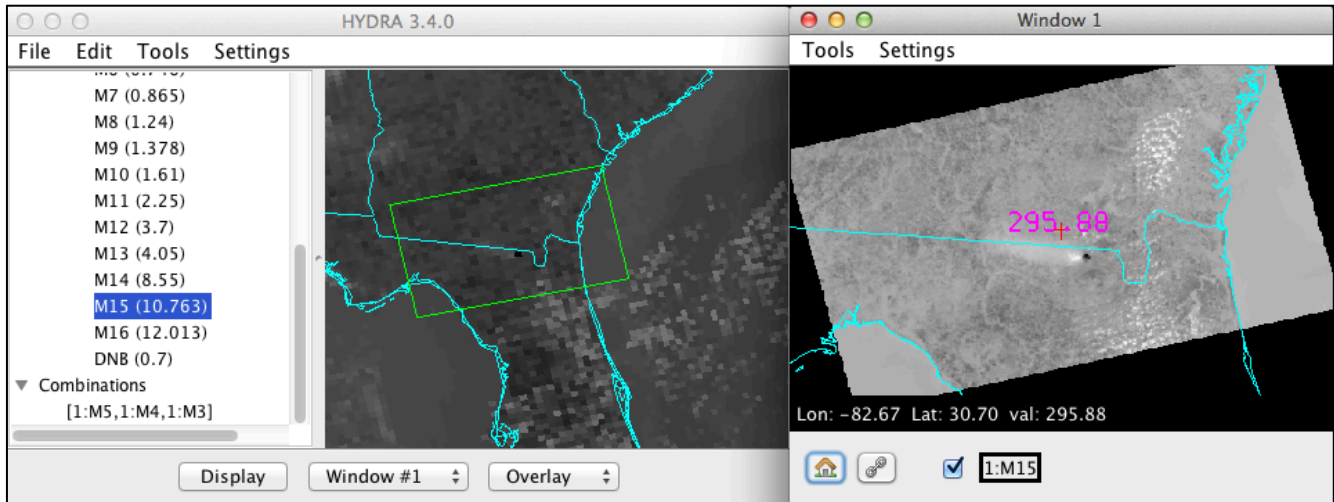


Figure 1: Suomi-NPP VIIRS Hydra screen capture from 7 April 2012, 18:14 UTC with the full resolution display of M-Band 15 (10.7 μm) brightness temperatures over Northern Florida.

2. Create a natural color (true color) image of this scene in a new Window by choosing **Tools->RGB Composite** from the main HYDRA window. Highlight a color box from the RGBComposite window, and then choose a dataset band from the S-NPP VIIRS band list to insert. **Choose Red->M-Band 5 (.67 μm), Green->M-Band 4 (.55 μm) and Blue->M-Band 3 (.48 μm)**. Once the RGBComposite boxes are filled, select the **Create** button. Your RGBComposite bands will be added to the bottom of the dataset list, under the **Combinations** heading. Once it has been added, overlay the true color image. Enhance your RGB image by clicking on the true color composite box in your image Window. A window will open allowing you to change the range of each band that went into the composite. Change the **Gamma value** in the bottom of the enhancement window to .4, and hit return (See Figure 2, Right Panel). What is the predominant feature in this scene?

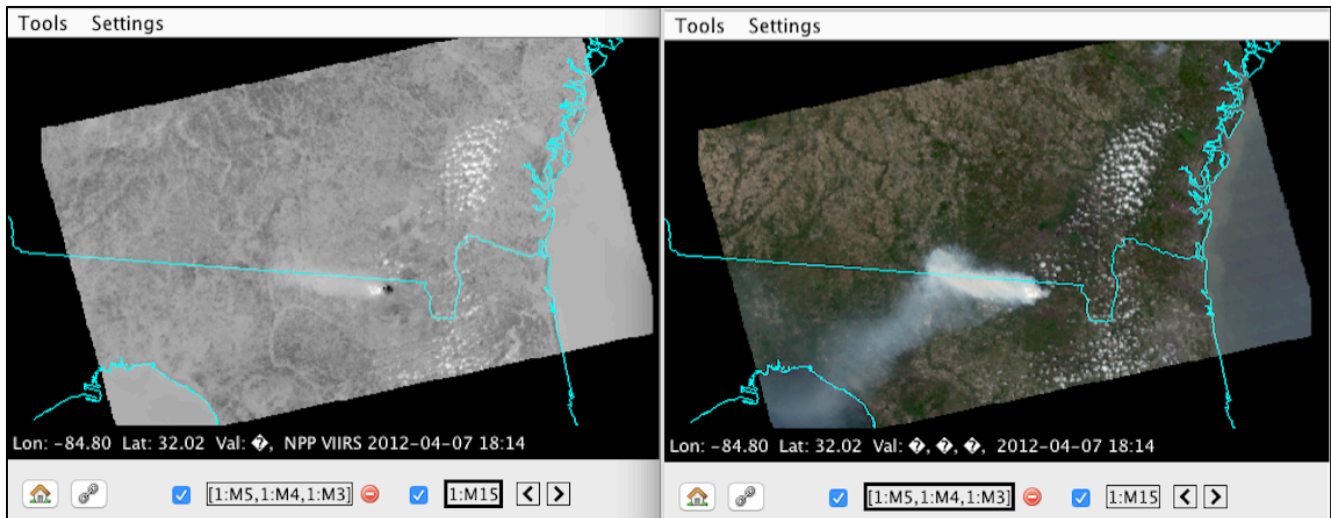


Figure 2: Suomi-NPP VIIRS Hydra screen capture from 7 April 2012, 18:14 UTC with a high resolution display of M-Band 15 (10.7 μm) brightness temperatures in the left panel and a natural color RGB composite image in the right panel.

3. Now display the M-Band 13 (4.05 μm) brightness temperatures in a new window. Look at the range of temperatures in both this and the M-Band 15 (10.7 μm) data (**use Settings->min/max** in each Window). How do they compare? Where do the warmest temperatures occur for each band?

4. Create a brightness temperature difference image of 4 micron (M-Band 13) minus 11 micron (M-Band 15) using the **Band Math tool** and display the result in a new Window. Close the Band Math window. Enhance the image to find the largest brightness temperature differences. Use the min/max setting to help you. Why are these window channel observed temperatures so different?

5. Most fire detection algorithms use a series of tests to determine if a pixel contains a hot spot or fire. The first step is to identify potential fire pixels. If we use the MODIS fire detection technique as an example, this involves testing a pixel to see if the 4 micron brightness temperature (BT4) > 310 K and $\text{BT}_{\text{DIF4-11}} = (\text{M-Band 13 (4.0 } \mu\text{m)} - \text{M-Band 15 (10.7 } \mu\text{m)}) > 10 \text{ K}$. To implement this on our data set, create a scatter diagram of (M-Band 13 (4.0 μm) minus M-Band 15 (10.7 μm)) versus M-Band 13 (4.0 μm) (choose **Scatter** from the M-Band 13 window first) (Refer to Figure 3). Identify the different clusters of points in the diagram. You can change the background color of the scatter diagram by choosing **Settings->Background Color** in the **Scatter Diagram** window.

Try out these thresholds by outlining the points which meet this criteria within the scatter diagram by selecting a color at the bottom of the scatter diagram and dragging the selection box over the region which satisfies both thresholds, as shown in Figure 3.

- How do you think this preliminary test performs?
- Do you think it captures all of the fire pixels? Too many?
- What thresholds would you choose for this data set?
- What are the advantages and disadvantages of hot spot detection at night?

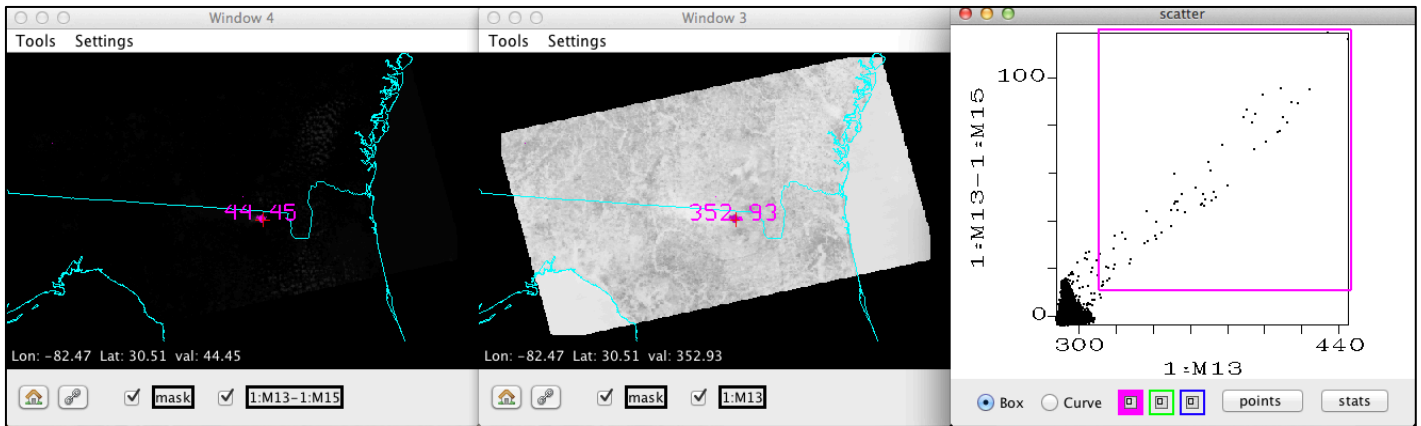


Figure 3: Hydra screen capture of VIIRS (M-Band 13 (4.0 μm) – M-Band 15 (10.7 μm)) brightness temperature differences (left panel), M-Band 13 (4.0 μm) brightness temperatures (center panel), and a scatter diagram of the (M-Band 13 (4.0 μm) – M-Band 15 (10.7 μm)) versus M-Band 13 (4.0 μm) (right panel) brightness temperatures from the VIIRS 7 April 2012 scene.

6. The next step for most fire detection techniques is to use spectral tests to differentiate the fire pixel from the non-fire pixel background region. This involves comparing the potential fire pixel to the surrounding pixels. This contextual approach uses the average brightness temperature of the non-potential fire pixels in the 4 micron data that surround the fire pixel along with the Mean Absolute Deviation (the mean of the absolute value of the differences between the average and the deviation from the average). For individual pixels that did not pass the original BT4 test, they must pass 3 dynamic thresholds to be labeled a fire pixel.

Describe how these factors may affect the instrument ability to detect fires:

- A very cloudy scene.
- A region with many fires.
- A very hot region.
- Instrument spatial resolution.
- Aggregation of Fields-of-View (FOVs) in VIIRS data prior to direct broadcast downlink.

7. Open the Aqua MODIS 5 minute granule data set from the same day (**MYD021KM.A2012098.1845.006.2012186084405.hdf**) and display the MODIS Band 21 (3.99 μm) temperatures in a new window. What is the range of brightness temperatures in this scene, and how do they compare to the VIIRS 4 micron scene M-Band 13 (4.0 μm)? Name two reasons why the observed hot spot pixel temperatures are not the same?

8. Now open the MODIS Level 2 fire product for this date/time by choosing **File->Files->MYD14.A2012098.1845.006.2015240073359.hdf** and overlaying it on the MODIS Band 21 (3.99 μm) image. The locations where nominal or high confidence fire pixels were found (yellow->orange->red = higher confidence) will be displayed. How do you think this product performed on our scene?

9. What are the advantages and disadvantages of geostationary imager satellite fire detection versus polar orbiter imager fire detection? When you are finished, close Hydra (**File->Exit**).