

Hawaii Direct Broadcast Remote Sensing Workshop 20-23 August 2013

22 August 2013 Lab 3 Part 1: Hot Spot Detection (Pu‘u ‘Ō‘ō and Halema‘uma‘u)

1.1. Use Hydra to open the VIIRS directory from the daytime pass of 11 August 2013. Select the directory and click on Open. Select the Big Island region as shown in Figure 1 and display the M-Band 13 (4.05 μm) data at full resolution.

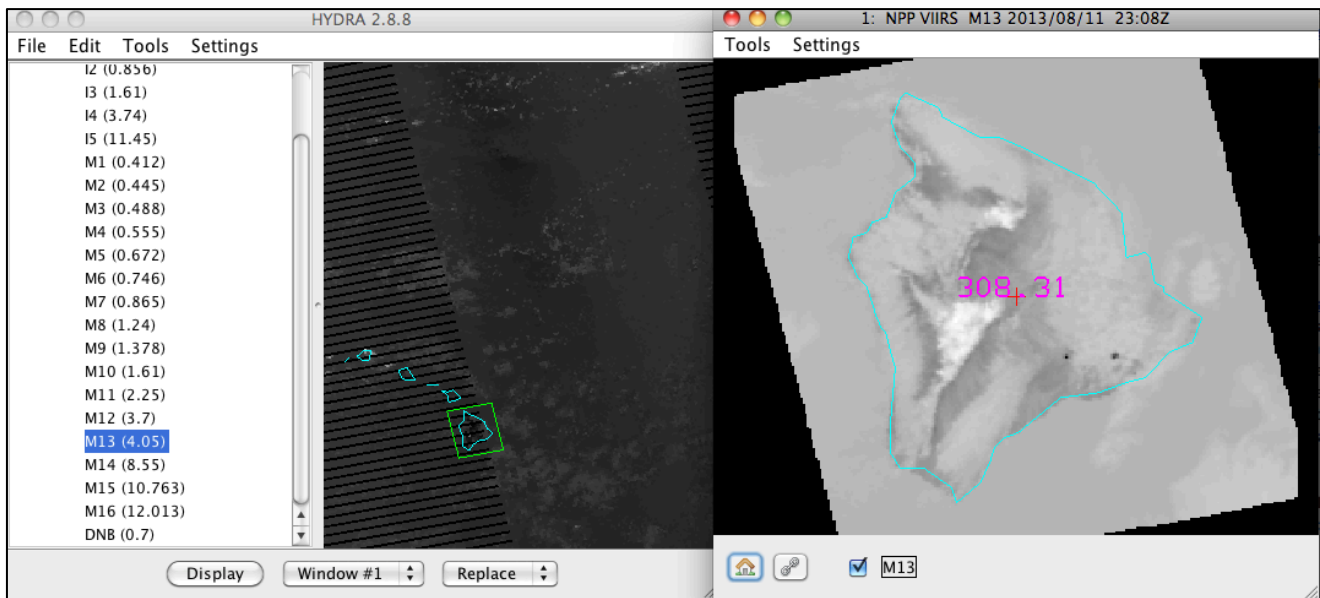


Figure 1: Suomi-NPP VIIRS Hydra screen capture from 11 August 2013, 23:20 UTC with a high resolution display of M-Band 13 (4.05 μm) brightness temperatures in the right panel.

2. Now display the M-Band 15 (10.7 μm) brightness temperatures into a new window. Look at the range of data in both. How do they compare? Where do the warmest temperatures occur for each band?

3. Create a brightness temperature difference image of 4 micron (M-Band 13) minus 11 micron (M-Band 15) using the FourChannelCombine tool. Enhance the image to find the largest brightness temperature differences. Approximately how large is this difference? Why are these window channel observed temperatures so different?

4. 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 (BT_4) > 310 K and $BTDIF_{4-11} ((M\text{-Band } 13 (4.05 \mu\text{m}) - M\text{-Band } 15 (10.7 \mu\text{m})) > 10$ K. To implement this on our data set, create a scatter diagram of (M-Band 13 (4.05 μm) minus M-Band 15 (10.7 μm)) versus M-Band 13 (4.05 μm) (choose Scatter from the M-Band 13 window first) (Refer to Figure 2). Identify the different clusters of points in the diagram.

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 2.

- 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?

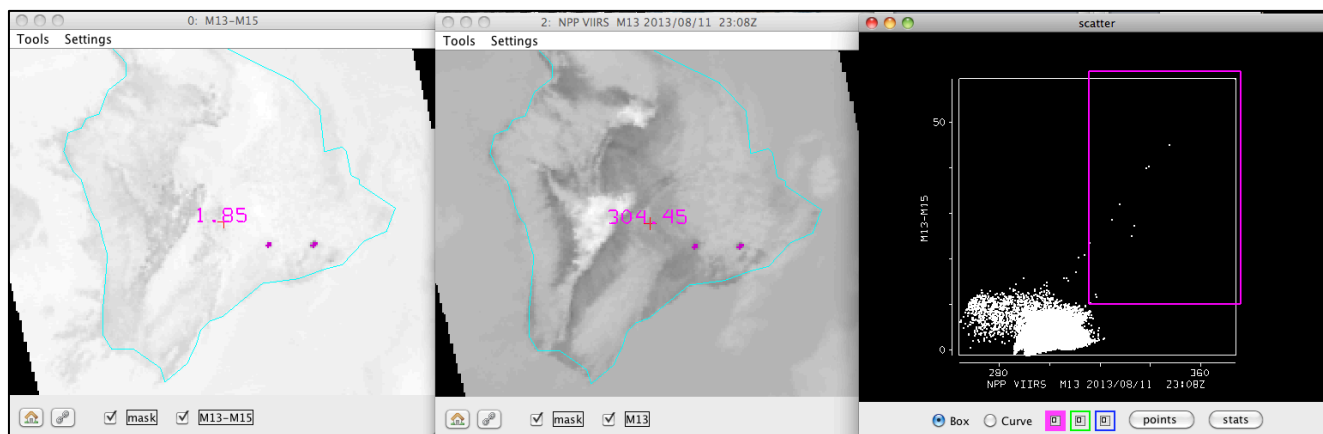


Figure 2: Hydra screen capture of VIIRS (M-Band 13 (4.05 μm) – M-Band 15 (10.7 μm)) brightness temperature differences (left panel), M-Band 13 (4.05 μm) brightness temperatures (center panel), and a scatter diagram of the (M-Band 13 (4.05 μm) – M-Band 15 (10.7 μm)) versus M-Band 13 (4.05 μm) (right panel) brightness temperatures from the VIIRS 11 August 2013 scene.

5. The MODIS fire detection technique uses a variety of 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 environments may affect the MODIS instrument ability to detect fires:

- A very cloudy scene.
- A region with many fires.
- A very hot region.

6. Open the Aqua MODIS data set from this day (a1.13223.2320.1000m.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 (4.05 μm)? Can you think of reasons for the differences? What is the advantage of high spatial resolution in hot spot detection?

7. Now open the MODIS Level 2 fire product by choosing File->Files-> a1.13223.2320.mod14.hdf and overlaying it on the MODIS Band 21 (3.99 μm) image. The locations where nominal or high confidence fire pixels were found will be displayed. How do you think this product performed on our scene?

Extra Credit - Hot Spot Investigation

8. Display the MODIS I-Band 4 micron (I-Band 4) data over the same region. Compare the range of values to the MODIS and VIIRS M-Band 4 micron data sets. Now draw a transect through the hot spots in the data sets, and compare the values in terms of detail and maximum/minimum values. What other things besides spatial resolution affect the results?

Lab 3 Part 2 - Investigating the VIIRS Day/Night band under different lunar illuminations.

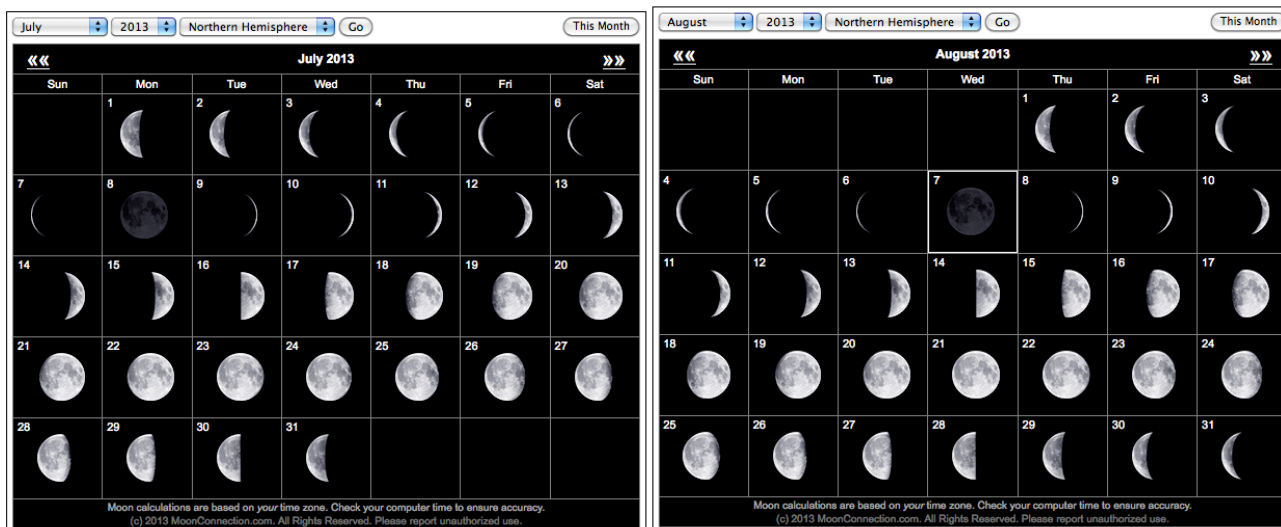
The VIIRS Day/Night Band is sensitive to a huge range of radiances (seven orders of magnitude) and can observe things such as nighttime lunar reflection and nighttime visible light emissions. However, because the instrument is not lunar synchronous, the ability of the band to detect atmospheric features like clouds is highly dependent on the amount of lunar illumination.

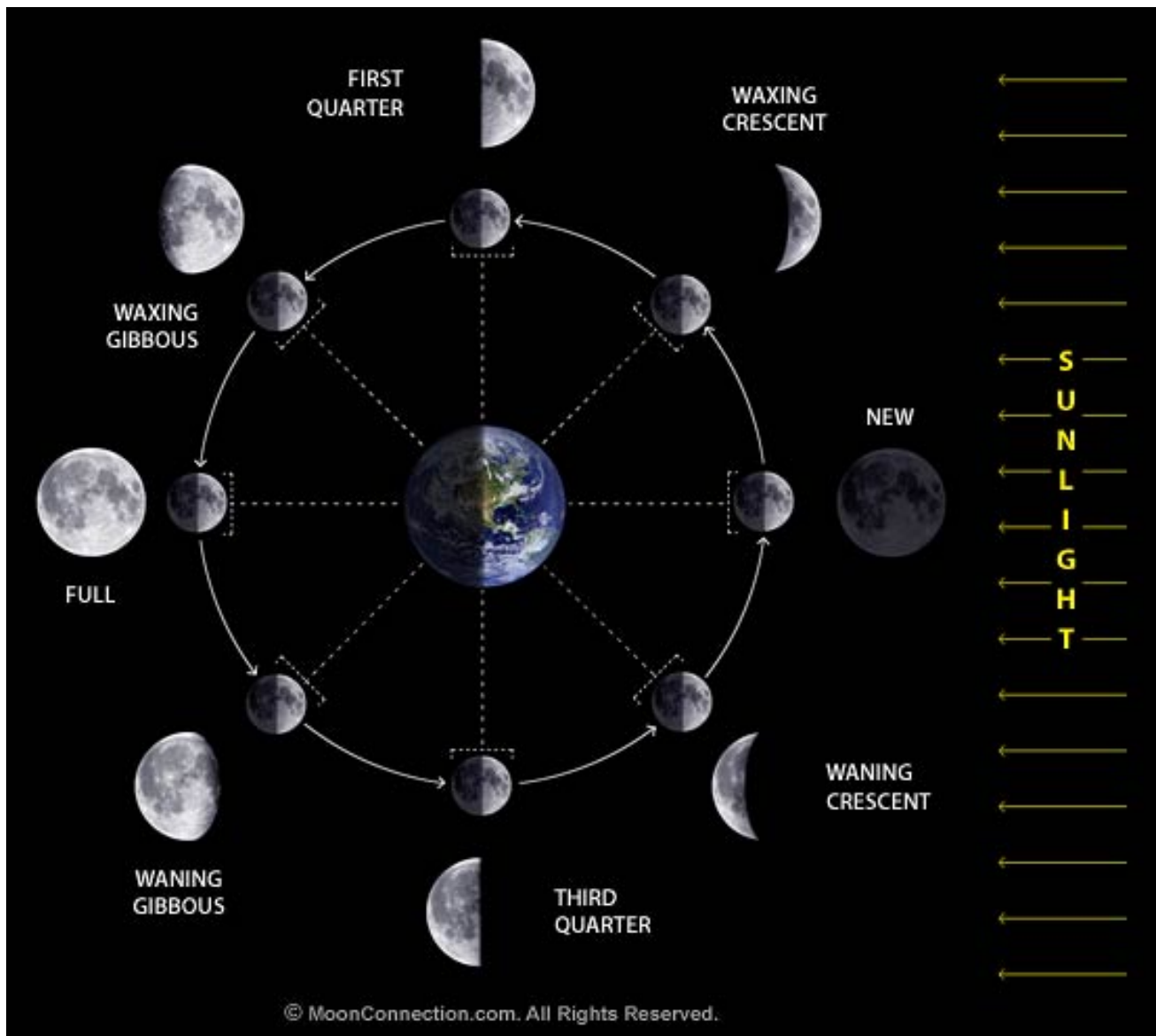
This lab invites you to investigate four different VIIRS Day/Night Band data sets representing 4 lunar illumination regimes over the Hawaiian Islands. As you look at these four data sets, note:

- The phase of the moon,
- The range of radiance values in each scene and where the maxima appear.
- How consistent the illumination is across the swath (why would this change across a scan?).
- What features can you see in the land/ocean/atmosphere and how do they vary depending on illumination?
- What advantages and disadvantages does this band have over standard infrared bands in terms of cloud detection?

You can use the following charts and table to help you.

Hint: For better image enhancements, you may have to drag the lower range bar below zero.





Rising and setting times for the Moon

Date	Moonrise	Moonset	Meridian Passing			Illuminated	Phase
			Time	Altitude	Distance (mi)		
Jul 1, 2013	1:03 AM	2:05 PM	7:33 AM	79.9°	245,360	34.8%	
Jul 2, 2013	1:44 AM	2:57 PM	8:19 AM	83.2°	247,999	25.5%	
Jul 3, 2013	2:26 AM	3:49 PM	9:06 AM	85.6°	250,031	17.3%	
Jul 4, 2013	3:10 AM	4:39 PM	9:54 AM	87.2°	251,450	10.6%	
Jul 5, 2013	3:56 AM	5:27 PM	10:42 AM	87.9°	252,285	5.3%	
Jul 6, 2013	4:44 AM	6:14 PM	11:30 AM	87.7°	252,586	1.9%	
Jul 7, 2013	5:34 AM	6:59 PM	12:17 PM	86.5°	252,409	0.3%	New Moon at 9:15 PM
Jul 8, 2013	6:24 AM	7:41 PM	1:04 PM	84.4°	251,794	0.6%	
Jul 9, 2013	7:15 AM	8:22 PM	1:50 PM	81.6°	250,759	2.8%	
Jul 10, 2013	8:05 AM	9:00 PM	2:34 PM	78.1°	249,302	6.9%	
Jul 11, 2013	8:56 AM	9:38 PM	3:18 PM	74.2°	247,412	12.9%	
Jul 12, 2013	9:47 AM	10:15 PM	4:03 PM	69.9°	245,084	20.4%	
Jul 13, 2013	10:39 AM	10:53 PM	4:47 PM	65.4°	242,337	29.4%	
Jul 14, 2013	11:32 AM	11:32 PM	5:34 PM	60.9°	239,223	39.6%	
Jul 15, 2013	12:27 PM	-	6:22 PM	56.7°	235,843	50.6%	First Quarter at 5:19 PM
Jul 16, 2013	- 12:15 AM 1:25 PM	-	7:14 PM	52.9°	232,364	61.9%	
Jul 17, 2013	- 1:01 AM 2:25 PM	-	8:10 PM	50.0°	229,027	72.9%	
Jul 18, 2013	- 1:53 AM 3:27 PM	-	9:09 PM	48.1°	226,126	83.0%	
Jul 19, 2013	- 2:49 AM 4:30 PM	-	10:10 PM	47.6°	223,976	91.3%	
Jul 20, 2013	- 3:51 AM 5:31 PM	-	11:13 PM	48.7°	222,850	97.0%	
Jul 21, 2013	- 4:56 AM 6:29 PM	-					
Jul 22, 2013	- 6:02 AM 7:22 PM	-	12:14 AM	51.2°	222,920	99.7%	Full Moon at 8:16 AM Super Full Moon
Jul 23, 2013	- 7:07 AM 8:11 PM	-	1:13 AM	55.0°	224,217	99.1%	
Jul 24, 2013	- 8:10 AM 8:57 PM	-	2:09 AM	59.5°	226,623	95.4%	
Jul 25, 2013	- 9:10 AM 9:39 PM	-	3:02 AM	64.5°	229,893	89.1%	
Jul 26, 2013	- 10:08 AM 10:21 PM	-	3:52 AM	69.4°	233,698	80.9%	
Jul 27, 2013	- 11:04 AM 11:01 PM	-	4:40 AM	74.1°	237,684	71.3%	
Jul 28, 2013	- 11:58 AM 11:42 PM	-	5:28 AM	78.3°	241,526	61.1%	
Jul 29, 2013		12:51 PM	6:15 AM	81.9°	244,966	50.7%	Third Quarter at 7:44 AM
Jul 30, 2013	12:24 AM	1:43 PM	7:03 AM	84.7°	247,821	40.6%	
Jul 31, 2013	1:08 AM	2:34 PM	7:50 AM	86.6°	249,984	31.1%	

Modify parameters

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Rising and setting times for the Moon

Date	Moonrise	Moonset	Meridian Passing			Illuminated	Phase
			Time	Altitude	Distance (mi)		
Aug 1, 2013	1:54 AM	3:24 PM	8:38 AM	87.6°	251,410	22.4%	
Aug 2, 2013	2:41 AM	4:11 PM	9:26 AM	87.7°	252,108	14.8%	
Aug 3, 2013	3:30 AM	4:57 PM	10:14 AM	86.9°	252,136	8.6%	
Aug 4, 2013	4:20 AM	5:40 PM	11:01 AM	85.2°	251,585	4.0%	
Aug 5, 2013	5:10 AM	6:21 PM	11:47 AM	82.6°	250,562	1.1%	
Aug 6, 2013	6:01 AM	7:01 PM	12:33 PM	79.4°	249,164	0.2%	New Moon at 11:51 AM
Aug 7, 2013	6:52 AM	7:39 PM	1:17 PM	75.6°	247,468	1.3%	
Aug 8, 2013	7:44 AM	8:17 PM	2:02 PM	71.4°	245,525	4.4%	
Aug 9, 2013	8:35 AM	8:54 PM	2:47 PM	66.9°	243,364	9.6%	
Aug 10, 2013	9:28 AM	9:33 PM	3:33 PM	62.5°	241,008	16.7%	
Aug 11, 2013	10:22 AM	10:15 PM	4:20 PM	58.2°	238,487	25.5%	
Aug 12, 2013	11:18 AM	10:59 PM	5:10 PM	54.3°	235,848	35.7%	
Aug 13, 2013	12:16 PM	11:47 PM	6:03 PM	51.1°	233,171	46.9%	
Aug 14, 2013	1:16 PM	-	6:59 PM	48.9°	230,587	58.6%	First Quarter at 12:57 AM
Aug 15, 2013	-	12:40 AM	7:57 PM	47.8°	228,275	70.0%	
	2:17 PM	-					
Aug 16, 2013	-	1:37 AM	8:57 PM	48.2°	226,456	80.5%	
	3:16 PM	-					
Aug 17, 2013	-	2:39 AM	9:57 PM	50.0°	225,358	89.3%	
	4:14 PM	-					
Aug 18, 2013	-	3:43 AM	10:56 PM	53.1°	225,166	95.7%	
	5:08 PM	-					
Aug 19, 2013	-	4:47 AM	11:53 PM	57.1°	225,984	99.2%	
	5:59 PM	-					
Aug 20, 2013	-	5:51 AM					Full Moon at 3:45 PM
	6:46 PM	-					
Aug 21, 2013	-	6:52 AM	12:47 AM	61.9°	227,798	99.6%	
	7:31 PM	-					