University of Puerto Rico at Mayagüez Direct Broadcast Polar Orbiter Workshop

27 April 2016 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.

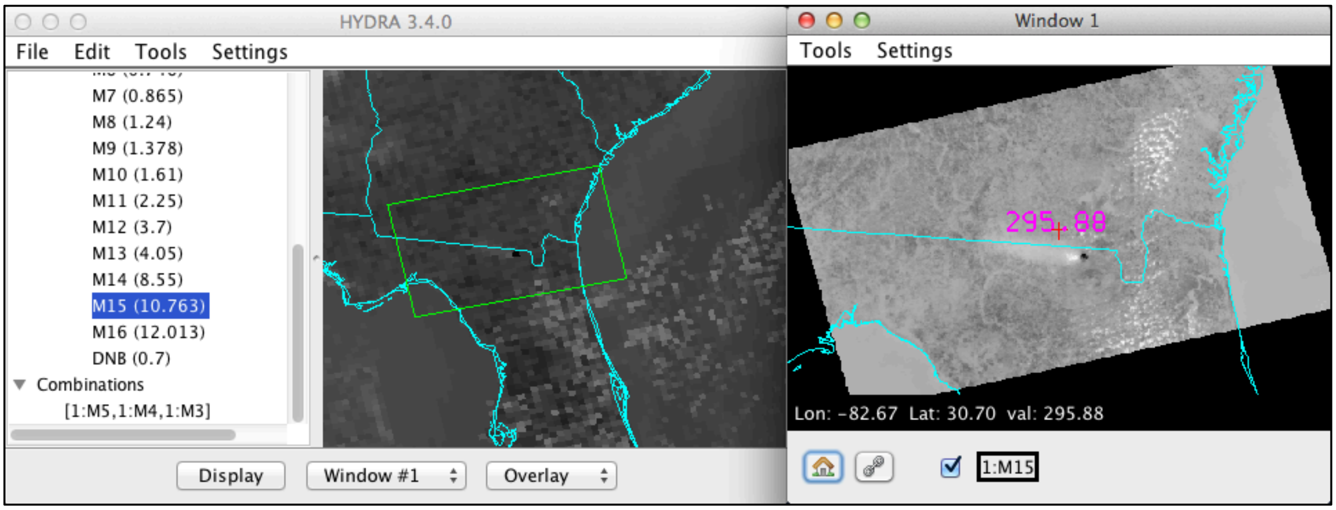


Figure 1: Suomi-NPP VIIRS Hydra screen capture from 7 April 2012, 18:14 UTC with a high resolution display of M-Band 15 (10.7 µm) brightness temperatures over Northern Florida.

2. Create a natural 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 rgb 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?

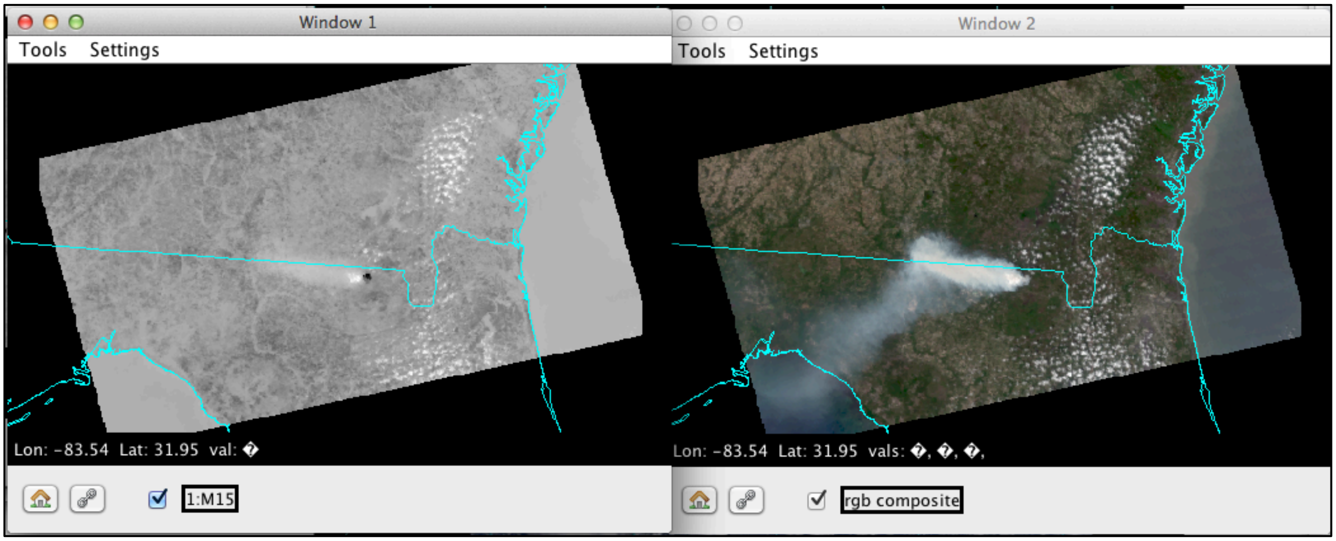


Figure 2: Suomi-NPP VIIRS Hydra screen capture from 7 April 2012 11 August 2013, 18:14 UTC with a high resolution display of M-Band 15 (10.7 μm) brightness temperatures in the left panel and a natural color RGB composite image in the right panel.

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. Approximately how large are the differences? 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 BTDIF4-11 ((M-Band 13 (4.0 μm) – M-Band 15 (10.7 μm)) > 10 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 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?

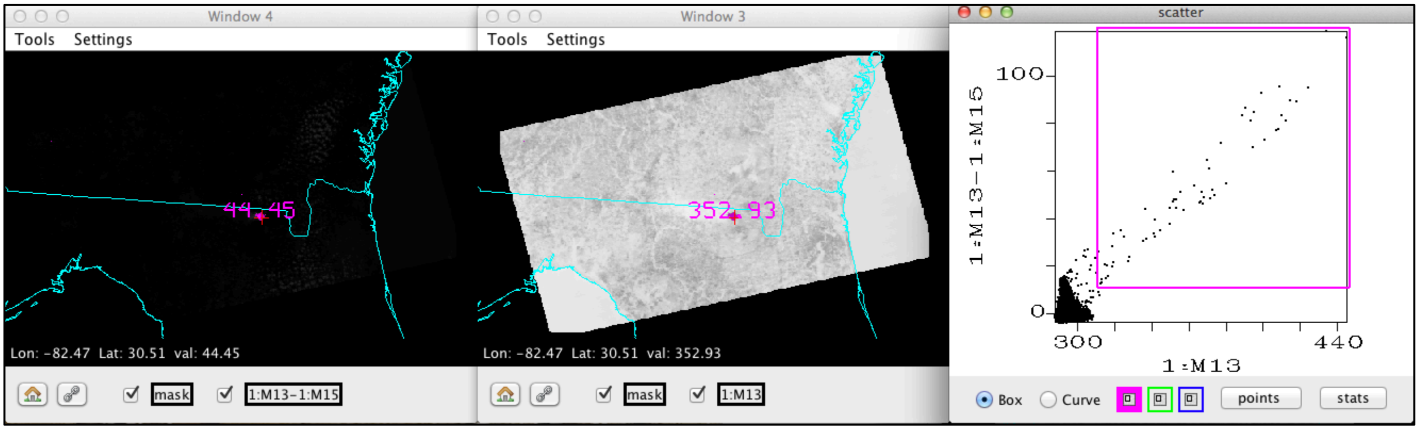


Figure 3: Hydra screen capture of VIIRS (M-Band 13 (4.0 µm) – M-Band 15 (10.7 µm)) brightness temperature differences (left panel), M-Band 13 (4.0 µm) brightness temperatures (center panel), and a scatter diagram of the (M-Band 13 (4.0 µm) – M-Band 15 (10.7 µm)) versus M-Band 13 (4.0 µm) (right panel)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

6. Most 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 instrument ability to detect fires:

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

7. Open an Aqua MODIS data set from a MODIS nighttime scene (a1.12099.0650.1000m.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 (4.0 µm)? Can you think of reasons for the differences? What is the advantage of high spatial resolution in hot spot detection?

8. Now open the MODIS Level 2 fire product by choosing File->Files-> a1.12099.0650.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?

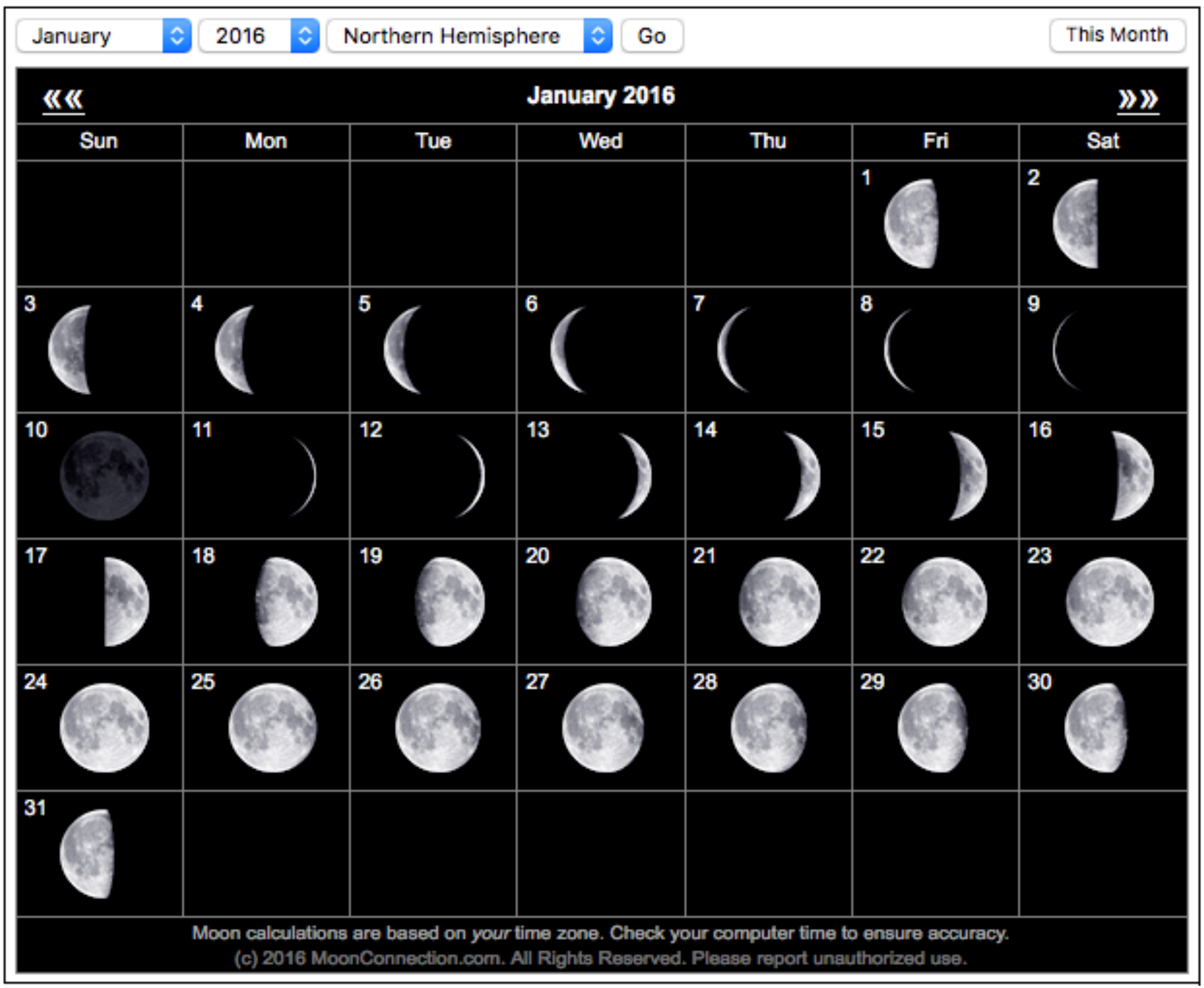
Lab 2 Part 5 - Investigating the VIIRS Day/Night band under different lunar illuminations.

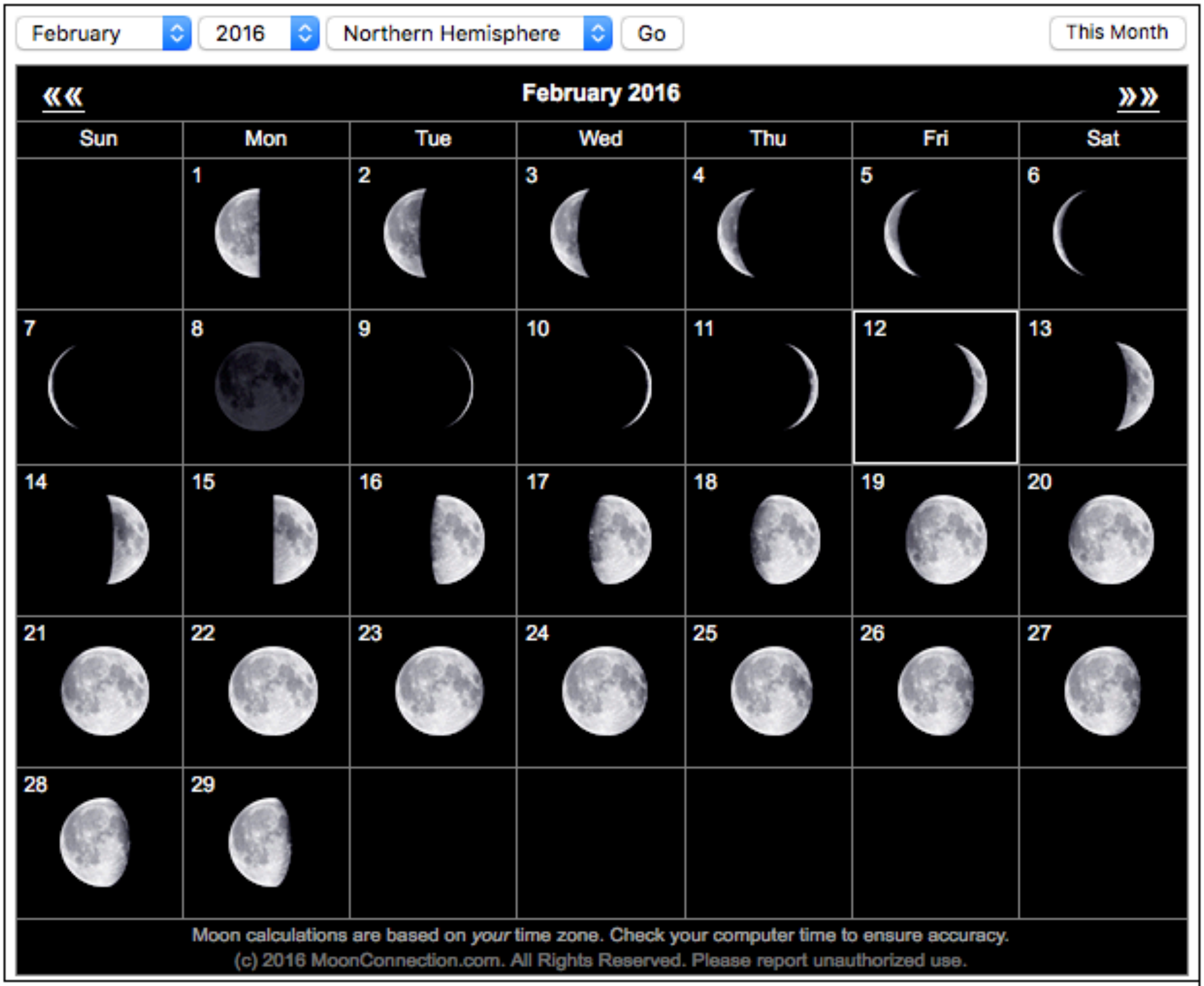
The VIIRS Day/Night Band is sensitive to a huge range of radiances (seven orders of magnitude) and can observe things such as nighttime lunar reflection and nighttime visible light emissions. However, because the instrument is not lunar synchronous, the ability of the band to detect atmospheric features 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 Puerto Rico and surrounding regions. As you examine these four data sets, note:

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

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

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Moon calculations are based on your time zone. Check your computer time to ensure accuracy.
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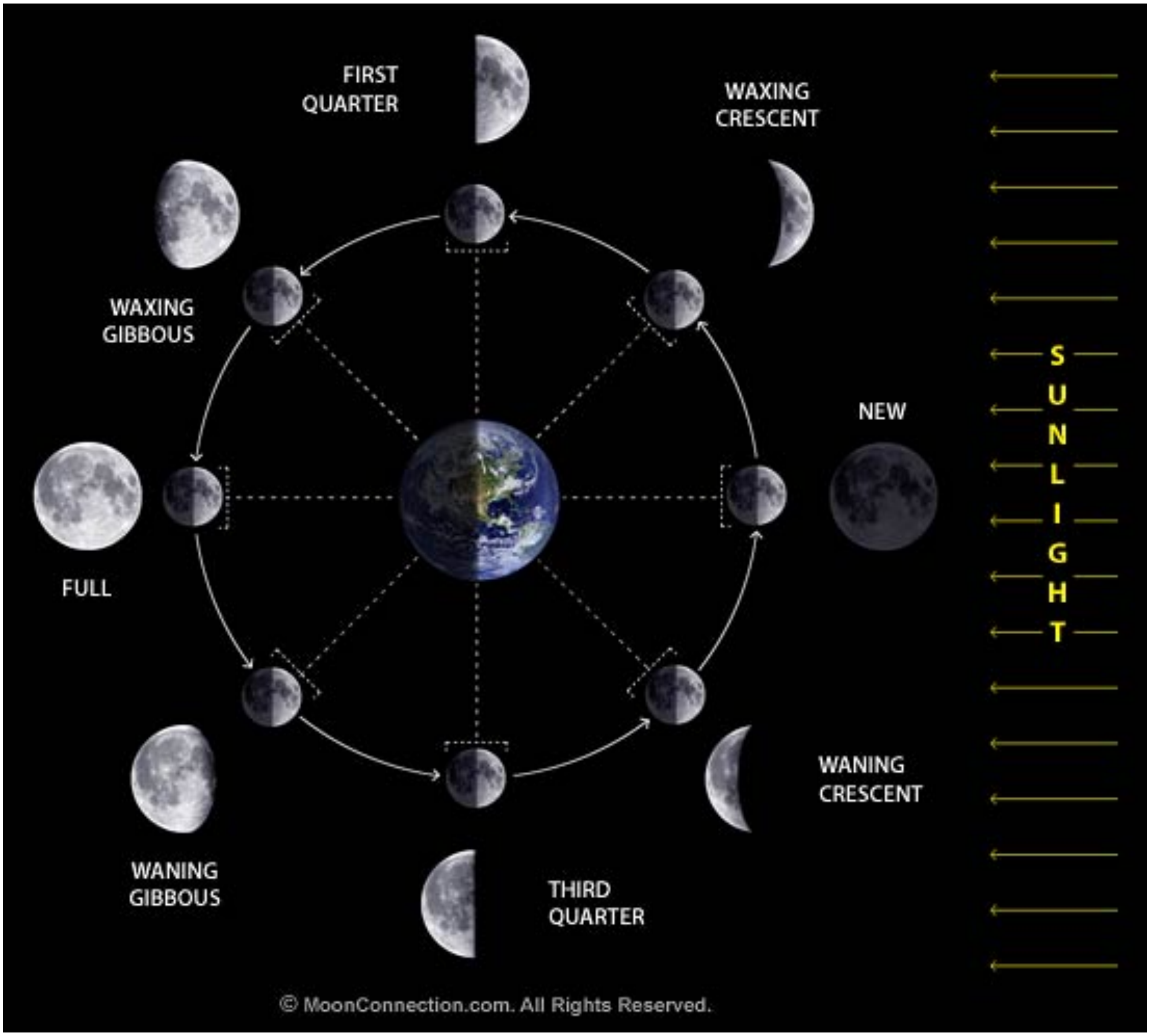
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SUNLIGHT
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Moonrise, Moonset, and Phase Calendar for San Juan, January 2016

Month: January Year: 2016 Go

2016	Moonrise/Moonset			Meridian Passing		
Jan	Moonrise	Moonset	Moonrise	Time	Distance (mi)	Illumination
1	-	11:58 AM ← (269°)	-	5:49 AM (71.2°)	250,723	57.8%
◑ 2	12:25 AM → (93°)	12:35 PM ← (265°)	-	6:31 AM (67.3°)	251,205	48.2%
3	1:13 AM → (97°)	1:13 PM ← (261°)	-	7:14 AM (63.6°)	250,820	38.6%
4	2:01 AM → (101°)	1:52 PM ↙ (258°)	-	7:58 AM (60.2°)	249,609	29.3%
5	2:51 AM ↘ (104°)	2:34 PM ↙ (255°)	-	8:44 AM (57.2°)	247,679	20.7%
6	3:42 AM ↘ (107°)	3:20 PM ↙ (252°)	-	9:32 AM (54.8°)	245,196	13.2%
7	4:35 AM ↘ (109°)	4:08 PM ↙ (251°)	-	10:22 AM (53.2°)	242,374	7.0%
8	5:28 AM ↘ (109°)	5:01 PM ↙ (251°)	-	11:14 AM (52.6°)	239,449	2.6%
● 9	6:21 AM ↘ (109°)	5:56 PM ↙ (251°)	-	12:08 PM (53.0°)	236,659	0.4%
10	7:14 AM ↘ (108°)	6:53 PM ↙ (253°)	-	1:03 PM (54.5°)	234,209	0.6%
11	8:05 AM ↘ (105°)	7:52 PM ↙ (256°)	-	1:58 PM (57.2°)	232,245	3.6%
12	8:55 AM ↘ (102°)	8:51 PM ← (260°)	-	2:51 PM (60.7°)	230,844	9.1%
13	9:42 AM → (98°)	9:50 PM ← (265°)	-	3:44 PM (64.9°)	230,007	17.0%
14	10:28 AM → (93°)	10:48 PM ← (269°)	-	4:36 PM (69.5°)	229,681	26.8%
15	11:13 AM → (88°)	11:46 PM ← (274°)	-	5:28 PM (74.2°)	229,787	37.9%
◐ 16	11:59 AM → (83°)	-	-	6:20 PM (78.7°)	230,244	49.6%
17	-	12:45 AM ← (279°)	12:46 PM → (79°)	7:13 PM (82.7°)	230,993	61.3%
18	-	1:43 AM ↖ (283°)	1:35 PM ↗ (75°)	8:07 PM (86.1°)	232,009	72.3%
19	-	2:42 AM ↖ (286°)	2:25 PM ↗ (73°)	9:02 PM (88.4°)	233,292	81.9%
20	-	3:40 AM ↖ (288°)	3:18 PM ↗ (71°)	9:57 PM (89.7°)	234,859	89.8%
21	-	4:37 AM ↖ (289°)	4:13 PM ↗ (71°)	10:53 PM (89.8°)	236,718	95.6%
22	-	5:32 AM ↖ (289°)	5:09 PM ↗ (71°)	11:47 PM (88.8°)	238,848	98.9%
○ 23	-	6:23 AM ↖ (288°)	6:04 PM ↗ (73°)	-	-	-
24	-	7:11 AM ↖ (285°)	6:58 PM ↗ (76°)	12:38 AM (86.8°)	241,184	99.9%
25	-	7:56 AM ↖ (282°)	7:50 PM → (79°)	1:28 AM (84.0°)	243,616	98.5%
26	-	8:38 AM ← (279°)	8:40 PM → (83°)	2:15 AM (80.7°)	245,990	95.1%
27	-	9:17 AM ← (275°)	9:30 PM → (87°)	3:00 AM (76.9°)	248,129	89.9%
28	-	9:55 AM ← (271°)	10:18 PM → (91°)	3:44 AM (73.0°)	249,848	83.2%
29	-	10:32 AM ← (267°)	11:05 PM → (95°)	4:26 AM (69.1°)	250,977	75.3%
30	-	11:10 AM ← (263°)	11:53 PM → (99°)	5:09 AM (65.3°)	251,377	66.5%
◑ 31	-	11:48 AM ← (259°)	-	5:52 AM (61.8°)	250,958	57.1%

* All times are local time for San Juan. Dates are based on the Gregorian calendar. Illumination is calculated at lunar noon.

Moonrise, Moonset, and Phase Calendar for San Juan, February 2016

Month: February Year: 2016 Go

2016	Moonrise/Moonset			Meridian Passing		
Feb	Moonrise	Moonset	Moonrise	Time	Distance (mi)	Illumination
1	12:42 AM ↘ (102°)	12:29 PM ↙ (256°)	-	6:36 AM (58.6°)	249,688	47.3%
2	1:31 AM ↘ (105°)	1:12 PM ↙ (254°)	-	7:22 AM (56.0°)	247,608	37.5%
3	2:22 AM ↘ (108°)	1:58 PM ↙ (252°)	-	8:11 AM (54.0°)	244,833	27.9%
4	3:15 AM ↘ (109°)	2:48 PM ↙ (251°)	-	9:01 AM (52.9°)	241,551	19.1%
5	4:08 AM ↘ (109°)	3:41 PM ↙ (251°)	-	9:54 AM (52.7°)	238,016	11.3%
6	5:01 AM ↘ (109°)	4:38 PM ↙ (252°)	-	10:49 AM (53.7°)	234,528	5.2%
7	5:53 AM ↘ (107°)	5:37 PM ↙ (255°)	-	11:44 AM (55.8°)	231,392	1.3%
● 8	6:45 AM ↘ (104°)	6:37 PM ↙ (258°)	-	12:39 PM (59.0°)	228,886	0.1%
9	7:34 AM → (100°)	7:37 PM ← (263°)	-	1:34 PM (63.0°)	227,208	1.7%
10	8:22 AM → (95°)	8:38 PM ← (267°)	-	2:29 PM (67.6°)	226,451	6.4%
11	9:10 AM → (90°)	9:38 PM ← (272°)	-	3:22 PM (72.4°)	226,594	13.7%