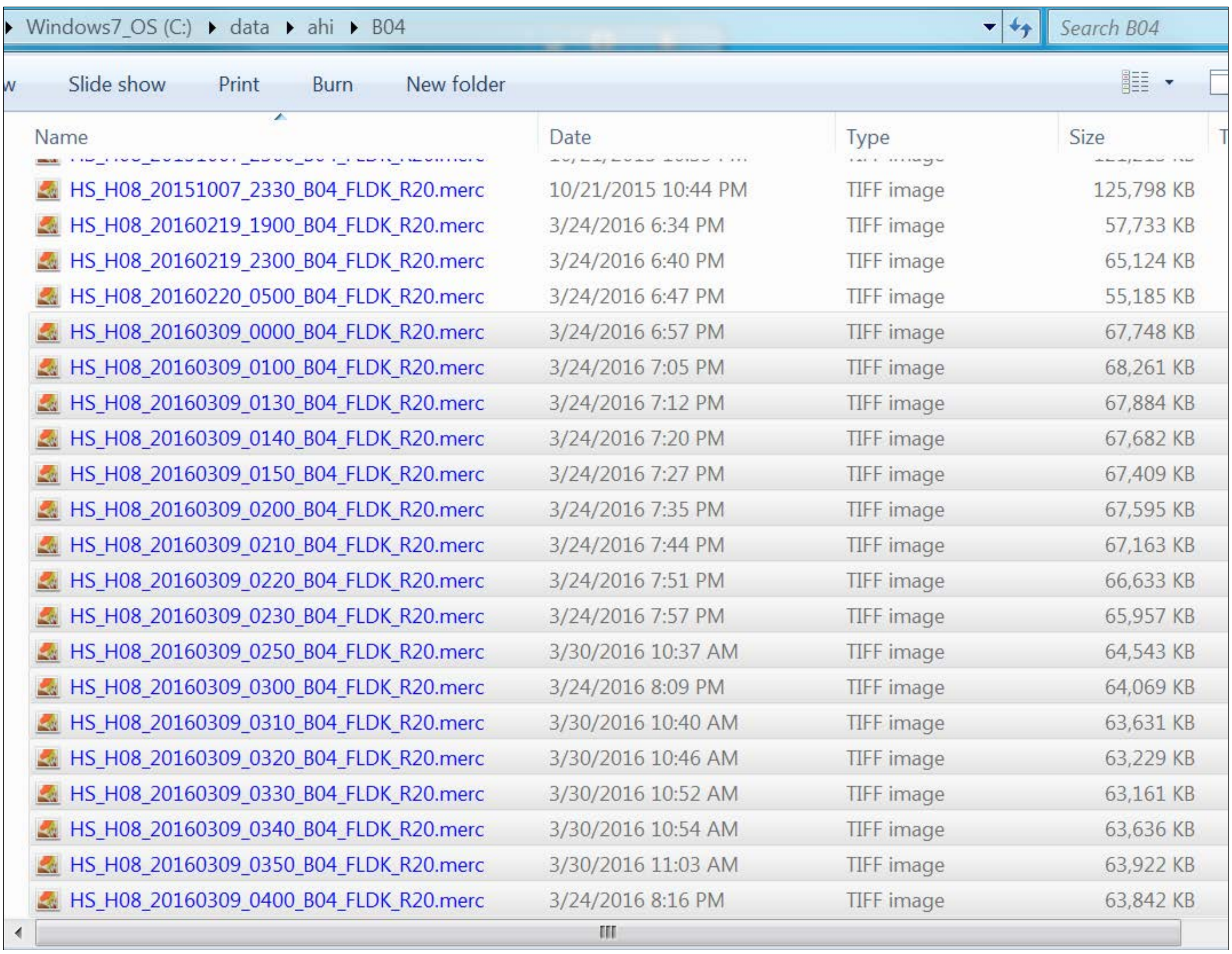
National Weather Service AHI Workshop Laboratory Part II

Introduction to the Advanced Himawari Imager (AHI) and the Satellite Information Familiarization Tool (SIFT) Part 2

Scott Lindstrom
scott.lindstrom@ssec.wisc.edu, kathy.strabala@ssec.wisc.edu
Cooperative Institute for Meterological Satellite Studies (CIMSS)
Space Science and Engineering Center (SSEC)
University of Wisconsin-Madison
Building off Work from Kathy Strabala

Section 1. Exploiting AHI multi-spectral capabilities Part 1 – Unique Event

1a) Launch SIFT and load in all 17 AHI Band 4 (.86 micron) images available from 9 March 2016, 00:00-04:00 UTC, which data are the last data in the list at **/data/ahi/B04/** (See Figure 1)**.** Center the SIFT display as shown in Figure 2.



Name	Date	Type	Size
HS_H08_20151007_2330_B04_FLDK_R20.merc	10/21/2015 10:44 PM	TIFF image	125,798 KB
HS_H08_20160219_1900_B04_FLDK_R20.merc	3/24/2016 6:34 PM	TIFF image	57,733 KB
HS_H08_20160219_2300_B04_FLDK_R20.merc	3/24/2016 6:40 PM	TIFF image	65,124 KB
HS_H08_20160220_0500_B04_FLDK_R20.merc	3/24/2016 6:47 PM	TIFF image	55,185 KB
HS_H08_20160309_0000_B04_FLDK_R20.merc	3/24/2016 6:57 PM	TIFF image	67,748 KB
HS_H08_20160309_0100_B04_FLDK_R20.merc	3/24/2016 7:05 PM	TIFF image	68,261 KB
HS_H08_20160309_0130_B04_FLDK_R20.merc	3/24/2016 7:12 PM	TIFF image	67,884 KB
HS_H08_20160309_0140_B04_FLDK_R20.merc	3/24/2016 7:20 PM	TIFF image	67,682 KB
HS_H08_20160309_0150_B04_FLDK_R20.merc	3/24/2016 7:27 PM	TIFF image	67,409 KB
HS_H08_20160309_0200_B04_FLDK_R20.merc	3/24/2016 7:35 PM	TIFF image	67,595 KB
HS_H08_20160309_0210_B04_FLDK_R20.merc	3/24/2016 7:44 PM	TIFF image	67,163 KB
HS_H08_20160309_0220_B04_FLDK_R20.merc	3/24/2016 7:51 PM	TIFF image	66,633 KB
HS_H08_20160309_0230_B04_FLDK_R20.merc	3/24/2016 7:57 PM	TIFF image	65,957 KB
HS_H08_20160309_0250_B04_FLDK_R20.merc	3/30/2016 10:37 AM	TIFF image	64,543 KB
HS_H08_20160309_0300_B04_FLDK_R20.merc	3/24/2016 8:09 PM	TIFF image	64,069 KB
HS_H08_20160309_0310_B04_FLDK_R20.merc	3/30/2016 10:40 AM	TIFF image	63,631 KB
HS_H08_20160309_0320_B04_FLDK_R20.merc	3/30/2016 10:46 AM	TIFF image	63,229 KB
HS_H08_20160309_0330_B04_FLDK_R20.merc	3/30/2016 10:52 AM	TIFF image	63,161 KB
HS_H08_20160309_0340_B04_FLDK_R20.merc	3/30/2016 10:54 AM	TIFF image	63,636 KB
HS_H08_20160309_0350_B04_FLDK_R20.merc	3/30/2016 11:03 AM	TIFF image	63,922 KB
HS_H08_20160309_0400_B04_FLDK_R20.merc	3/24/2016 8:16 PM	TIFF image	63,842 KB

Figure 1: AHI highlighted Band 4 (.86 micron) files from 9 March 2016 used for Section 1 tasks.

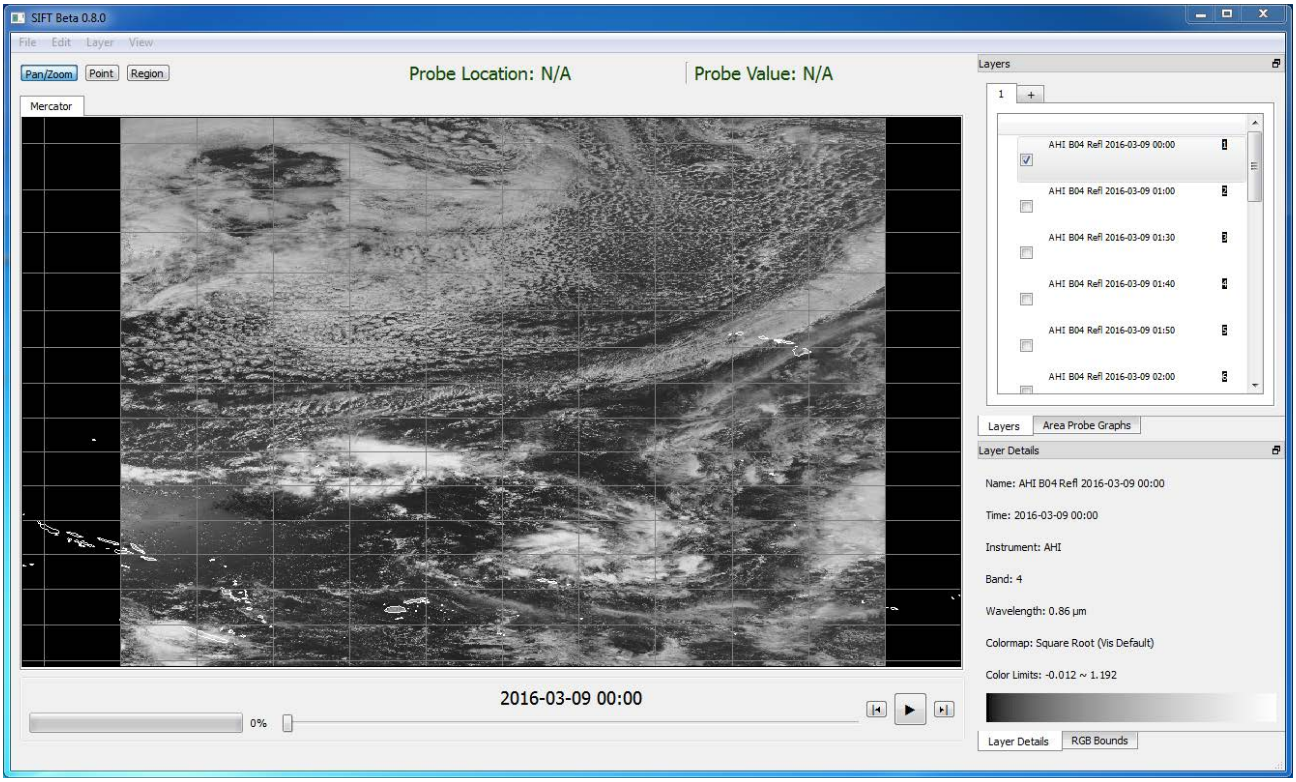


Figure 2: SIFT display of AHI Band 4 (.86 micron) data from 9 March 2016.

1b) Loop the AHI images in the sequence.

1

What unusual feature is prominent in this daytime animation?
What might be the cause?

Stop the animation and display the first image in the sequence. Place the Probe on the cloud deck show in Figure 3, and step through the sequence of images.

What is the range of reflectances over this time period?

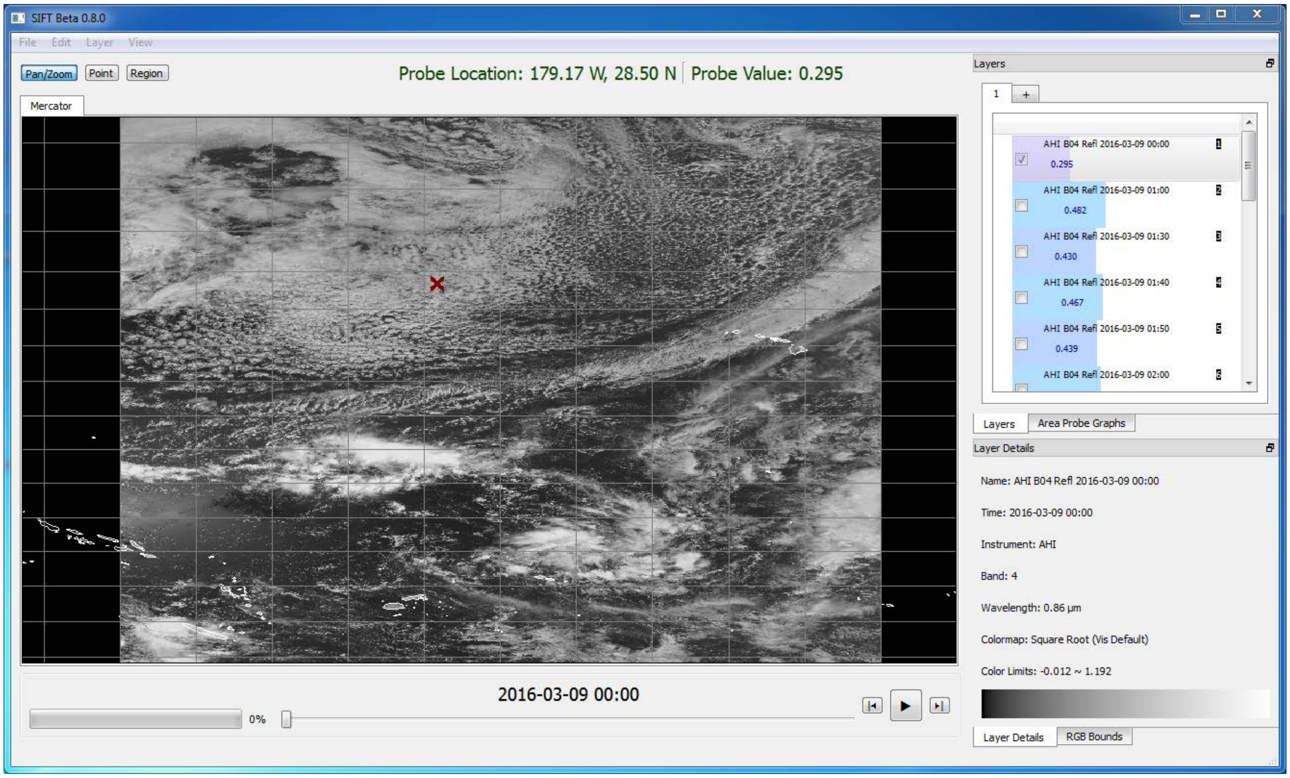


Figure 3: SIFT Display with **Probe** from 9 March 2016.

1c) To help in your evaluation of this event, load in the AHI Band 14 (11.2 micron) brightness temperature images covering the same time period into SIFT. Once you do this, it will make the Band 14 image loop active, and the **Probe** will now display the current Band 14 image brightness temperatures Start the animation.

2

Is the feature seen in the Band 4 (.86 micron) reflectances apparent in the infrared imagery?

Stop the animation and step through the sequence of images slowly. Toggle between the Band 14 (11.2 micron) and Band 4 (.86 micron) imagery by using the **up and down** arrows on you keyborad as you step through. You can activate the animation controls on either band by using the **"O"** key when the band of your choice is displayed. Zoom into the Probe region and find the lowest reflectances in your image sequence. Then step through the Band 14 set of images again. You may want to use the **Layers** window to help you (see Figure 4).

3

Do you see any signal of this dark region in the infrared?

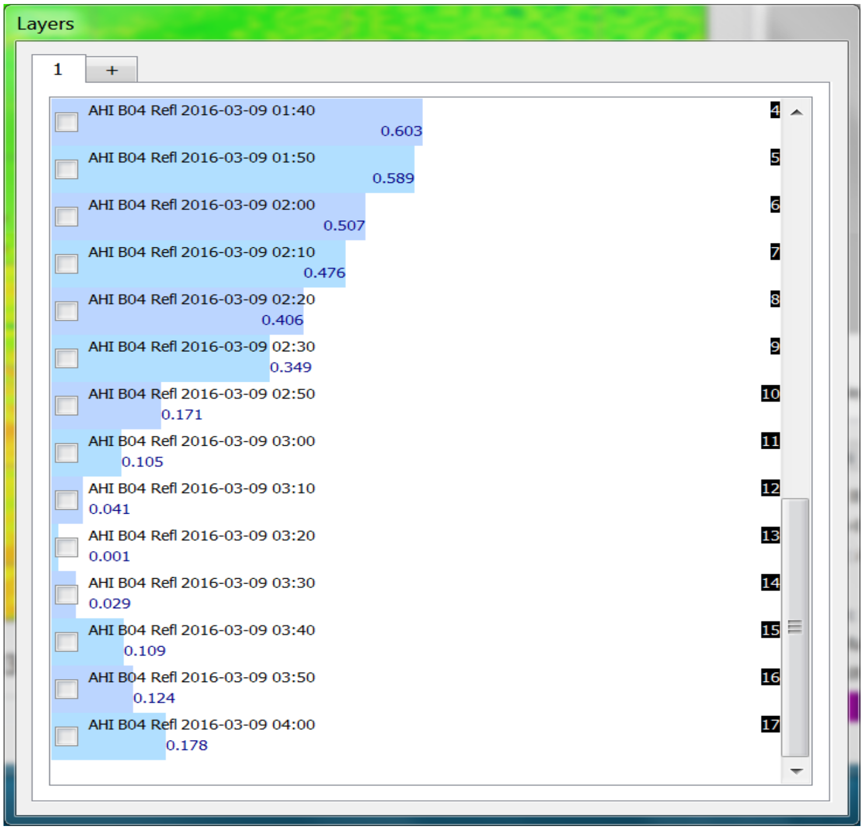


Figure 4: Layers window AHI Band 4 (.86 micron) reflectance display of **Probe** values over the 00:00-04:00 UTC time period on 9 March 2016.

1d) Finally, load in the Band 7 (3.9 micron) brightness temperature files from the same time period. Animate the Band 7 images.

4

Is there evidence of the event observed in the visible reflectance Band 4 imagery in the sequence?

Compare the brightness temperatures between the Band 7 (3.9 micron) and Band 14 (11.2 micron) imagery as you step through the loop, or compare using the Layers window values (see Figure 5 – you may have to **Right Click** in a Band 7 image window for all **Layers** values to appear).

5

Why are the values so different between the Band 7 and Band 14 infrared window channels for some times, and similar for others?

From our investigations using these three AHI bands, what is the event observed on this day? Based upon your observations, do you think there would be any affect on local weather?

When you have completed this exercise, close SIFT. P.S.: Note that a total solar eclipse will cross the central United States in mid-August of 2017!

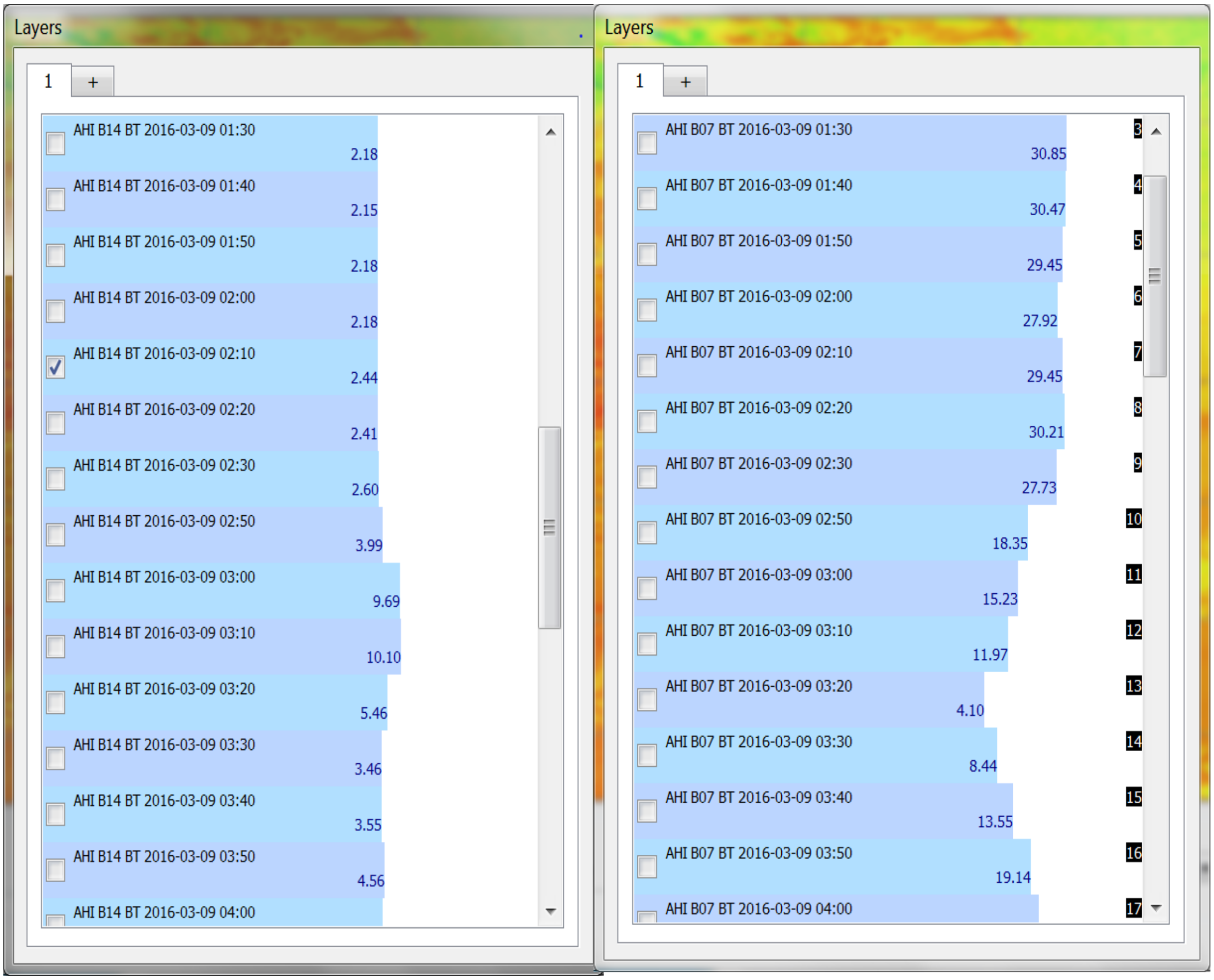


Figure 5: AHI Band 14 (11.2 micron) brightness temperatures (Left Panel) and AHI Band 7 (3.9 micron) brightness temperatures for the 01:30 to 04:00 UTC time period for a point over clouds as shown in Figure 3.

Section 2. Exploiting AHI multi-spectral capabilities Part 2 - Discriminating atmosphere and surface features.

2a) Re-launch SIFT and load in AHI Band 3 (.64 micron) image files from 9 March 2016, 02:00 – 03:00 UTC (6 images total). <u>This half-kilometer spatial resolution imagery **will take longer to load**</u>. Once it displays, focus on the Hawaiian Island chain as shown in Figure 6.

2b) Animate the images. Note the location and movement of the cloud features.

6

How does the spatial and spectral AHI coverage over the islands compare with imagery you currently receive from Geostationary Satellites in your WFO?
Based only upon this sequence of images, what would your local short term wind/wave/temperature forecast be for Oahu?
For the Big Island?
A surface analysis from 00 UTC, 9 March 2016 is available at the end of this document for reference.

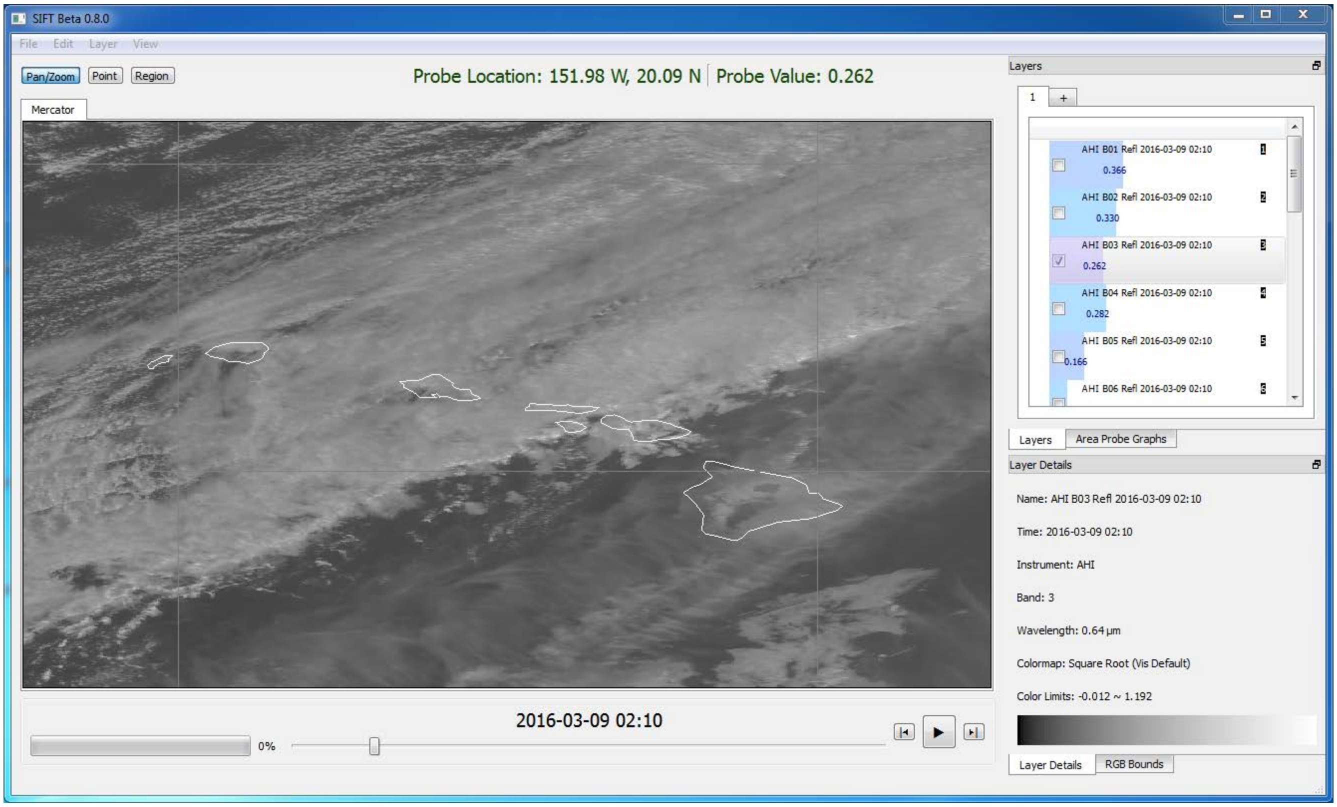


Figure 6: SIFT display of the AHI Band 3 (.64 micron) reflectances from 02:10 UTC, 9 March 2016.

2c) Remove all of the AHI Band 3 images from SIFT by highlighting the first file in the sequence in the **Layers** window, **Shift+Click** on the last file in the sequence (this highlights all of files), and then select **Edit->Remove Layer** from the top level SIFT navigation bar.

2d) Now load all AHI bands from 02:30 UTC, 9 March 2016 into SIFT. Step slowly through all of the bands and consider the following questions.

For this particular AHI scene:

7

What AHI visible reflectance band is best for detecting/identifying low clouds?

What AHI visible reflectance band is best for detecting/identifying high clouds?

What AHI thermal infrared band is best for detecting/identifying low clouds?

What AHI thermal infrared band is best for detecting/identifying high clouds?

What AHI visible reflectance band is best for detecting/identifying land surface features?

What AHI thermal infrared band is best for detecting/identifying land surface features?

What AHI band or bands are best for detecting/identifying mid atmosphere features?

Are your selections applicable to AHI data sets at other dates/times/locations? Why/Why not?

2e) Investigate the relationship between visible reflectance and infrared data over our area of interest by examining the region outlined in Figure 7.

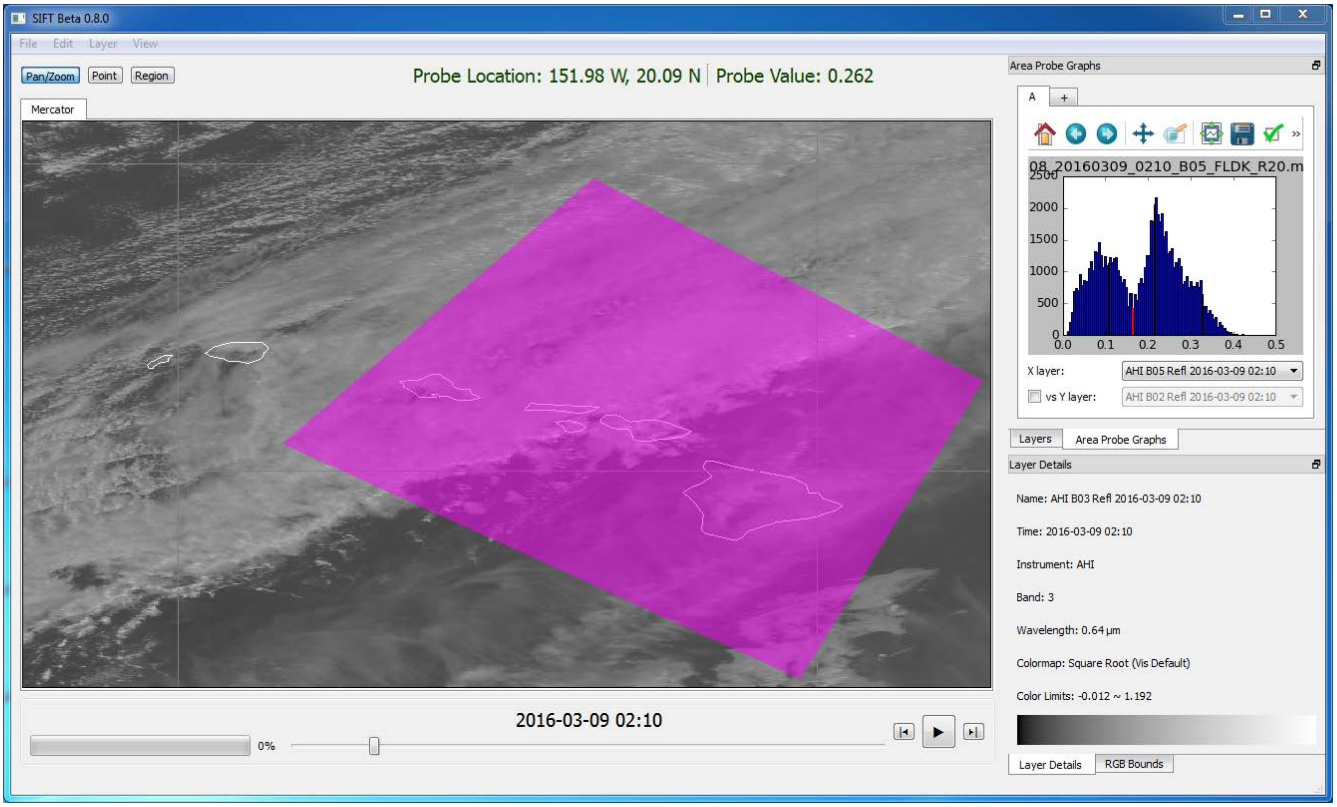


Figure 7: AHI region of interest for visible reflectance/thermal infrared investigations.

Create a histogram of Band 3 (.64 micron) reflectances in the **Area Probe Graphs** section (See Figure 8 – left panel). Identify the image features that correspond to the peaks in the histogram (Use the **Probe** to help you).

8 Compare histograms for different AHI visible bands for our region. How do they compare? Do they have the same shapes? The same peaks?

Use the **Probe** to look at **Layer** window reflectance values for all AHI visible bands for the same location. Compare values over different clouds/surface features.

9 Would you change any your answers from section **2d** after this investigation?

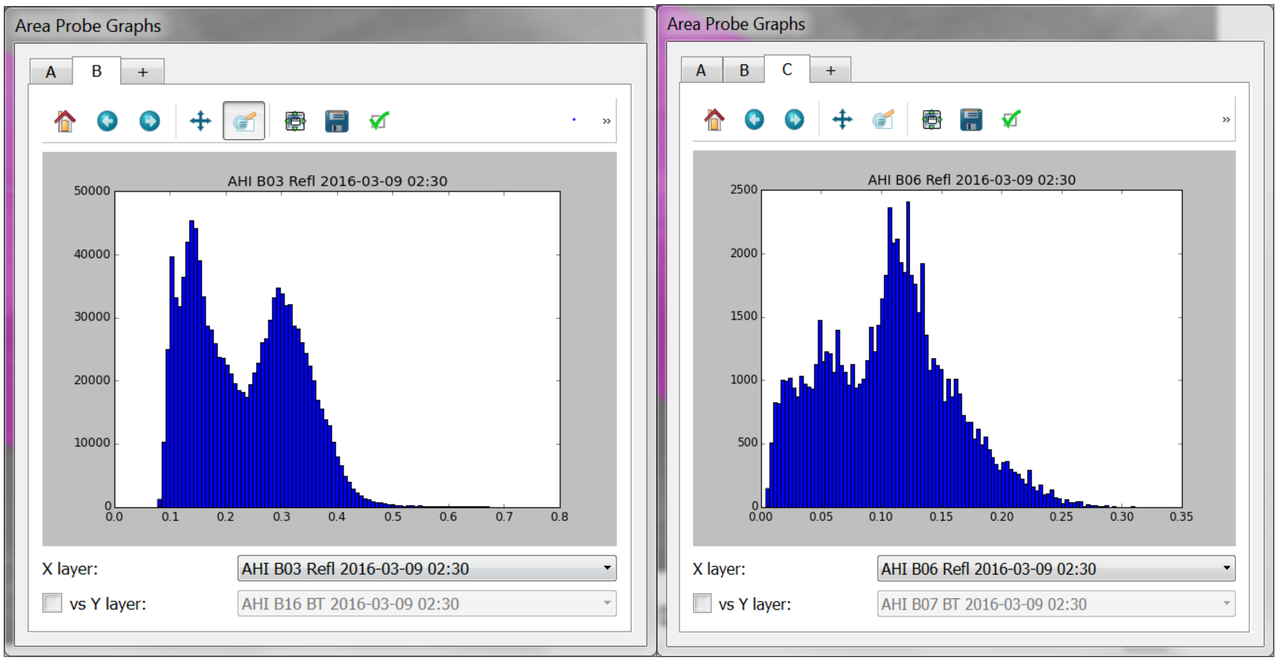


Figure 8: AHI Band 3 (.64 micron) histogram of reflectances (left panel) and Band 6 (2.3 micron) (right panel) over our region of interest outlined in Figure 7.

Now create a X versus Y density scatter diagram using Band 3 (.64 micron) reflectances in the **X-layer** and Band 14 (11.2 micron) brightness temperatures in the **Y-layer** (see Figure 9 – left panel). Map the patterns in the scatter diagram with the features in the imagery.

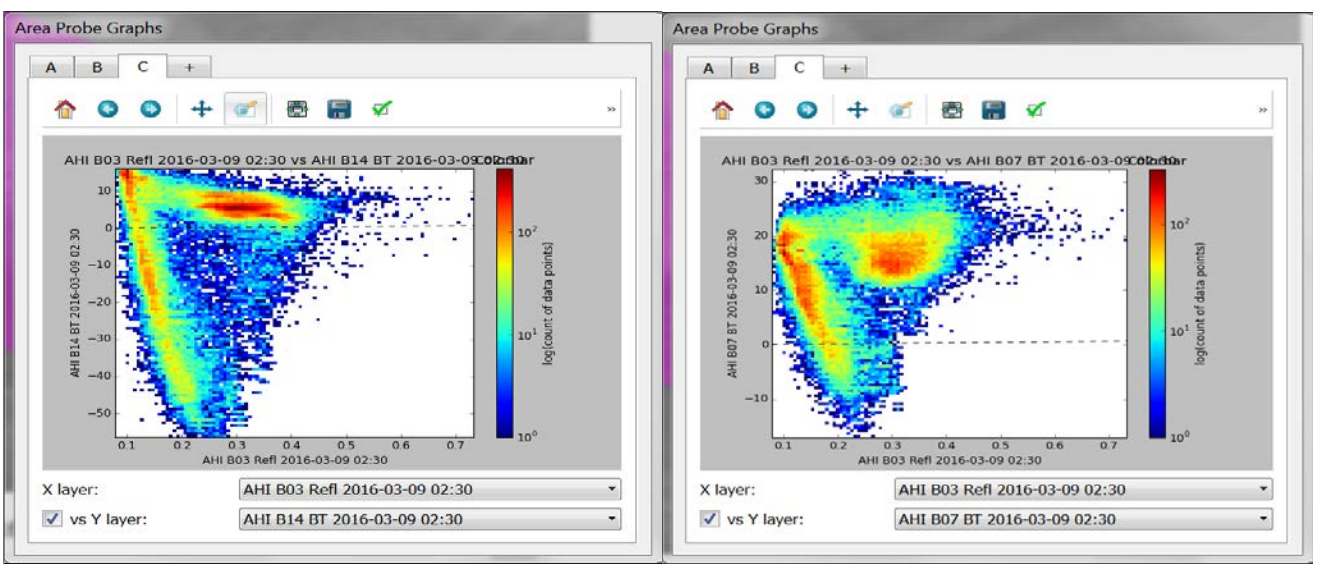


Figure 9: Scatter diagram of AHI Band 14 (11.2 micron) brightness temperatures versus AHI Band 3 (.64 micron) reflectances (left panel) and AHI Band 7 (3.9 micron) brightness temperatures versus AHI Band 3 (.64 micron) reflectances (right panel).

2f) Now using the AHI Band 14 versus AHI Band 3 scatter diagram (Figure 9 – left panel), could you identify a combination of IR/visible thresholds for automatically detecting clear Fields-of-View (FOVs)

10

(for example FOVs with brightness temperature greater than ? and reflectances less than ? are clear)?
Can you develop thresholds for detection of low cloud?
How about high cloud?

Once these thresholds have been determined, look at other Infrared band brightness temperatures versus visible band scatter diagrams to see if your thresholds are valid for that combination of bands too (see example in Figure 9 – right panel).

11

Can you find better band combinations for discriminating different features in the imagery?

2g) Finally, lets compare two infrared window channels by creating a scatter diagram using the AHI Band 14 (11.2 micron) brightness temperatures for the **X-layer** and AHI Band 11 (8.6 micron) brightness temperatures in the **Y-layer**. Your scatter diagram should look like the display in Figure 10.

12

Why are these two infrared window brightness temperatures so different?
Where are the differences the greatest (moving the cursor over the scatter diagram will provide an interactive display of X and Y values in the upper right corner of the **Area Probe Graph** display).
Where do these large differences map to in the image?
How could this information be useful?

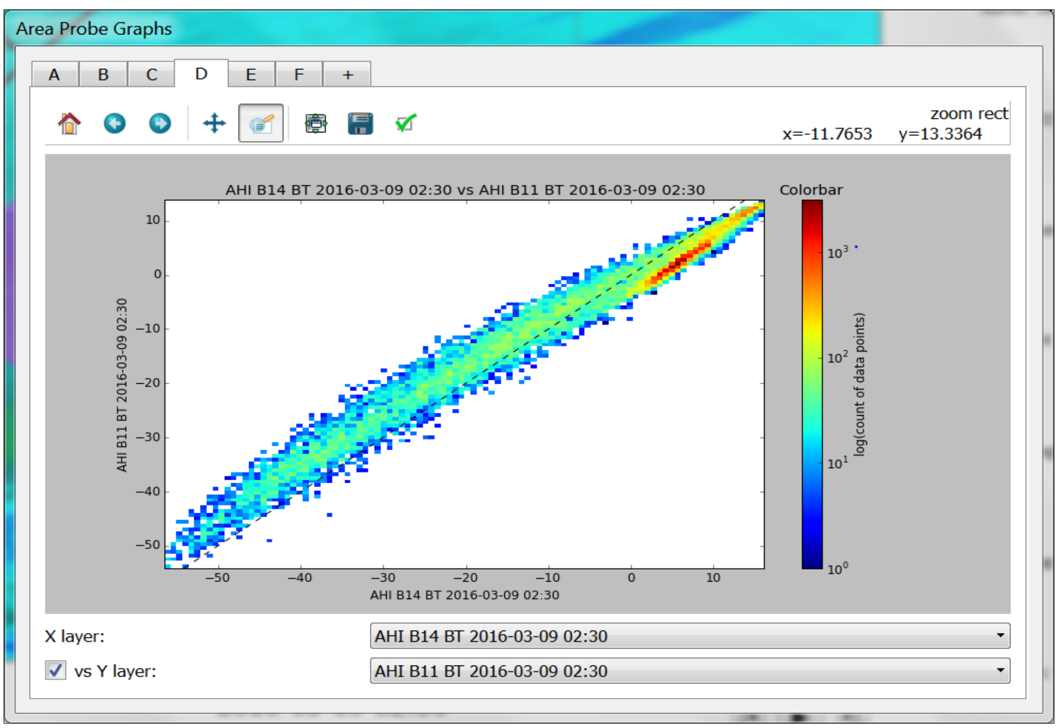
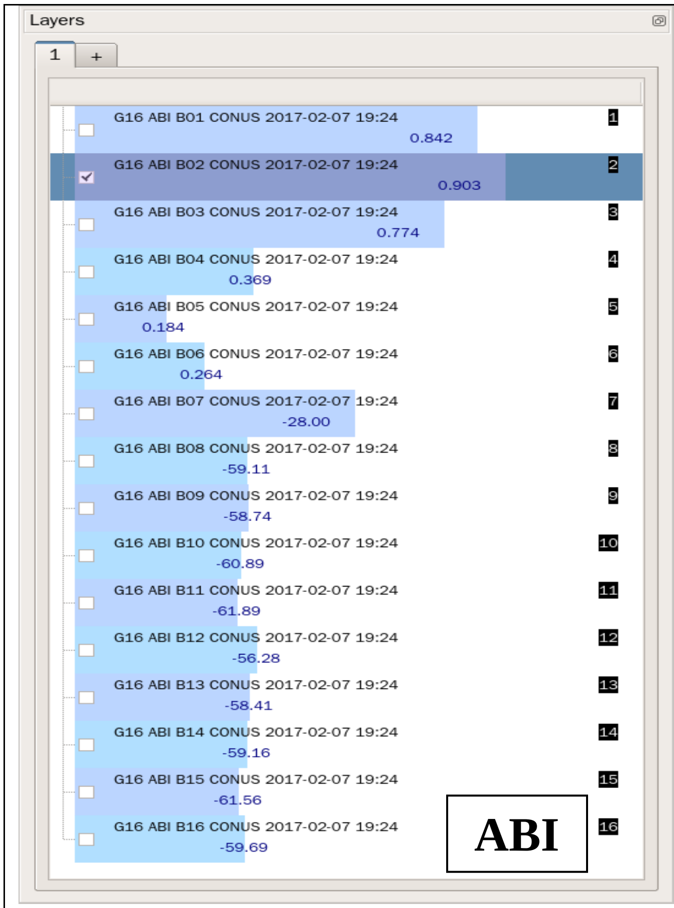
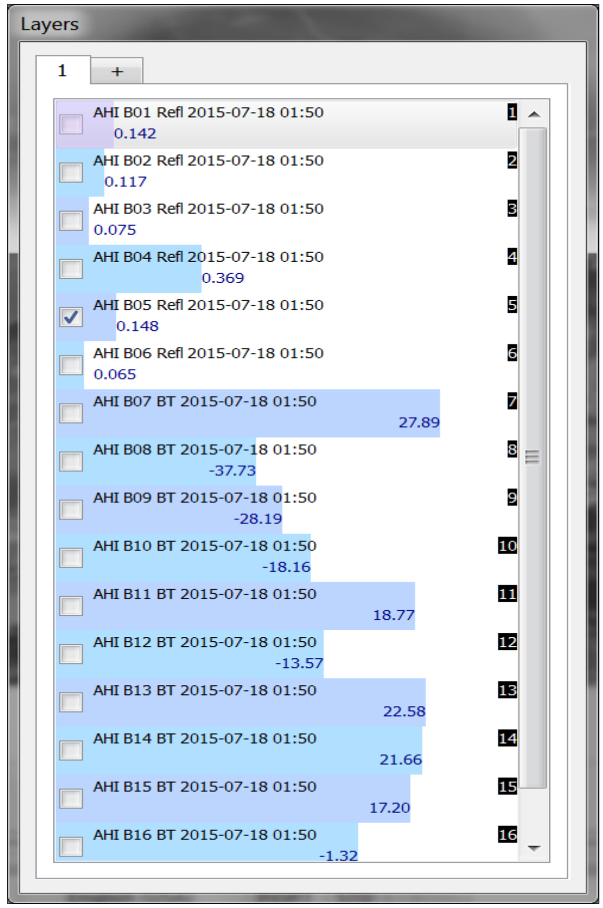


Figure 10: Scatter diagram of AHI infrared window band 11 (8.6 micron) brightness temperatures versus AHI infrared window band 14 (11.2 micron) brightness temperatures for our area of investigation.

Section 3: Exploiting AHI multi-spectral capabilities Part 3 – Layers Exercises
For each **Layers** window screen capture from a single AHI (**or ABI**) Field-Of-View (FOV), select the scene attributes that fit the reflectance and brightness temperatures for this point.

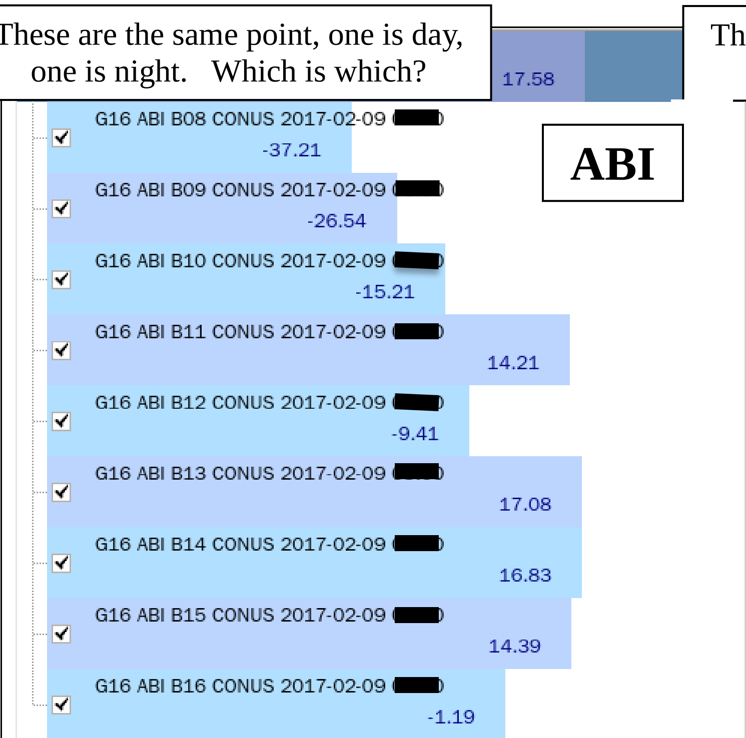




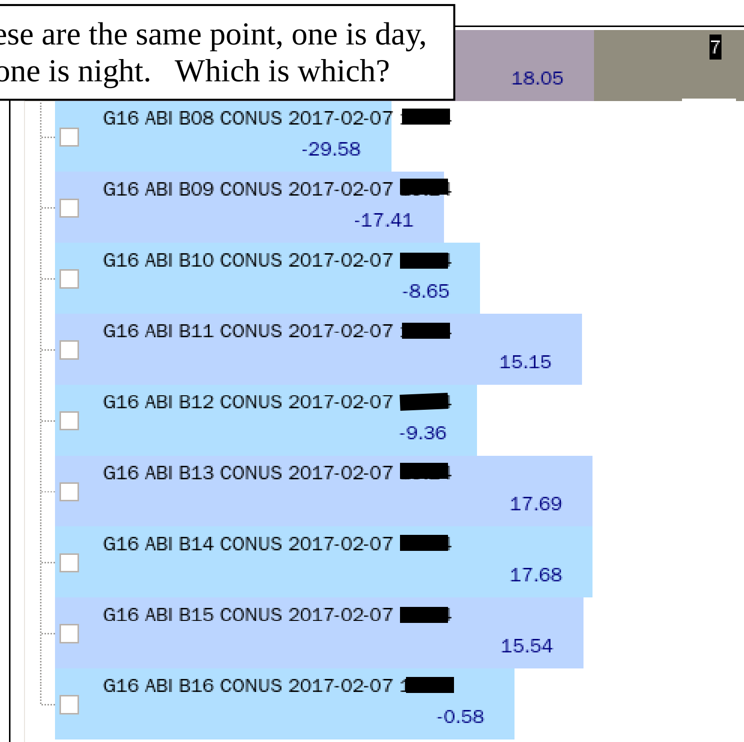
1 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thick Ice Cloud **g)** Dust

2 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thick Ice Cloud **g)** Dust

These are the same point, one is day, one is night. Which is which?

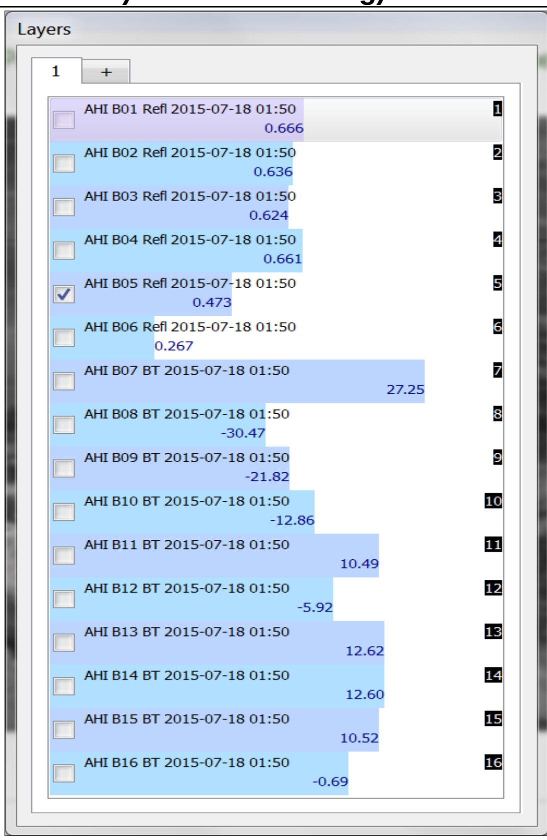


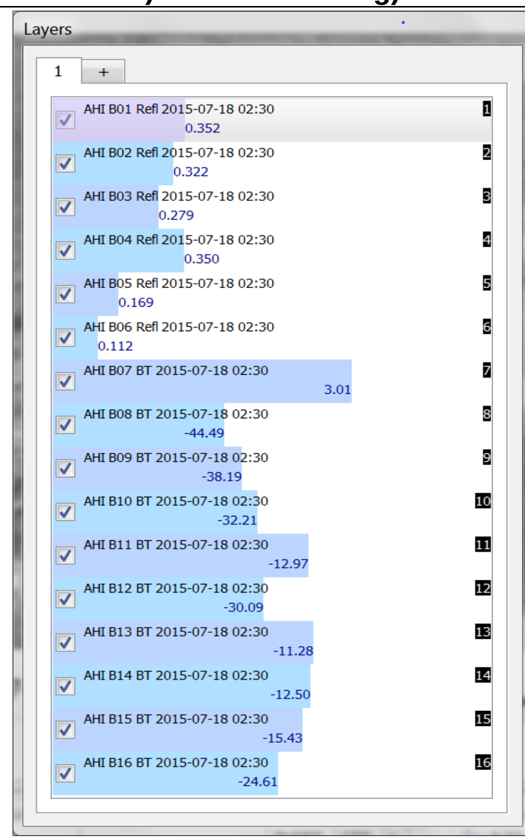
These are the same point, one is day, one is night. Which is which?



3 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thick Ice Cloud **g)** Dust

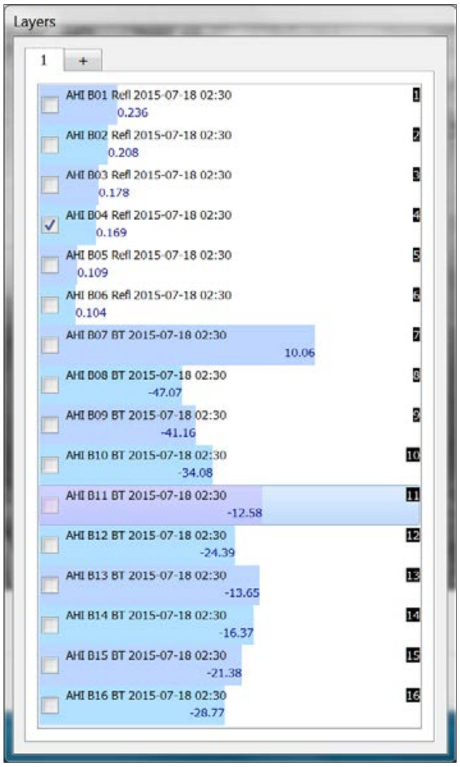
4 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thick Ice Cloud **g)** Dust



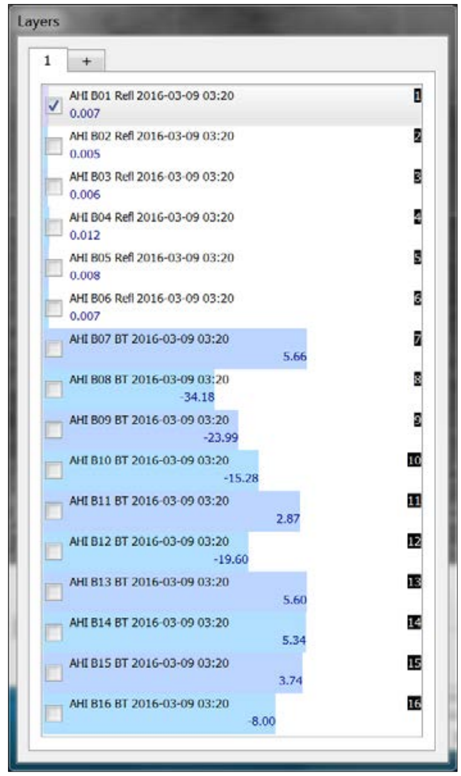


5 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thick Ice Cloud **g)** Dust

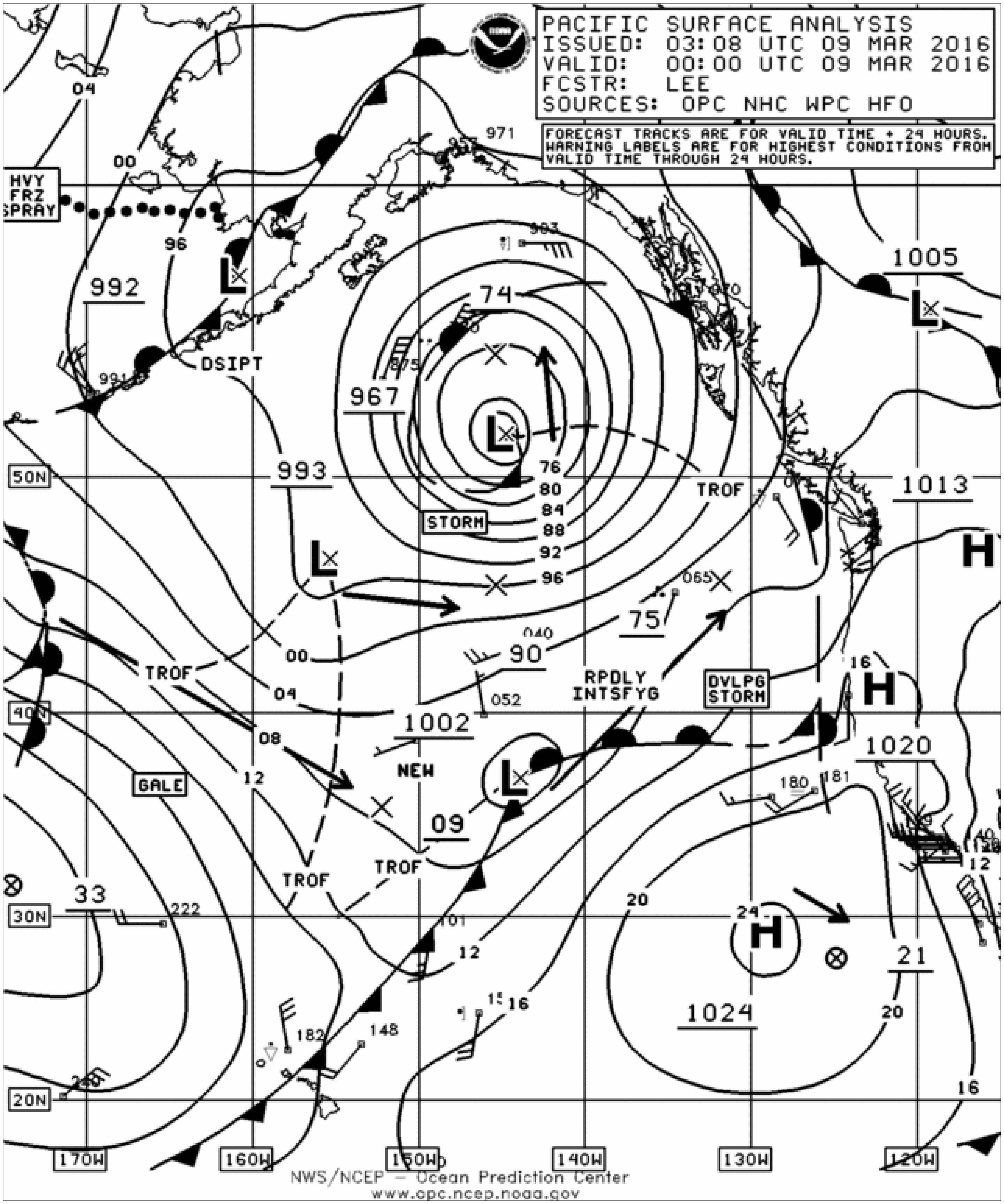
6 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thick Ice Cloud **g)** Dust



7 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thin Ice Cloud **g)** Dust



8 a) Day **b)** Night **c)** Clear Ocean **d)** Clear Land **e)** Water Cloud **f)** Thick Ice Cloud **g)** Dust


PACIFIC SURFACE ANALYSIS
ISSUED: 03:08 UTC 09 MAR 2016
VALID: 00:00 UTC 09 MAR 2016
FCSTR: LEE
SOURCES: OPC NHC WPC HFO
FORECAST TRACKS ARE FOR VALID TIME + 24 HOURS.
WARNING LABELS ARE FOR HIGHEST CONDITIONS FROM VALID TIME THROUGH 24 HOURS.
HVY FRZ SPRAY
992
DSIPT
967
74
993
STORM
TROF
1005
1013
1002
NEW
09
RPDLY INTSFYG
DVLPG STORM
1020
GALE
TROF
TROF
33
1024
21
50N
40N
30N
20N
170W
160W
150W
140W
130W
120W
NWS/NCEP — Ocean Prediction Center
www.opc.ncep.noaa.gov

Section 4: Glaciated Clouds and Temperatures: Testing a hypothesis with SIFT

Here's a Hypothesis to test:

When glaciation occurs, the brightness temperature in the cleanest window channel drops below freezing.

As you (now) know, AHI and ABI have a 1.6 µm channel (2-km resolution on AHI, 1-km resolution on ABI) that allows discrimination between ice clouds and water based clouds because ice absorbs energy at 1.6 µm, and it will appear darker (less energy is reflected if more is absorbed, so reflectance values will be smaller). **Is there a relationship between this glaciation and Band 13 Brightness Temperature**?

Delete any data that are in your SIFT, and then load data from 0400 on July 14 2015. Zoom in to southern China, centering on this latitude/longitude pair: 26.70 N, 112.18 E. Your SIFT window should look something similar to the figure below

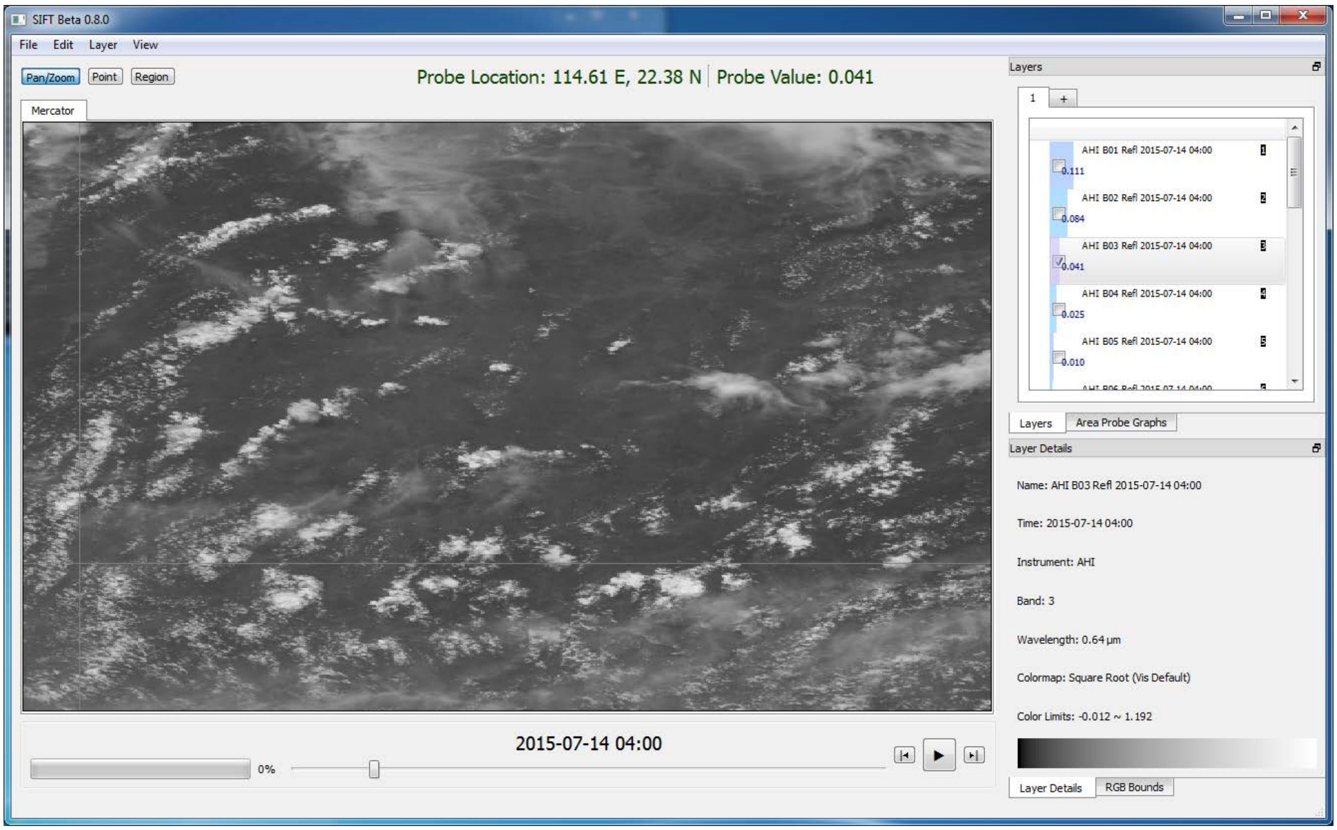


Figure 11: SIFT Band 3 at 0400 UTC on 14 July 2015

Cycle through the different visible bands using the arrow keys. Compare the three visible bands on AHI, Bands 1, 2 and 3 (the blue 0.47 µm, green 0.51 µm and red 0.64 µm bands).

13

With which band are surface features more obscured?
With which band are they more distinct?
Can you think of two reasons why detection of surface features varies with the three visible channels?

Using bands 4 (the veggie band) and 5 (the ice channel), find clouds in this cumulus field that have glaciated. Why might you be interested in knowing which clouds have glaciated? Three that should leap out are at 28.24 N/111.33 E, 26.57N/111.13 E, 27.82N/111.55 E.

14

How do you know from these two reflective channels that glaciation has occurred?

Consider Figure 12, below. What kind of cloud is represented by the values in this SIFT Probe? Which Bands are you focusing on as you make that determination?

Now look at Figure 13, which shows a small region selected over a cloud that shows glaciation. Construct a similar region on your own SIFT, by selecting ‘Region’ and then right-clicking around the cloud edges, finishing up the polygon by clicking near the start point (this is difficult to do because the crosses that denote the points chosen will mask much of the region. Compare Band 5 and Band 6 in the region: are you able in the density diagram to distinguish between glaciated and non-glaciated parts of the cloud? Compare Band 5 with Band 13 – the cleanest window channel on AHI. Is there a relationship there that you expect for glaciated clouds and temperatures?

Figure 14 shows Band 4 v. Band 5 on the left, and Band 13 v. Band 5 on the right. Note the one large circle, which corresponds to a single pixel within the purple polygon in Figure 13.

15

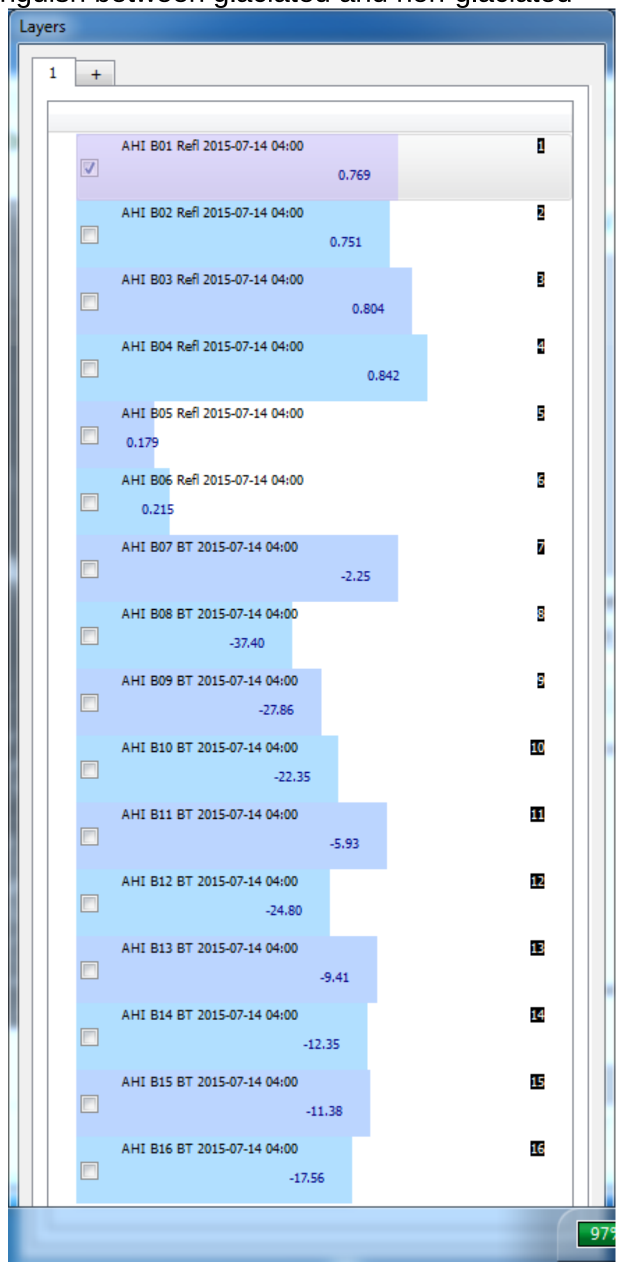
Based on the Band 4 v. Band 5 comparison, what kind of cloud are you seeing? What kind of temperature is occurring at that point?

Has the hypothesis that there is a relationship between the Band 5/Band 4 difference and Band 13 temperature been confirmed?

Why might glaciated and non-glaciated regions show up clearly in the clean IR window channel?

Which GOES-R Instrument will complement the Ice Channel for regions of convection?

When GLM is sending data, I hope to create a lab with visible, 1.6 μm, and 10.3 μm data. My expectation is that visible data will show the developing cumulonimbus cloud, then the GLM will show lightning, then the 1.6 μm will show glaciation, and the 10.3 μm will become steadily colder as this is happening, dropping below the melting point near the time of glaciation.



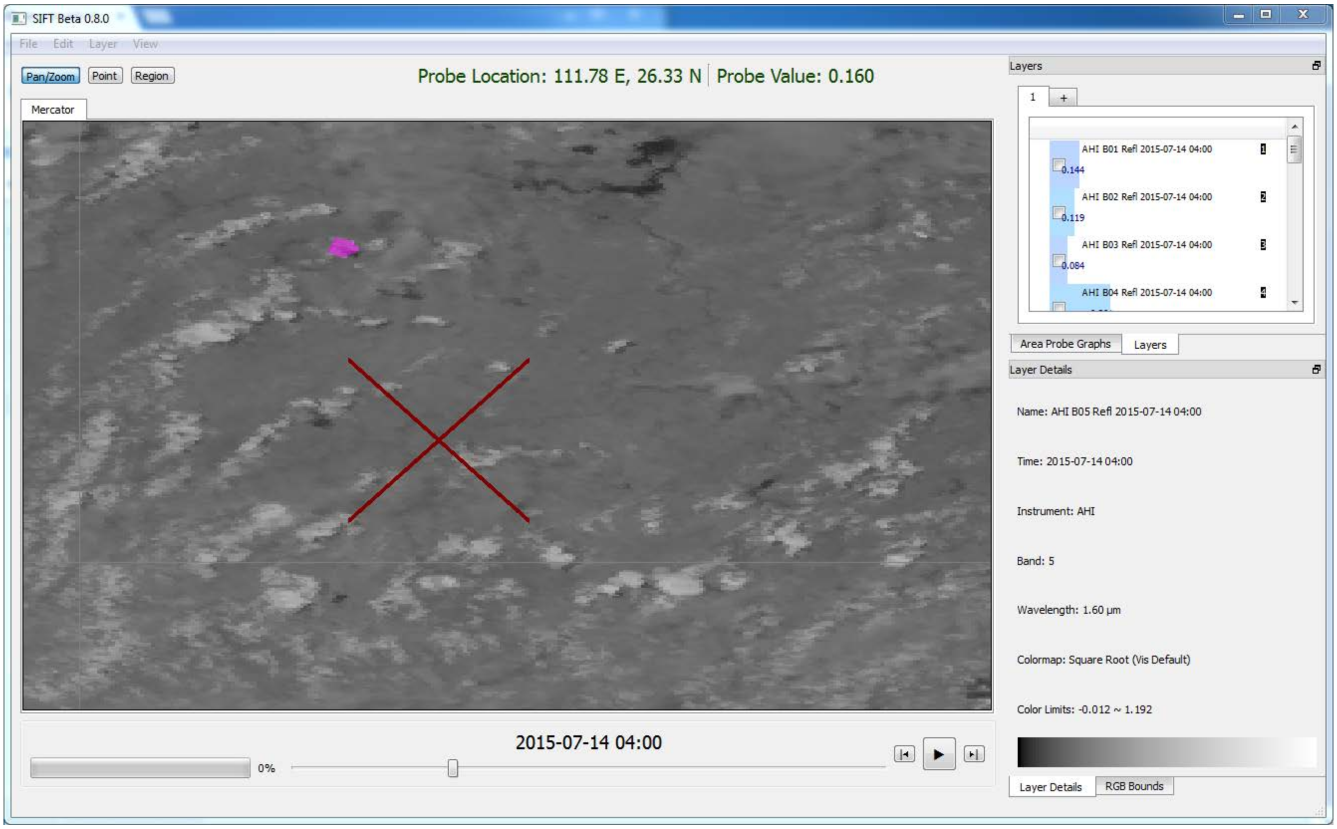


Figure 13: Selected Region over a glaciated cloud.

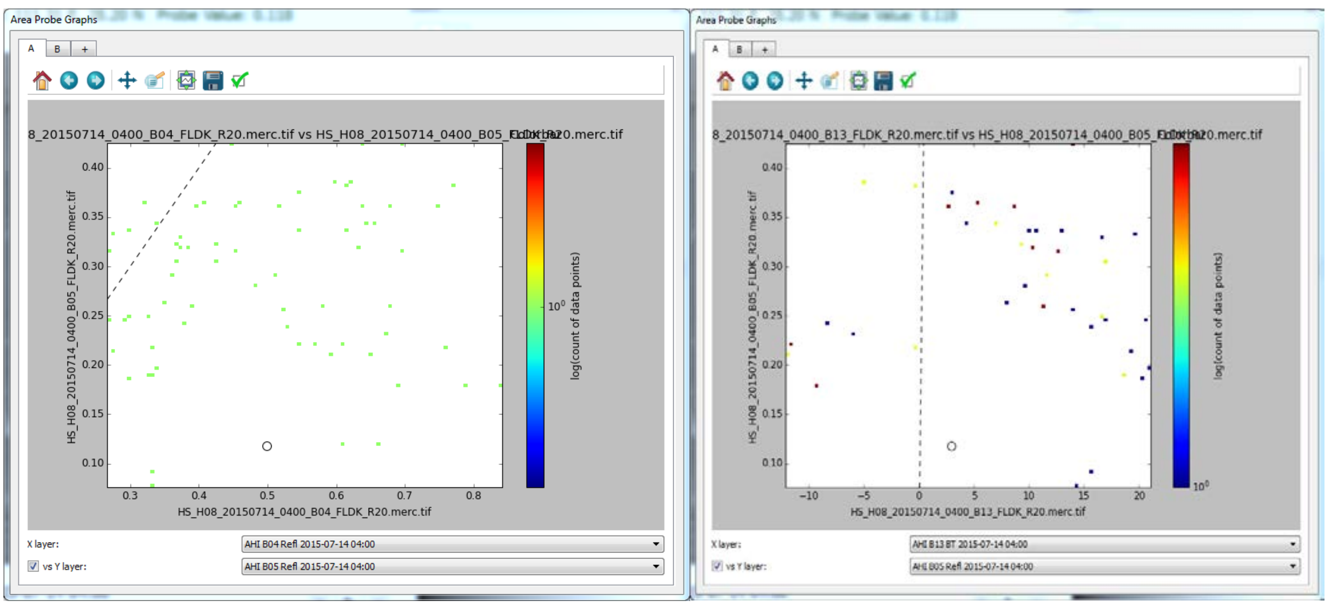


Figure 14: Density Diagrams. Band 4 (x-axis) vs Band 5 (y-axis) on the left, Band 13 (x-axis) vs. Band 5 (y-axis) on the right.