Guam NWS Polar Orbiter Direct Broadcast Applications Workshop

Introduction
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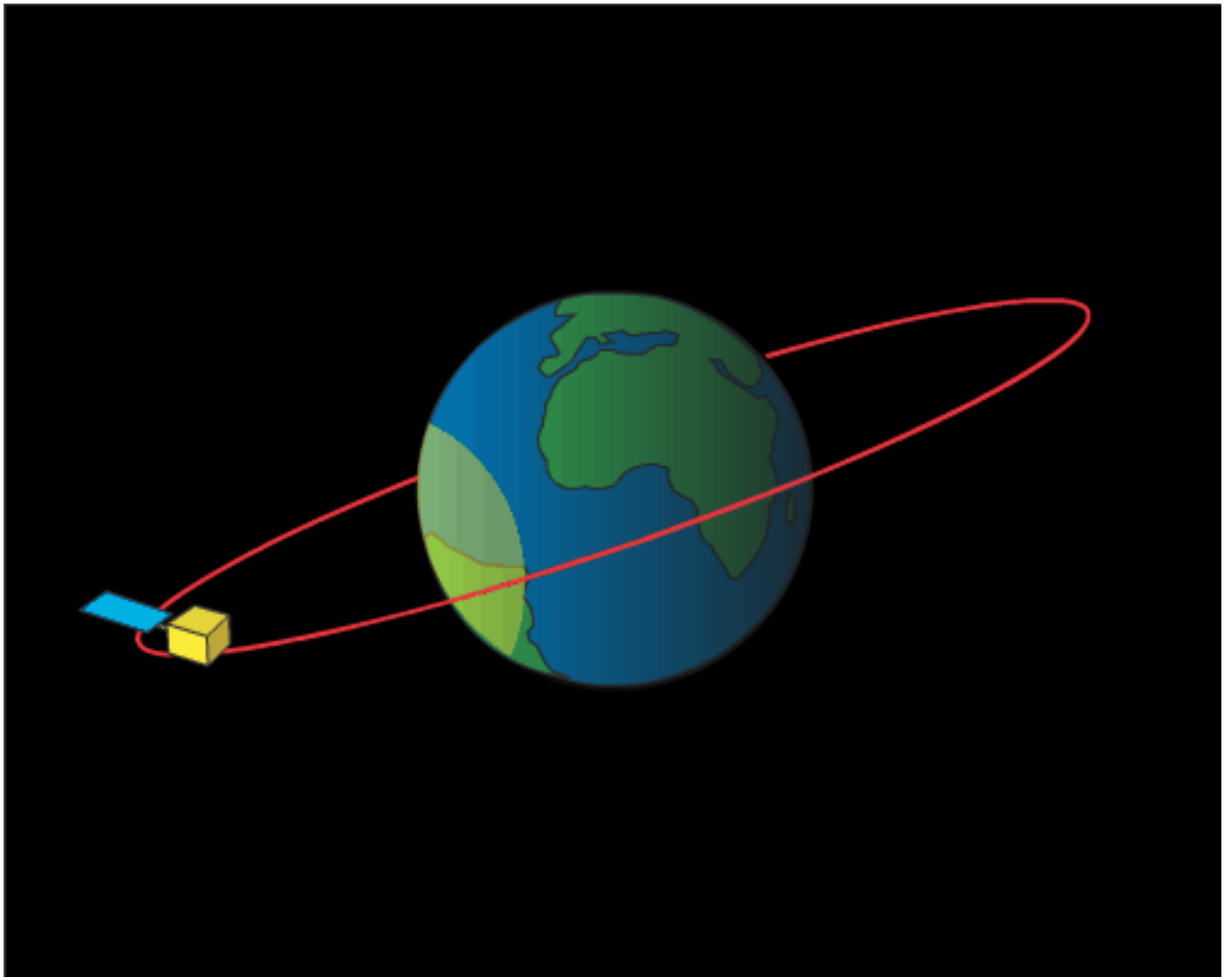
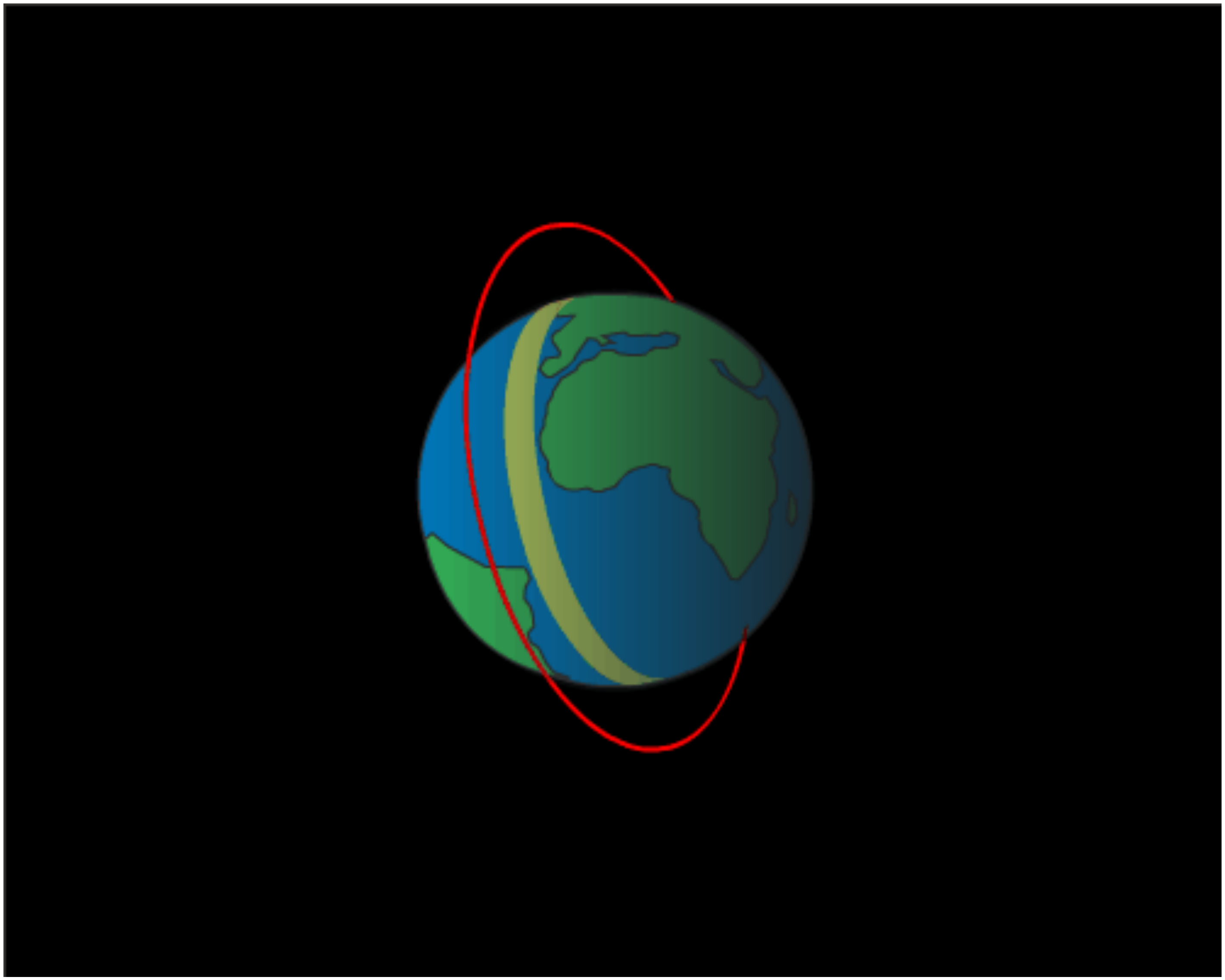
Cooperative Institute for Meteorological Satellites Studies (CIMSS)
Space Science and Engineering Center (SSEC)
16 and 19 April 2018

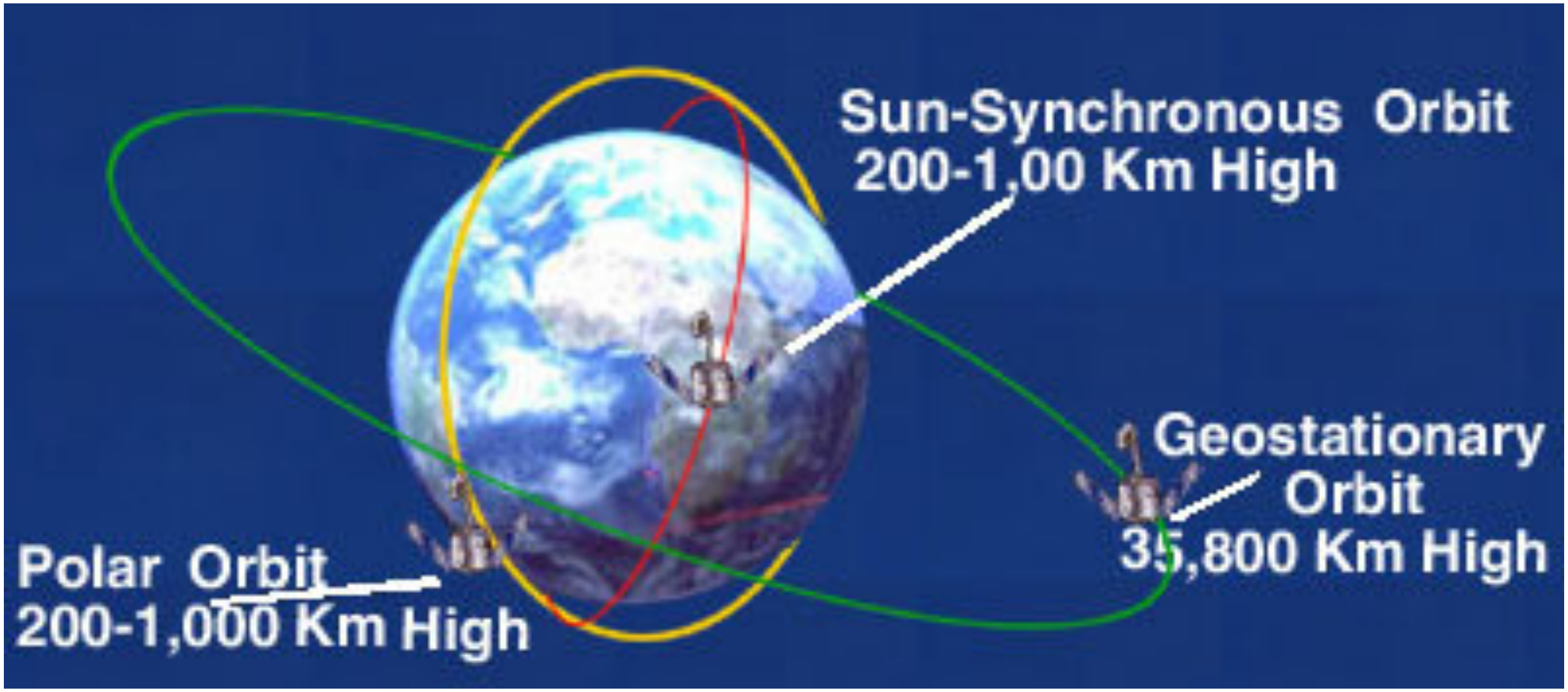
Geostationary Satellite Orbit



Polar Satellite Orbit - Low Earth Orbit (LEO)



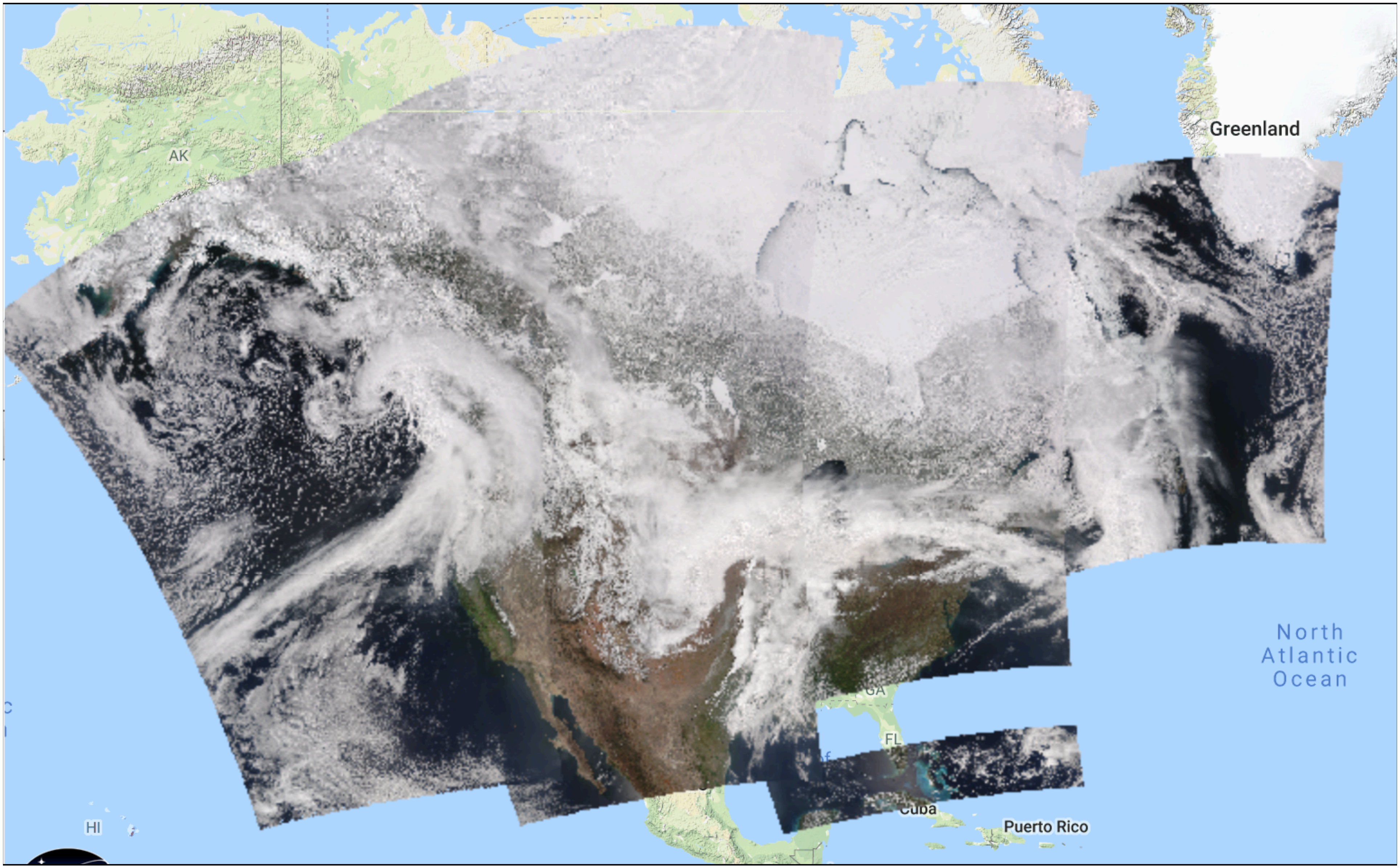
Polar Versus Geostationary Orbit



A Sun-synchronous orbit is one where the satellite passes over any given point of the planet's surface at the same local solar time.


EPOCH=18103.84296719 --- UPDATED=2018105
16:35
14:
10:00
18:15
11:45
21:35
19:55
08:20
06:40
16:30
10:05
18:10
21:30
19:50
08:25
SSEC
06:45
10:10
18:05
08:30
19:45
06:50
http://www.ssec.wisc.edu/datacenter/npp
Note: Dashed circle indicates nominal coverage from SSEC
NPP PREDICTED PASSES APRIL 14, 2018 (DAY 2018104) (ALL TIMES IN UTC)
McIDAS

Daytime Passes Observed at UW-Madison Antenna Facility on 14 April 2018



Advanced Himawari Imager Spectral Bands

AHI Band	AHI Approximate Central Wavelength (µm)	Type	AHI Resolution (km)	Nickname	MTSAT Resolution (km)
1	0.47	Visible	1	Blue	
2	0.51	Visible	1	Green	
3	0.64	Visible	0.5	Red	1
4	0.86	Near-Infrared	1	Veggie	
5	1.6	Near-Infrared	2	Snow/Ice	
6	2.3	Near-Infrared	2	Cloud Particle Size	
7	3.9	Infrared	2	Shortwave Window	4
8	6.2	Infrared	2	Upper-level Water Vapor	4
9	6.9	Infrared	2	Mid-level Water Vapor	
10	7.3	Infrared	2	Lower-level Water Vapor	
11	8.6	Infrared	2	Cloud-Top Phase	
12	9.6	Infrared	2	Ozone	
13	10.4	Infrared	2	"Clean" Longwave Window	4
14	11.2	Infrared	2	Longwave Window	
15	12.4	Infrared	2	"Dirty" Longwave Window	4
16	13.3	Infrared	2	CO_2 Longwave	

Source: http://www.data.jma.go.jp/mscweb/en/himawari89/space_segment/spsg_ahi.html

LEO verses GEO Satellite Instruments

GEO

- High Spatial Resolution
- Moderate Spectral Resolution
- Well Calibrated
- High Temporal Coverage
- Hemispheric Observations
- No Microwave
- Most no IR sounders

LEO

- Higher Spatial Resolution
- Moderate Spectral Resolution with Some Unique Bands
- Very Well Calibrated
- Low Temporal Coverage
- Global Observations
- Microwave Sounders
- Hyperspectral IR Sounders

VIIRS Instrument Characteristics

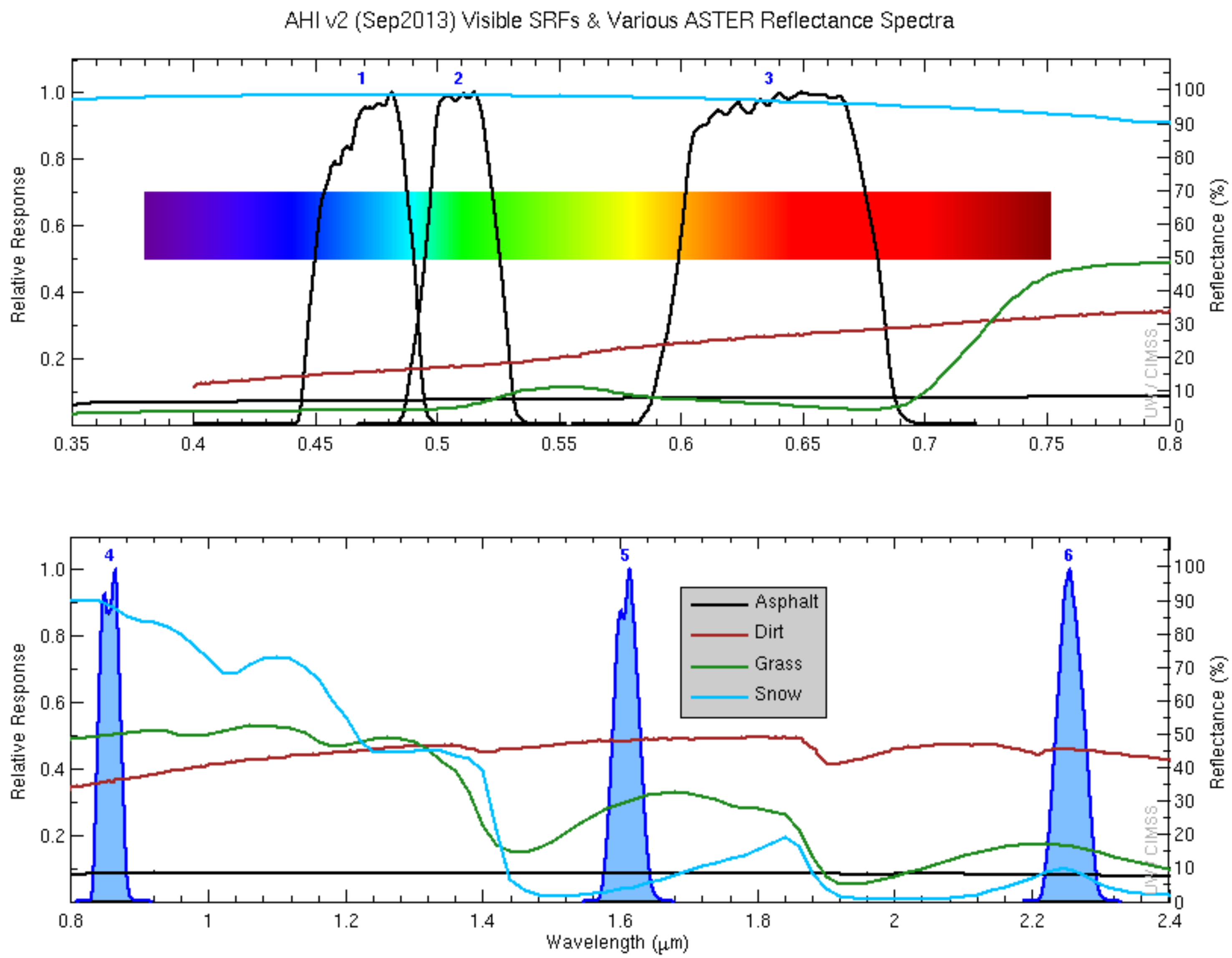
		Band No.	Wave-length (µm)	Horiz Sample Interval (km Downtrack x Crosstrack)		Driving EDRs	Radi-ance Range	Ltyp or Ttyp	Signal to Noise Ratio (dimensionless) or NE∆T (Kelvins)		
				Nadir	End of Scan				Required	Predicted	Margin
VIS/NIR FPA	Silicon PIN Diodes	M1	0.412	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	44.9	352	441	25%
						Aerosols	High	155	316	807	155%
		M2	0.445	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	40	380	524	38%
						Aerosols	High	146	409	926	126%
		M3	0.488	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	32	416	542	30%
						Aerosols	High	123	414	730	76%
		M4	0.555	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	21	362	455	26%
						Aerosols	High	90	315	638	102%
		I1	0.640	0.371 x 0.387	0.80 x 0.789	Imagery	Single	22	119	146	23%
		M5	0.672	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	10	242	298	23%
						Aerosols	High	68	360	522	45%
		M6	0.746	0.742 x 0.776	1.60 x 1.58	Atmospheric Corr'n	Single	9.6	199	239	20%
		I2	0.865	0.371 x 0.387	0.80 x 0.789	NDVI	Single	25	150	225	50%
		M7	0.865	0.742 x 0.259	1.60 x 1.58	Ocean Color	Low	6.4	215	388	81%
						Aerosols	High	33.4	340	494	45%
CCD		DNB	0.7	0.742 x 0.742	0.742 x 0.742	Imagery	Var.	6.70E-05	6	5.7	-5%
S/MWIR	PV HgCdTe (HCT)	M8	1.24	0.742 x 0.776	1.60 x 1.58	Cloud Particle Size	Single	5.4	74	98	32%
		M9	1.378	0.742 x 0.776	1.60 x 1.58	Cirrus/Cloud Cover	Single	6	83	155	88%
		I3	1.61	0.371 x 0.387	0.80 x 0.789	Binary Snow Map	Single	7.3	6.0	97	1523%
		M10	1.61	0.742 x 0.776	1.60 x 1.58	Snow Fraction	Single	7.3	342	439	28%
		M11	2.25	0.742 x 0.776	1.60 x 1.58	Clouds	Single	0.12	10	17	66%
		I4	3.74	0.371 x 0.387	0.80 x 0.789	Imagery Clouds	Single	270 K	2.500	0.486	415%
		M12	3.70	0.742 x 0.776	1.60 x 1.58	SST	Single	270 K	0.396	0.218	82%
		M13	4.05	0.742 x 0.259	1.60 x 1.58	SST	Low	300 K	0.107	0.063	69%
						Fires	High	380 K	0.423	0.334	27%
LWIR	PV HCT	M14	8.55	0.742 x 0.776	1.60 x 1.58	Cloud Top Properties	Single	270 K	0.091	0.075	22%
		M15	10.763	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K	0.070	0.038	85%
		I5	11.450	0.371 x 0.387	0.80 x 0.789	Cloud Imagery	Single	210 K	1.500	0.789	90%
		M16	12.013	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K	0.072	0.051	42%

MODIS Instrument Characteristics

Band	Wavelength (nm)	Resolution (m)	Primary Use
1	620–670	250	Land/Cloud/Aerosols Boundaries
2	841–876	250	
3	459–479	500	Land/Cloud/Aerosols Properties
4	545–565	500	
5	1230–1250	500	
6	1628–1652	500	
7	2105–2155	500	
8	405–420	1000	Ocean Color/ Phytoplankton/ Biogeochemistry
9	438–448	1000	
10	483–493	1000	
11	526–536	1000	
12	546–556	1000	
13	662–672	1000	
14	673–683	1000	
15	743–753	1000	
16	862–877	1000	
17	890–920	1000	Atmospheric Water Vapor
18	931–941	1000	
19	915–965	1000	

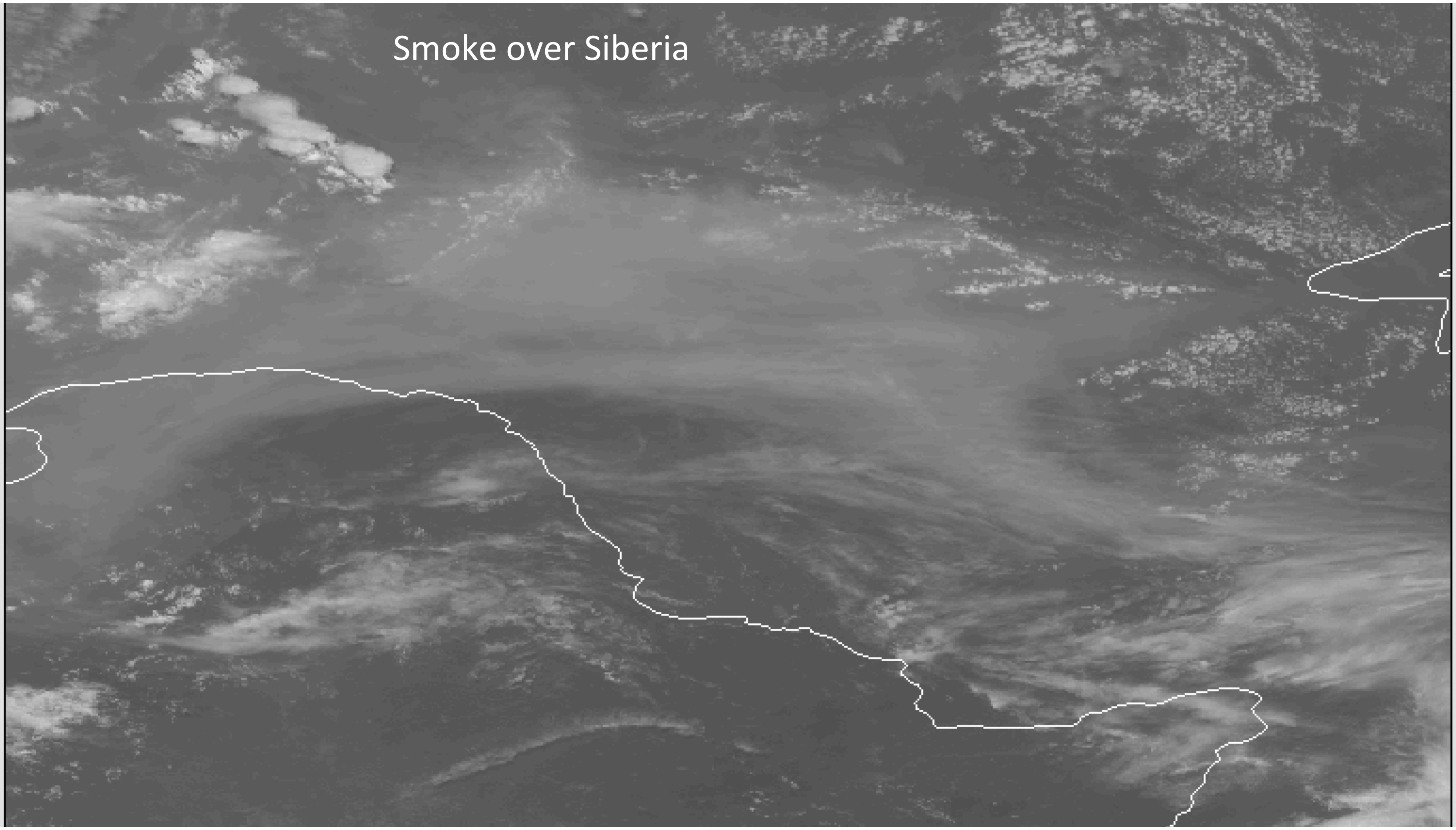
Band	Wavelength (μm)	Resolution (m)	Primary Use
20	3.660–3.840	1000	Surface/Cloud Temperature
21	3.929–3.989	1000	
22	3.929–3.989	1000	
23	4.020–4.080	1000	
24	4.433–4.498	1000	Atmospheric Temperature
25	4.482–4.549	1000	
26	1.360–1.390	1000	Cirrus Clouds Water Vapor
27	6.535–6.895	1000	
28	7.175–7.475	1000	
29	8.400–8.700	1000	Cloud Properties
30	9.580–9.880	1000	Ozone
31	10.780–11.280	1000	Surface/Cloud Temperature
32	11.770–12.270	1000	
33	13.185–13.485	1000	Cloud Top Altitude
34	13.485–13.785	1000	
35	13.785–14.085	1000	
36	14.085–14.385	1000	

Visible and Near-IR bands on the AHI ….

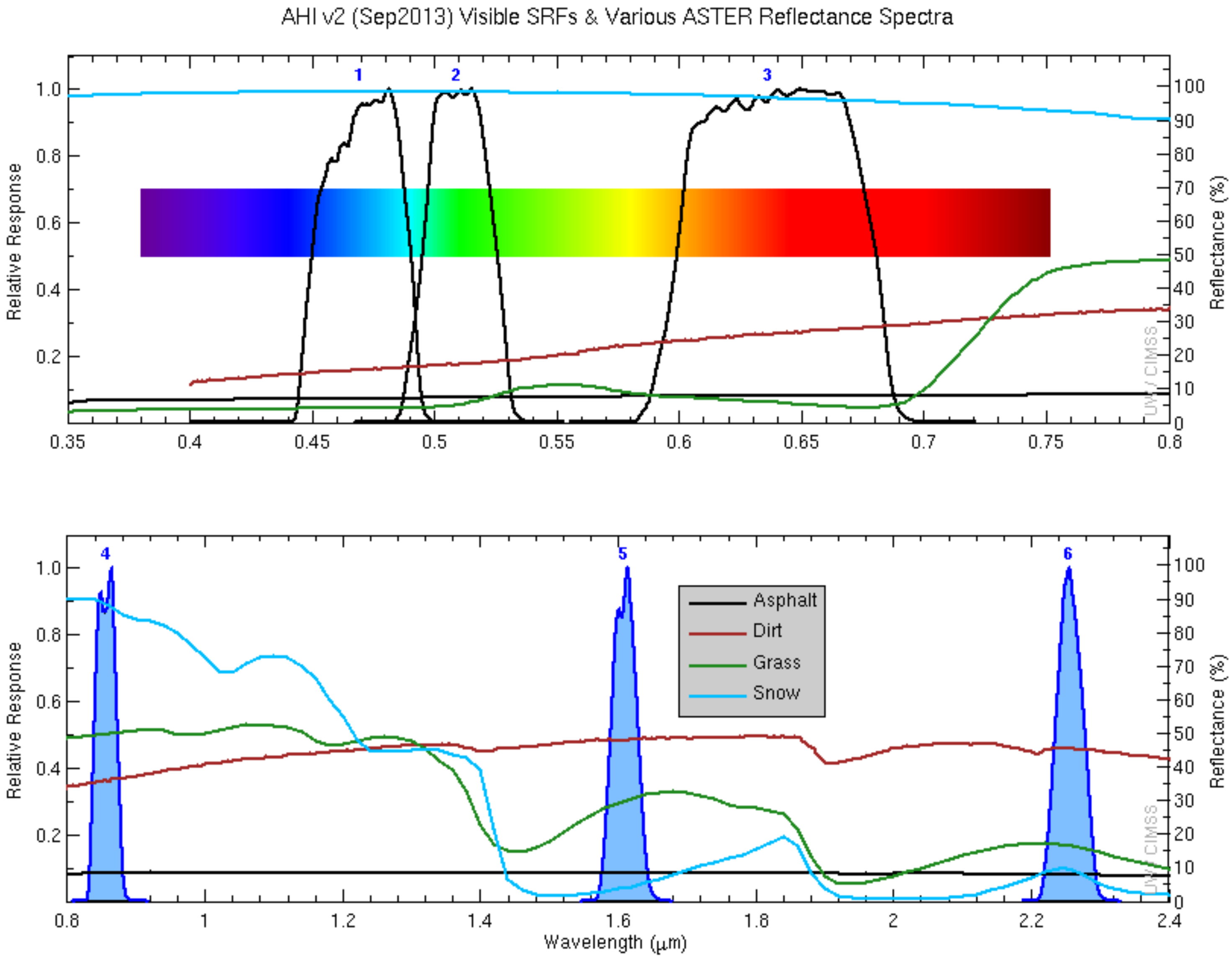


ABI/AHI Band 1 (0.47 µm)

Example from the Advanced Himawari Imager



Visible and Near-IR bands on the AHI ….



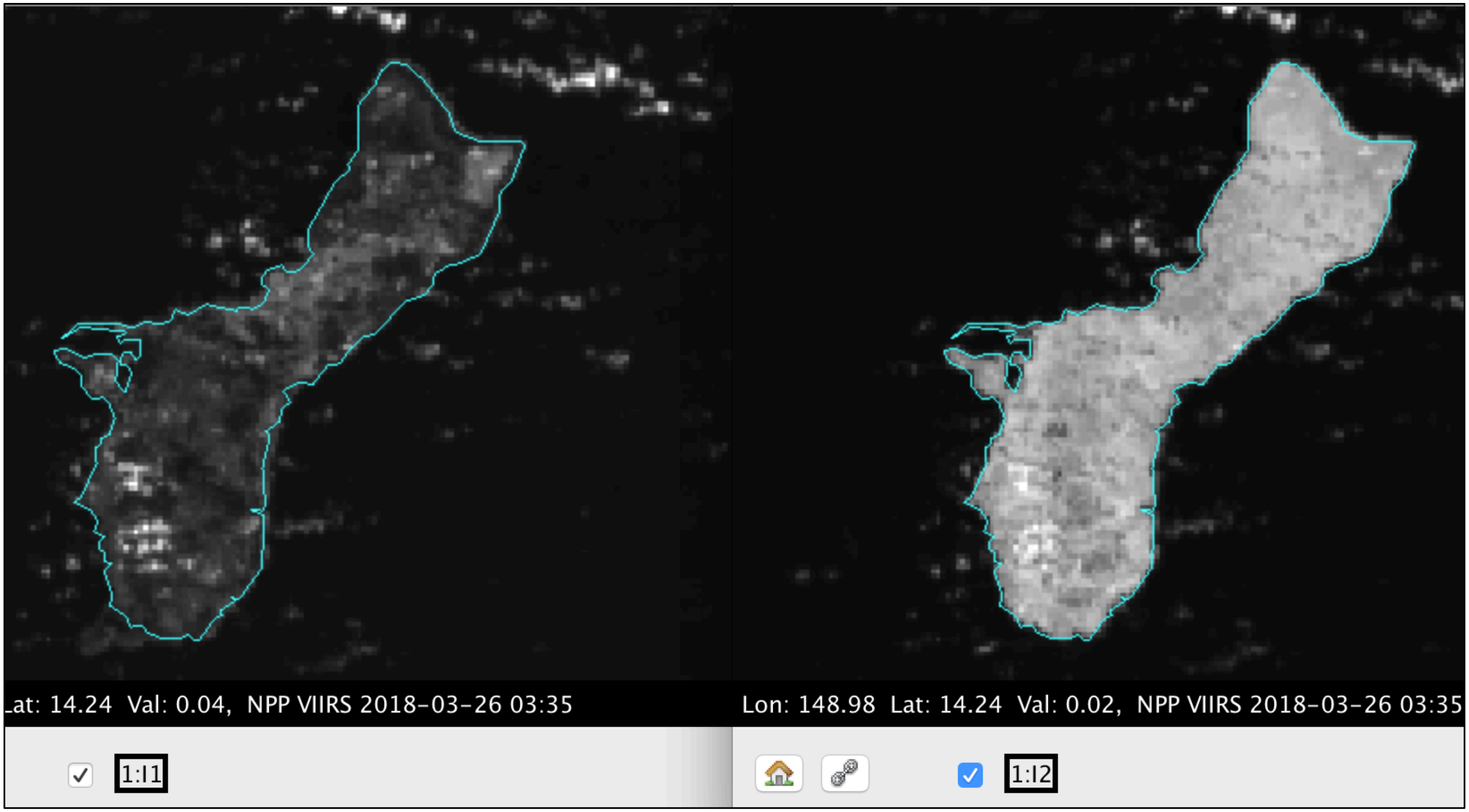
AHI Band 3 Versus Band 4

AHI Band 3 (.64 µm)

AHI Band 4 (.86 µm)

Philippine Island of Mindanao

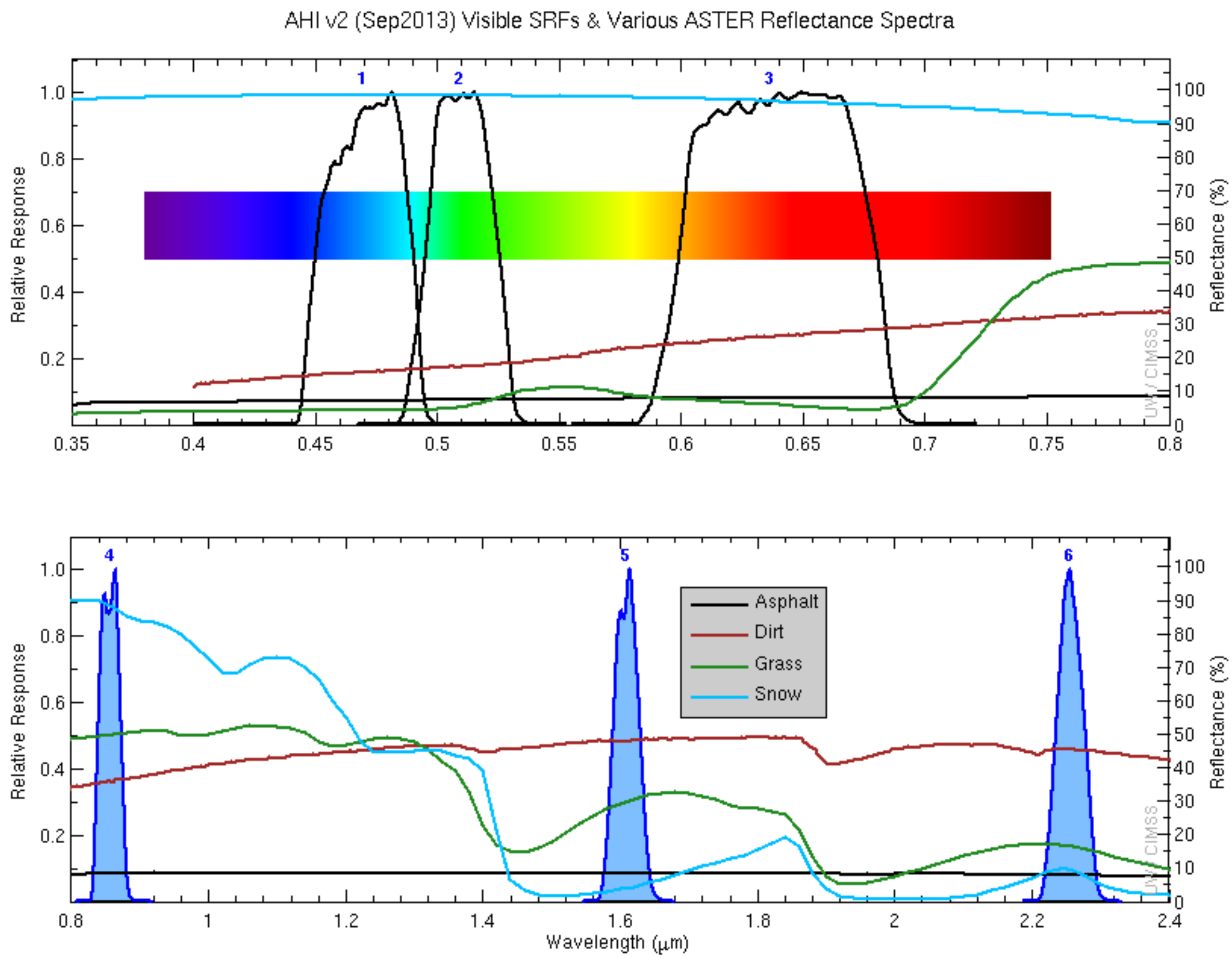
VIIRS I-Band 1 versus 2



VIIRS I-Band 1 (.64 µm)

VIIRS I-Band 2 (.86 µm)

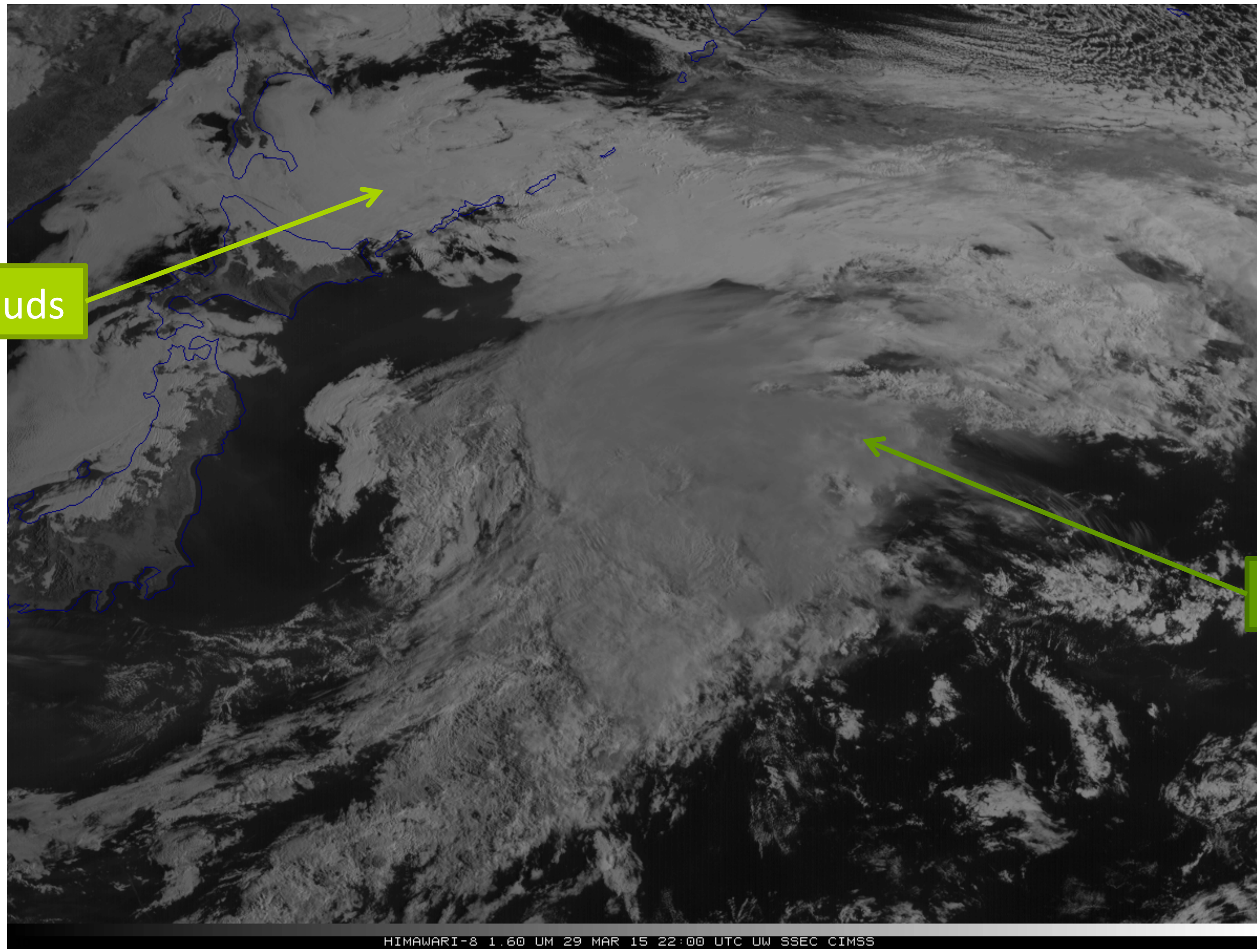
Visible and Near-IR bands on the AHI ….



ABI/AHI Band 5 (1.6 µm)

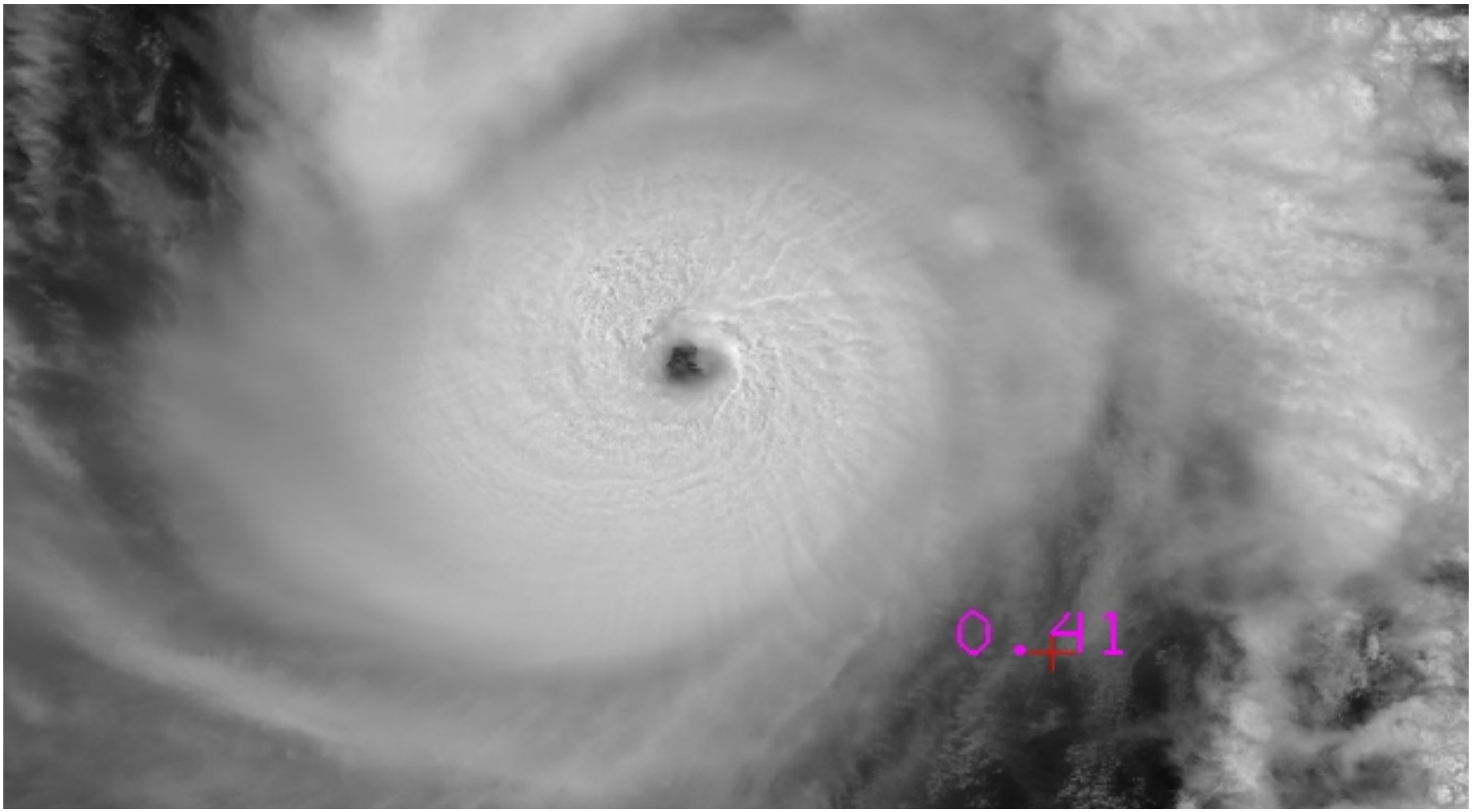
Example from the Advanced Himawari Imager

Water clouds



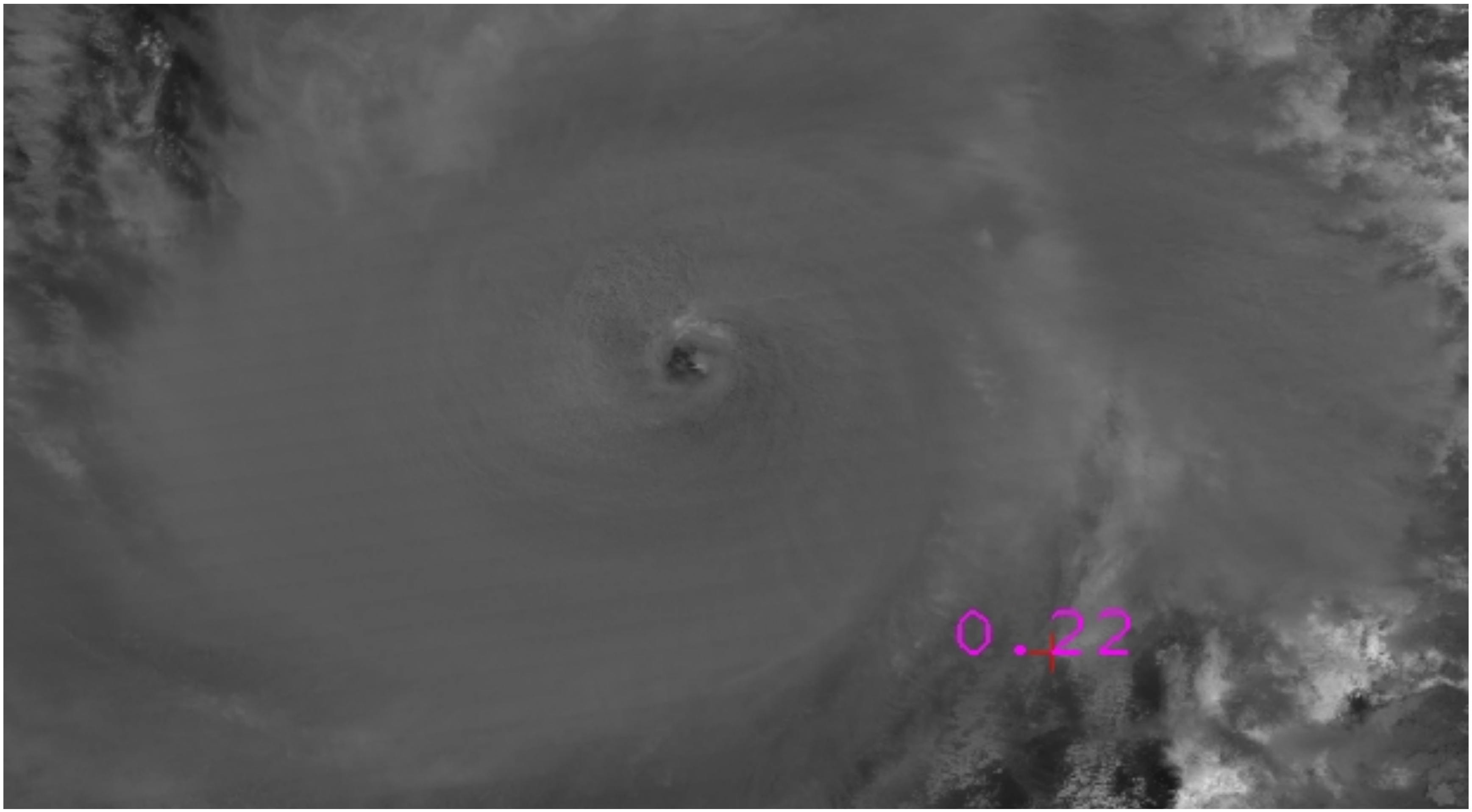
Ice clouds

Super Typhoon Jelawat
VIIRS I-Band 1 (.64 µm) 375m
Reflectances



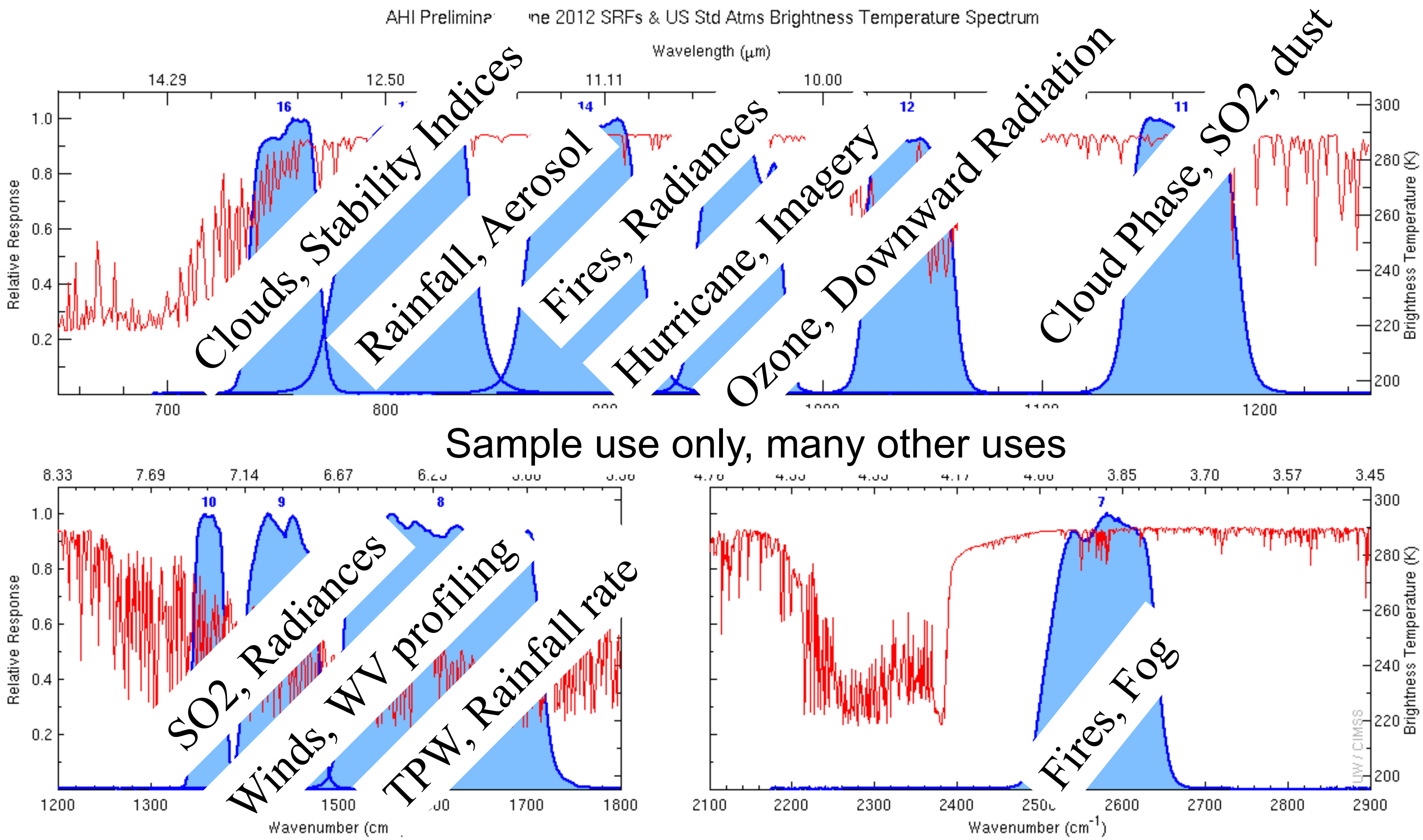
30 March 2018 – 0401 UTC

Super Typhoon Jelawat
VIIRS I-Band 3 (1.6 µm) 375m
Reflectances



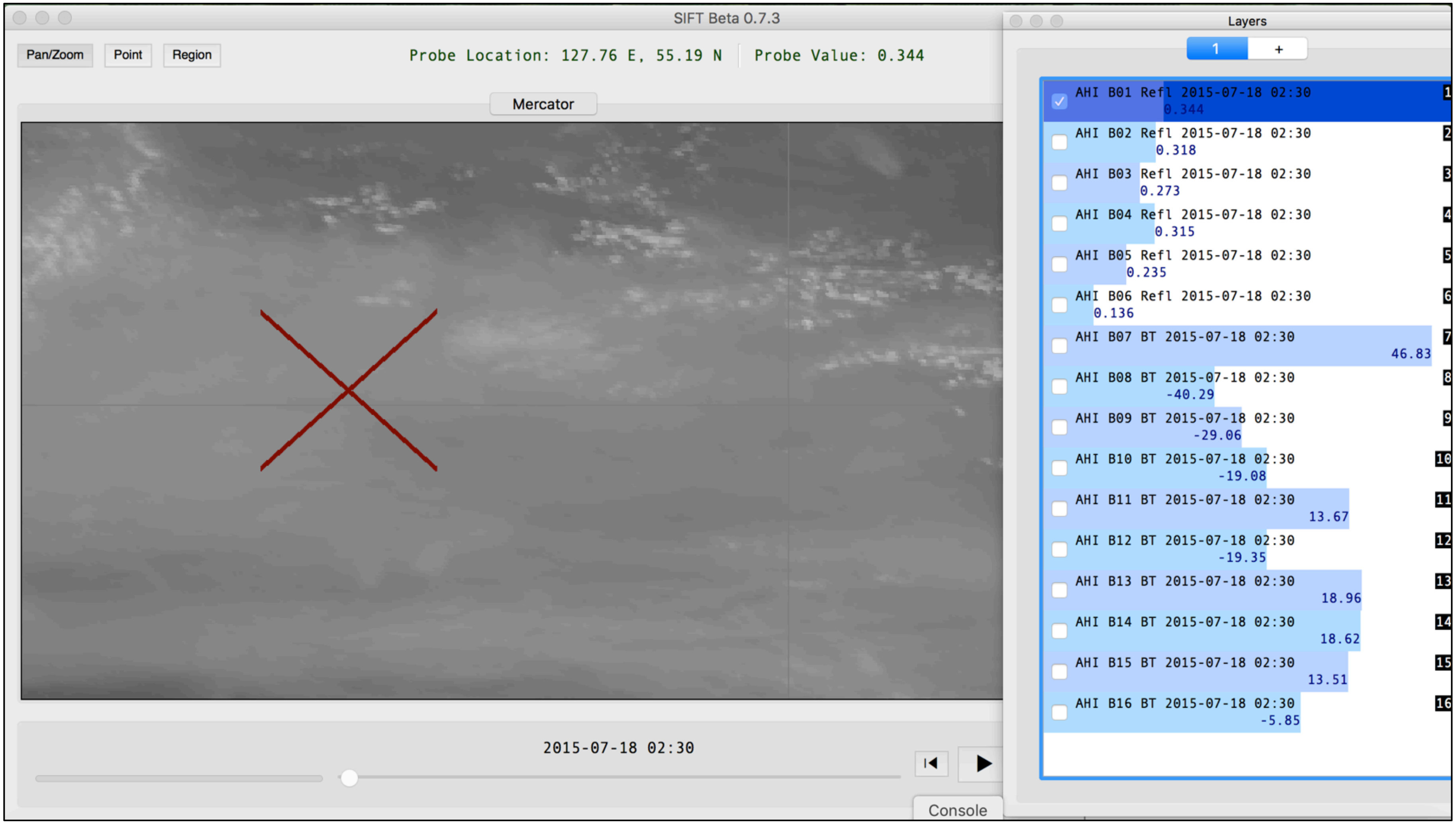
30 March 2018 – 0401 UTC

The IR channels on the AHI

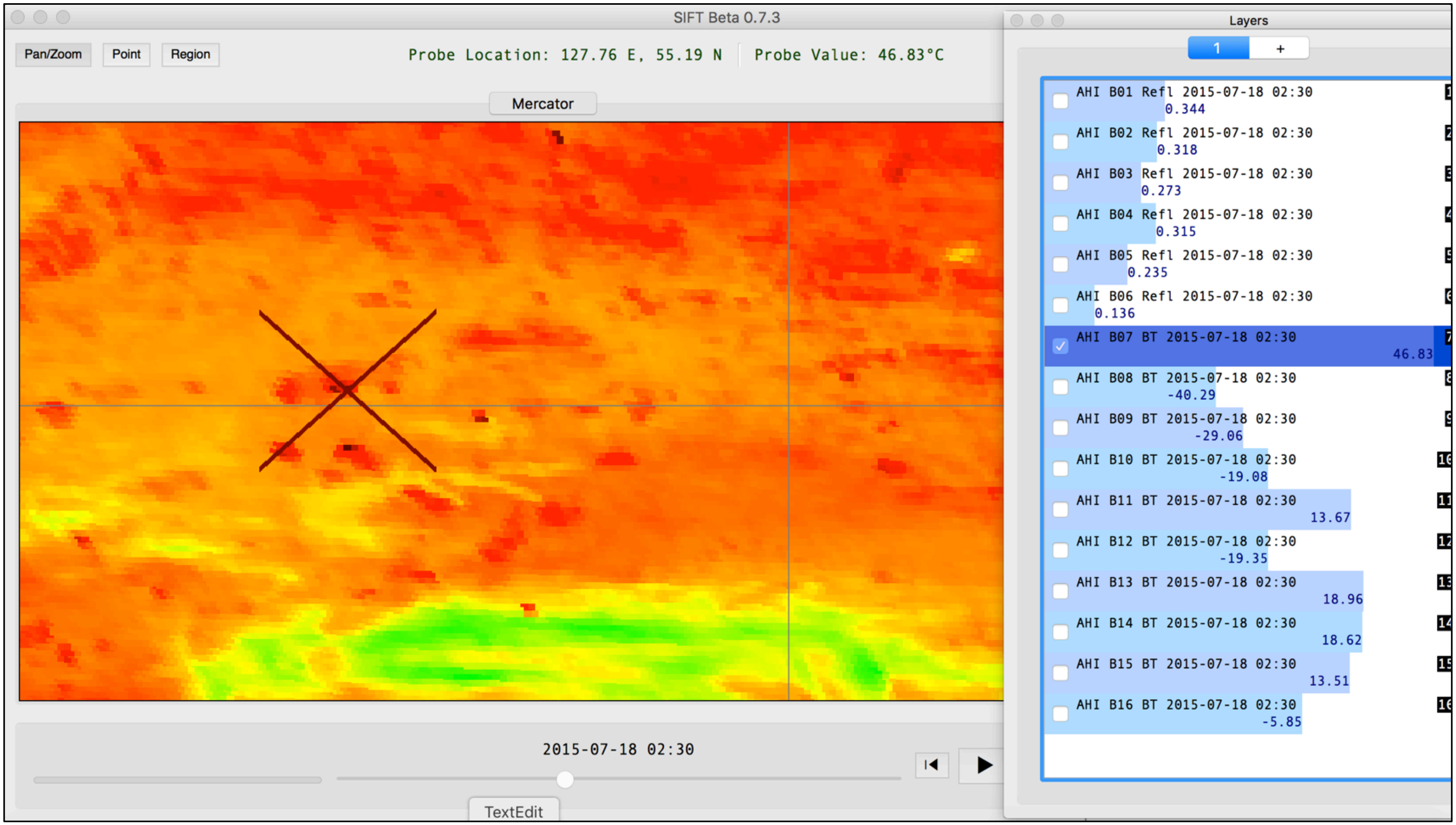


AHI has many more bands than the MTSAT imagers.

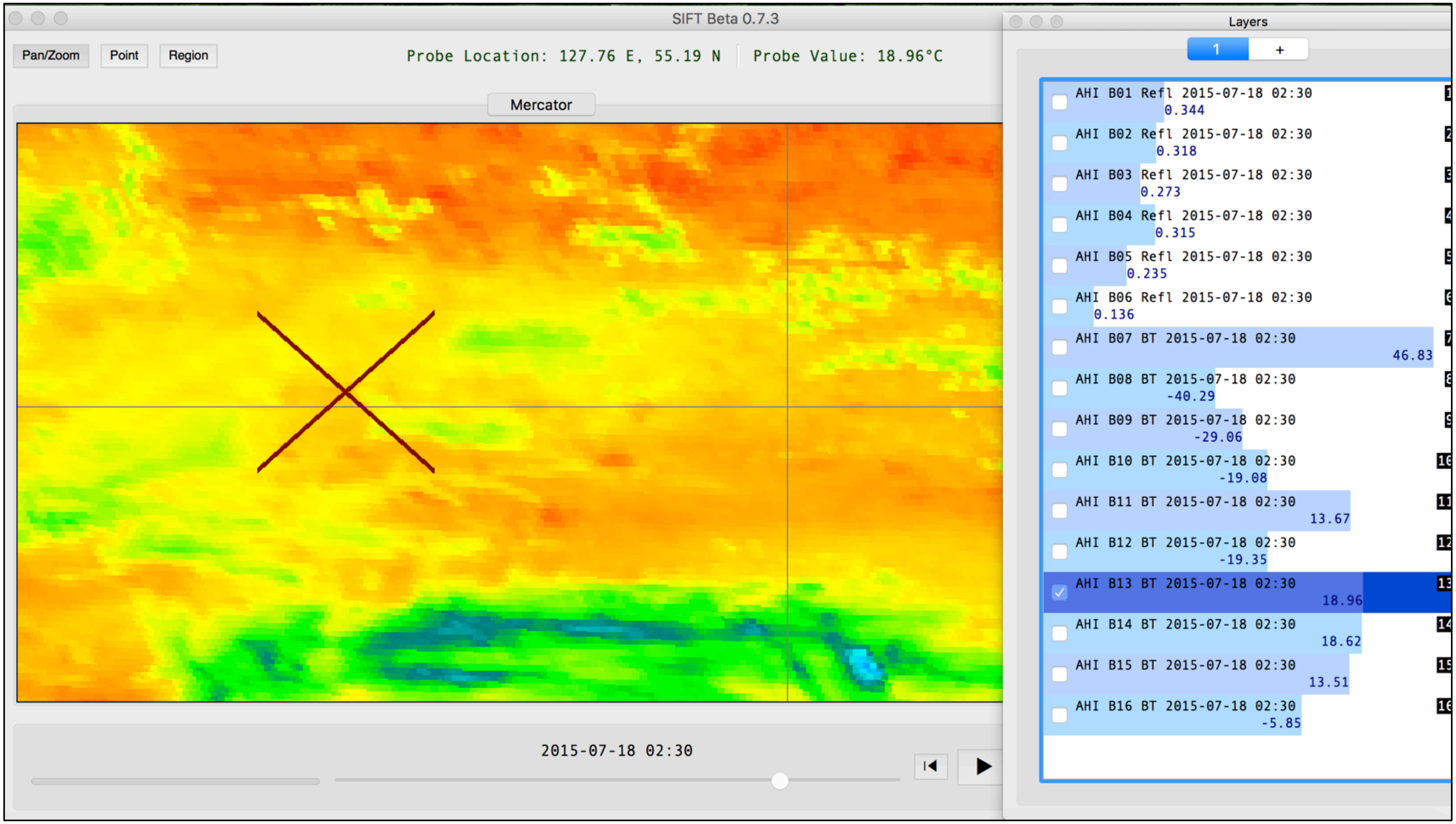
AHI Band 1 (.47 micron)



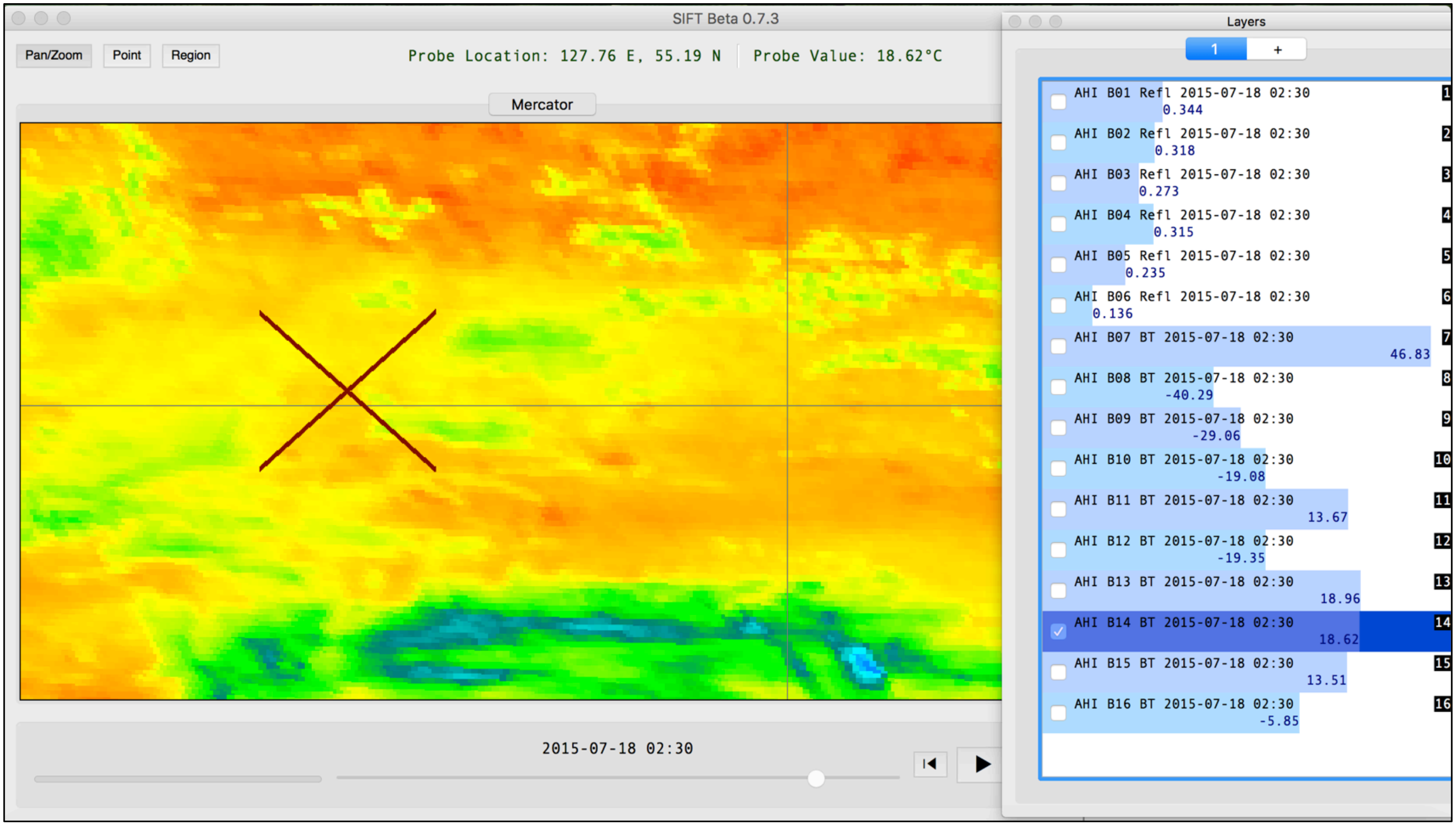
AHI Band 7 (3.9 micron)



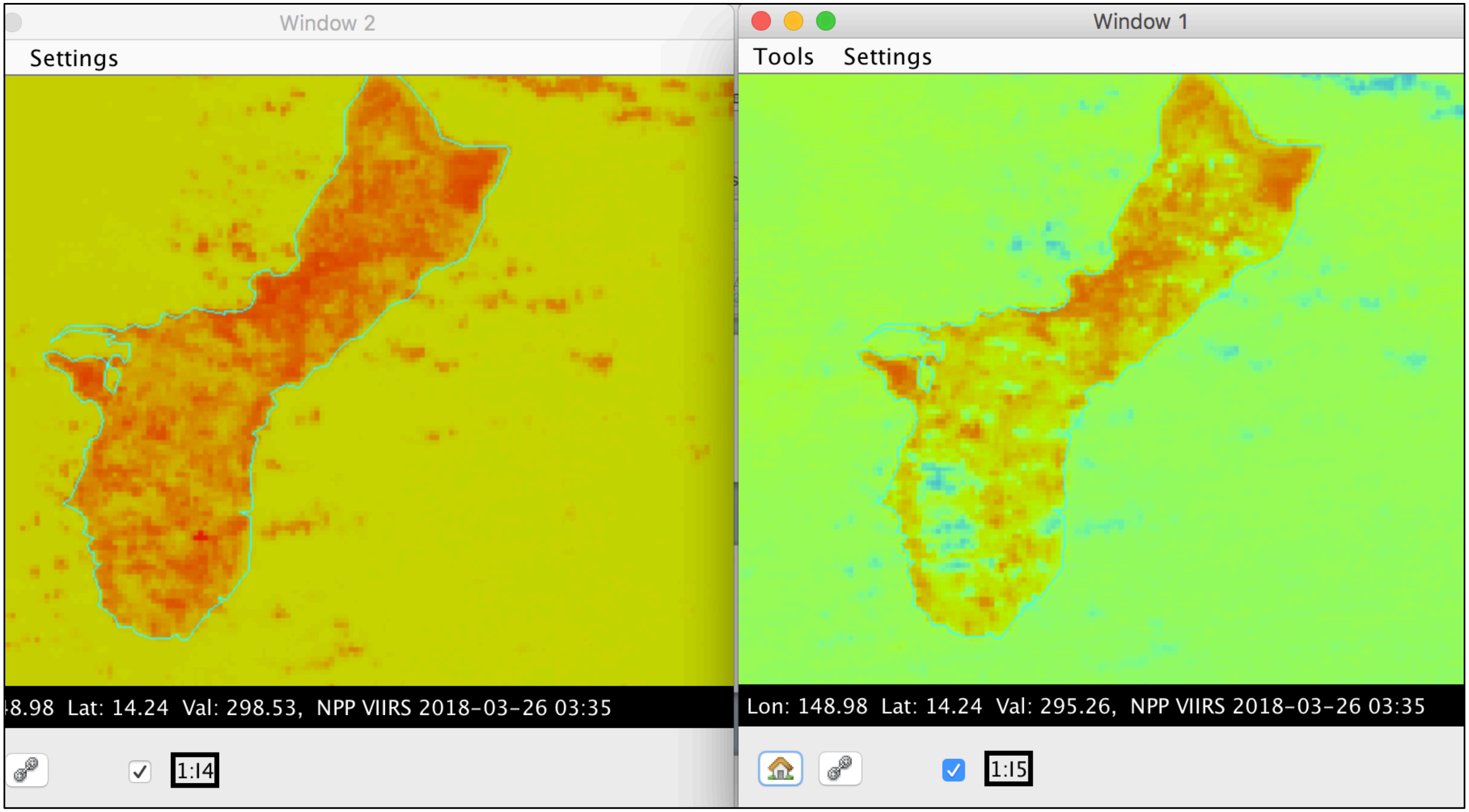
AHI Band 13 (10.4 micron)



AHI Band 14 (11.2 micron)

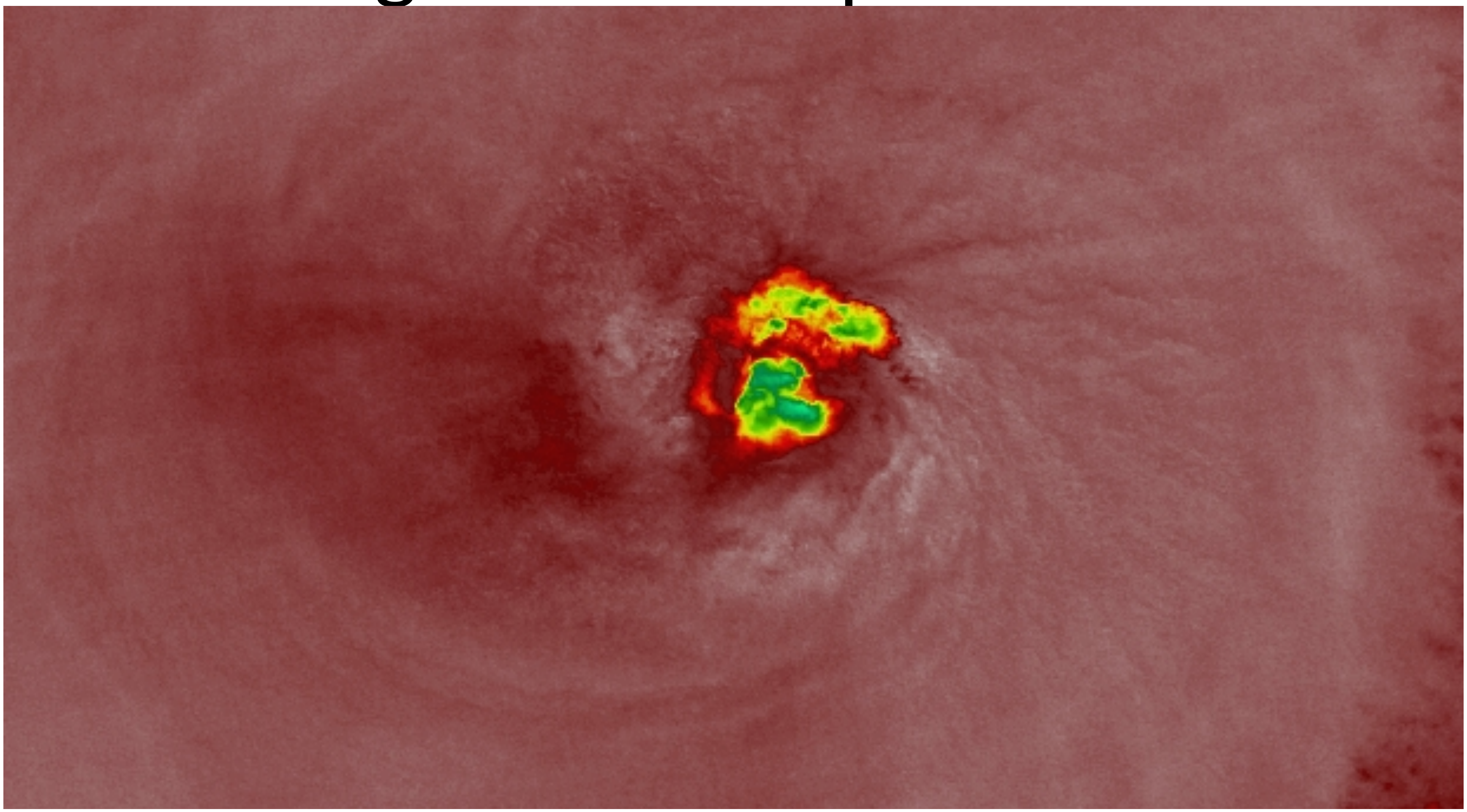


VIIRS I-Band 4 versus 5 (375m)



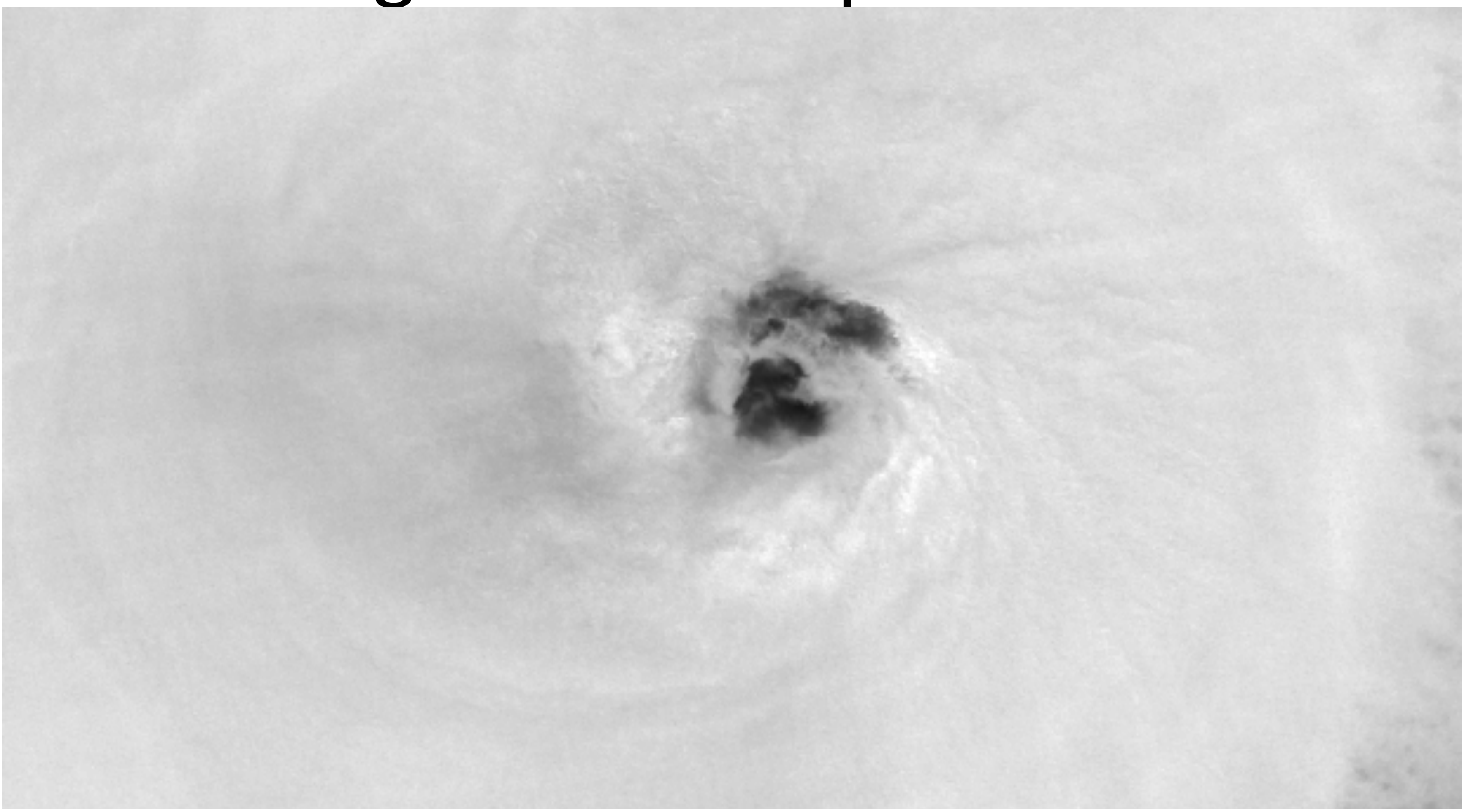
VIIRS I-Band 4 (3.74 µm) VIIRS I-Band 5 (11.45 µm)

Super Typhoon Jelawat
VIIRS I-Band 4 (3.74 µm) 375m
Brightness Temperatures



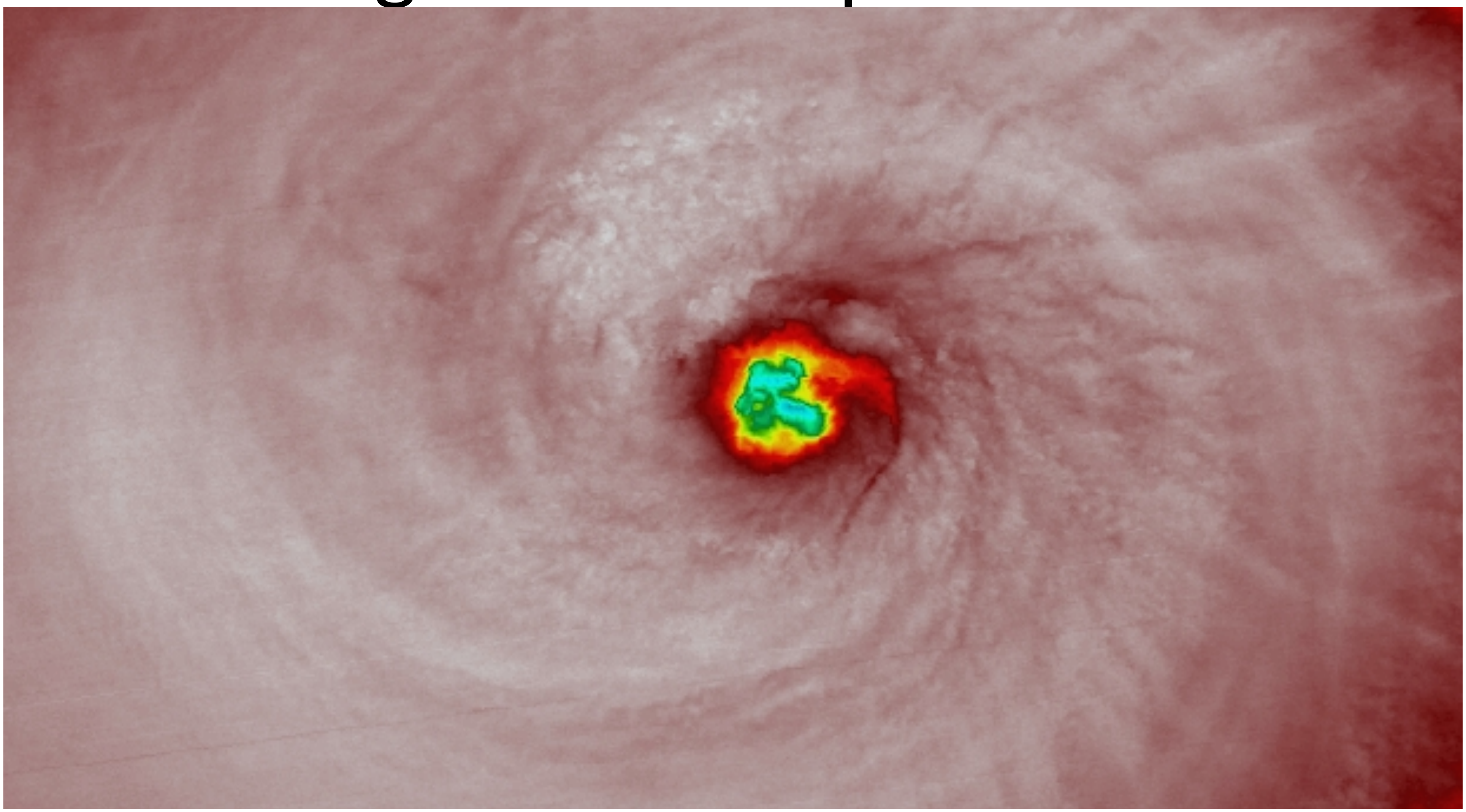
30 March 2018 – 0401 UTC

Super Typhoon Jelawat
VIIRS I-Band 4 (3.74 µm) 375m
Brightness Temperatures



30 March 2018 – 0401 UTC

Super Typhoon Jelawat
VIIRS I-Band 5 (11.4 µm) 375m
Brightness Temperatures



30 March 2018 – 0401 UTC

VIIRS Day/Night Band

- Visible wavelength available at night!
  - 735 m spatial resolution centered at about .7 microns
- What can now be seen at night?
  - Cities
  - Smoke, Dust, Ash
  - Low Clouds/Fog
  - Fires, Volcanoes (Lava)
  - Auroras
  - Lightning
- How much can be seen depends heavily on lunar illumination – Phase of moon, and rising setting times

VIIRS Day/Night Band

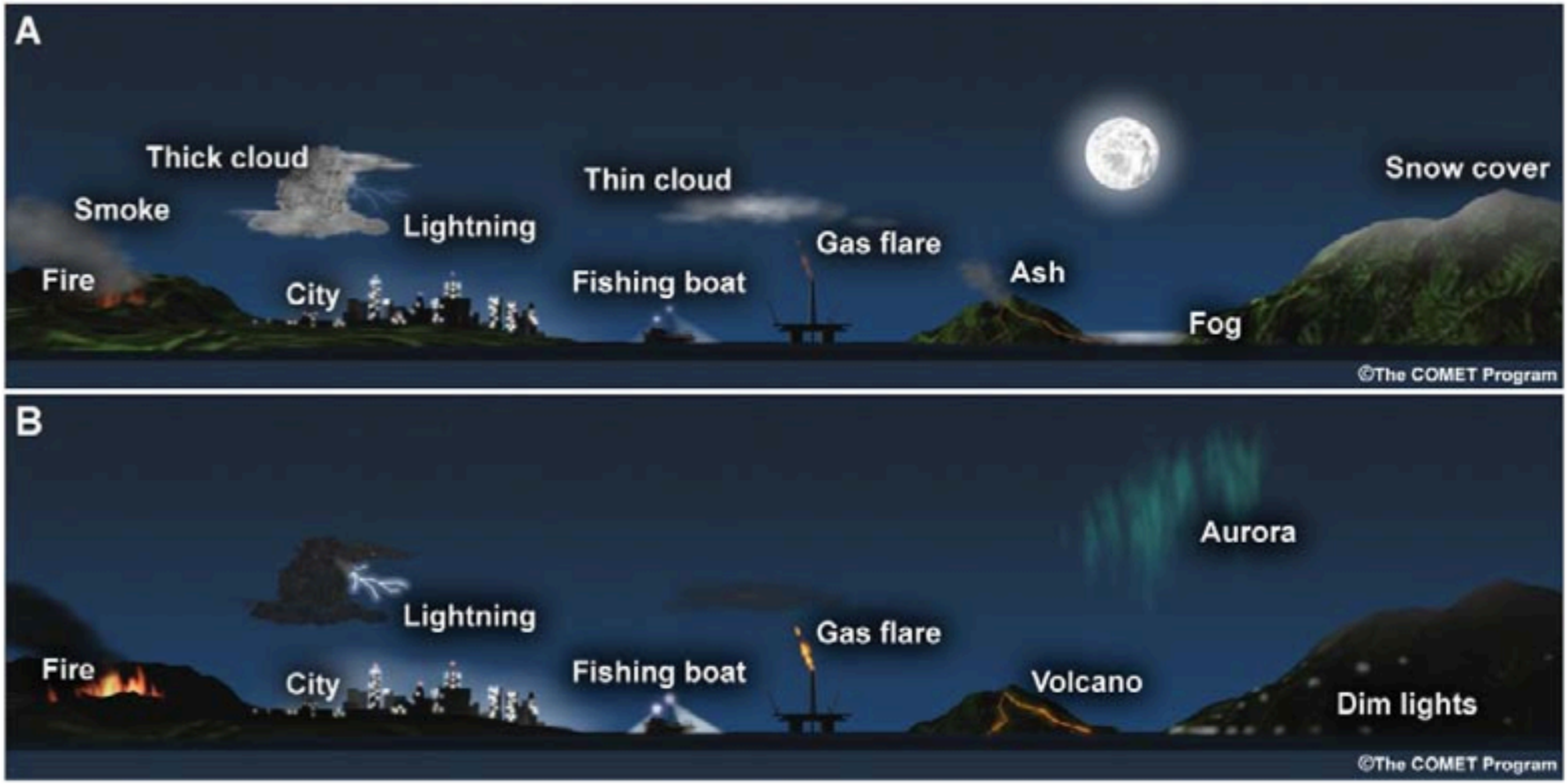
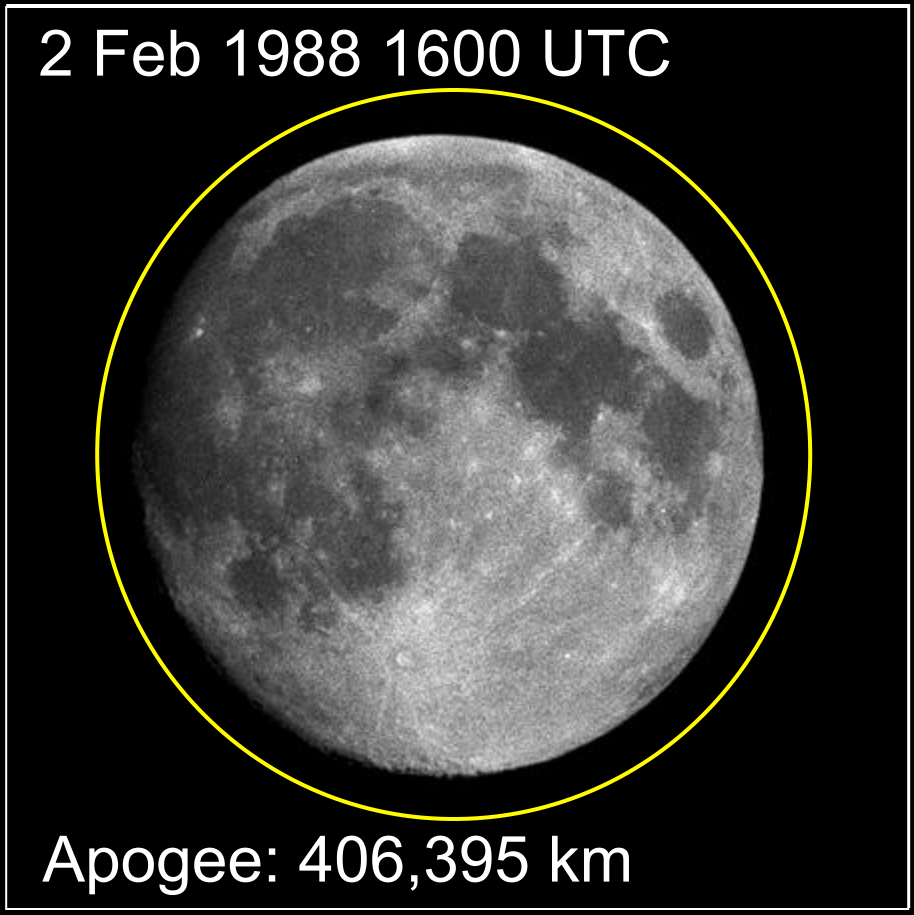


FIG. 1. Nighttime visible detection capabilities (a) with and (b) without lunar illumination.

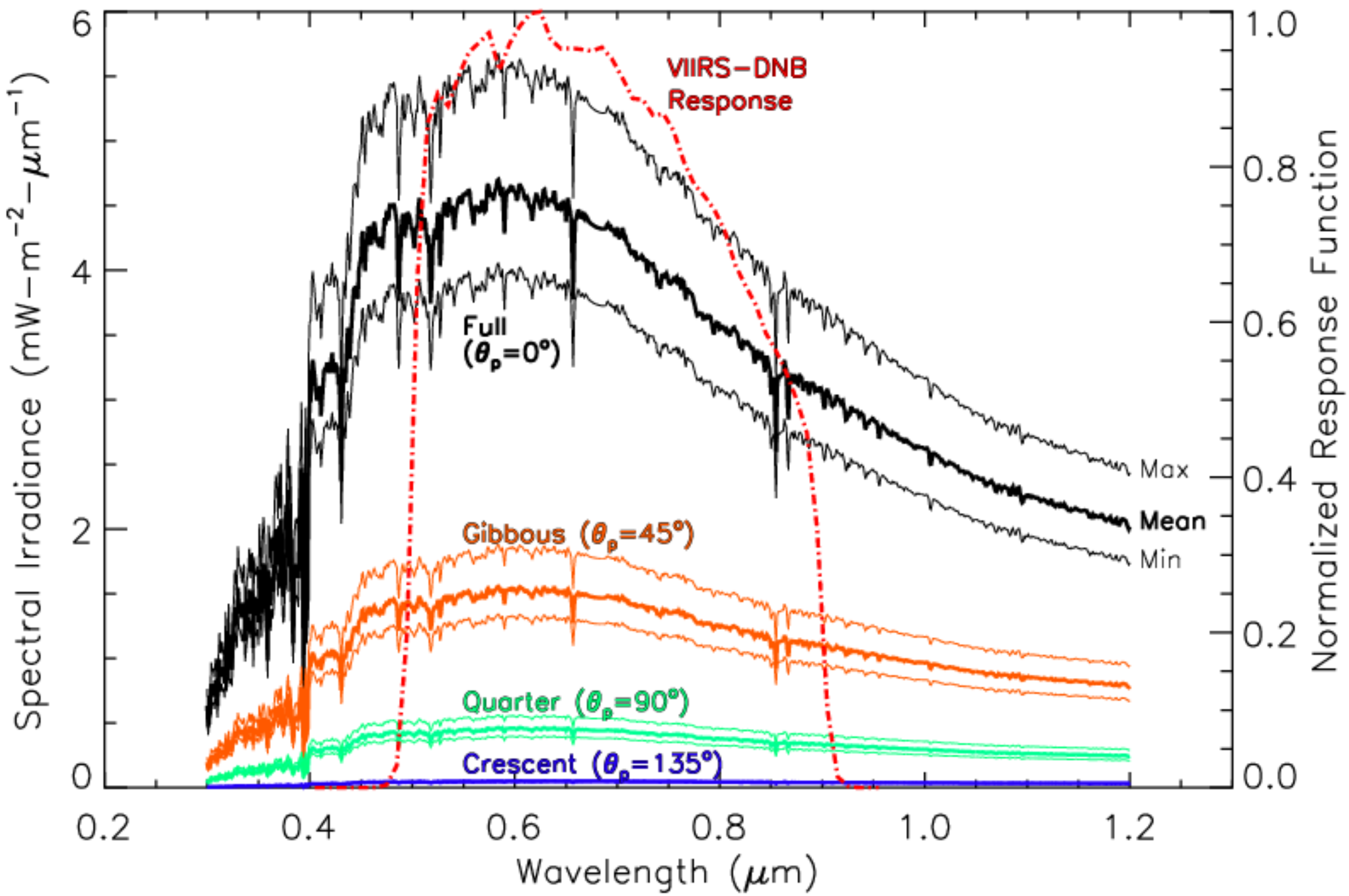
Taken from: T., Miller, S. D., Turk, F. J., Schueler, C., Jullian, R., Deyo, S., Dills, P., and Wang, S., 2006: The NPOESS VIIRS Day/Night Visible Sensor, Bulletin Am. Met. Society, DOI:10.1175/BAMS-87-2-191, p. 191-199.

Lunar Reflectance Model

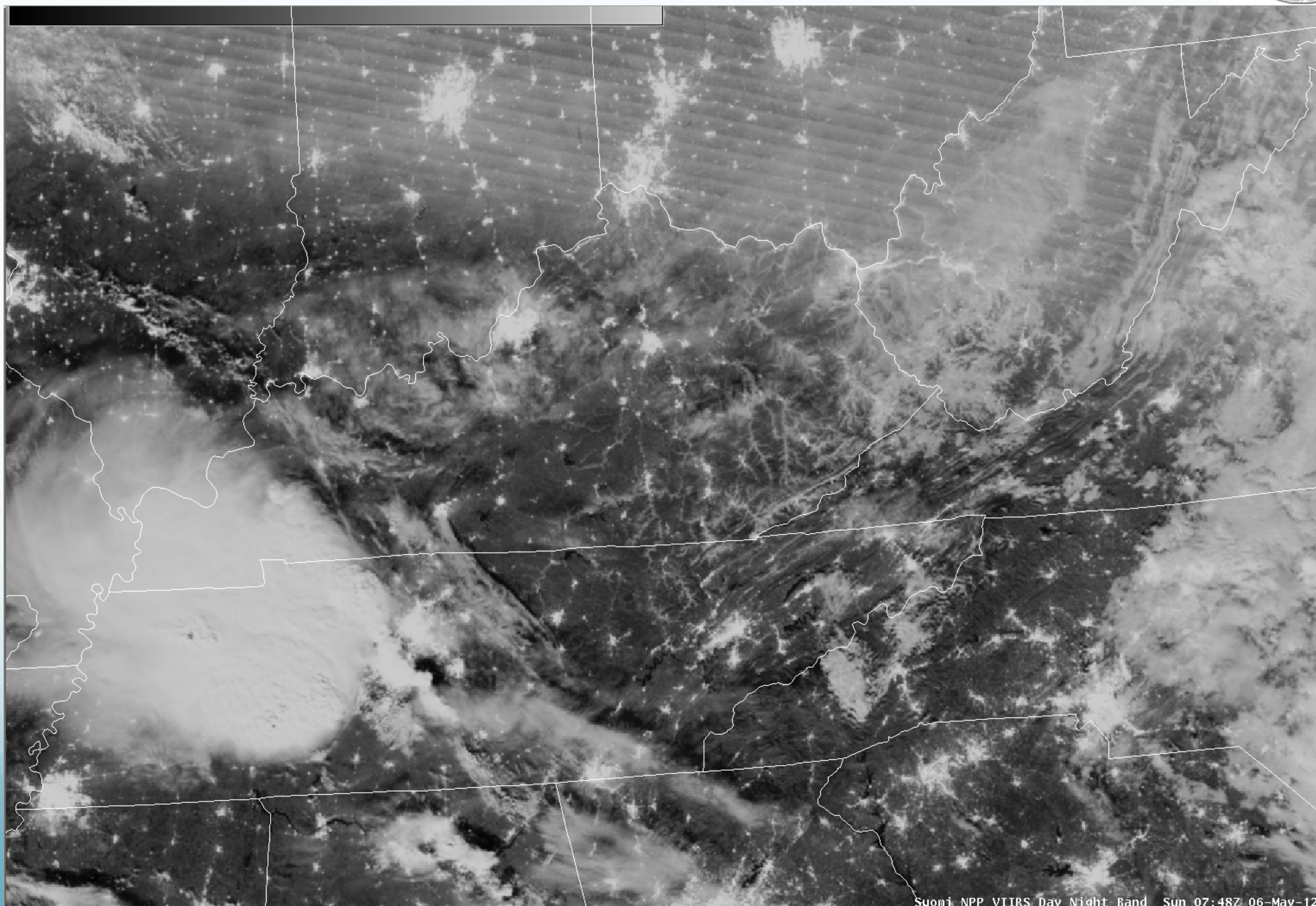


Mean Distance = 384,401 km

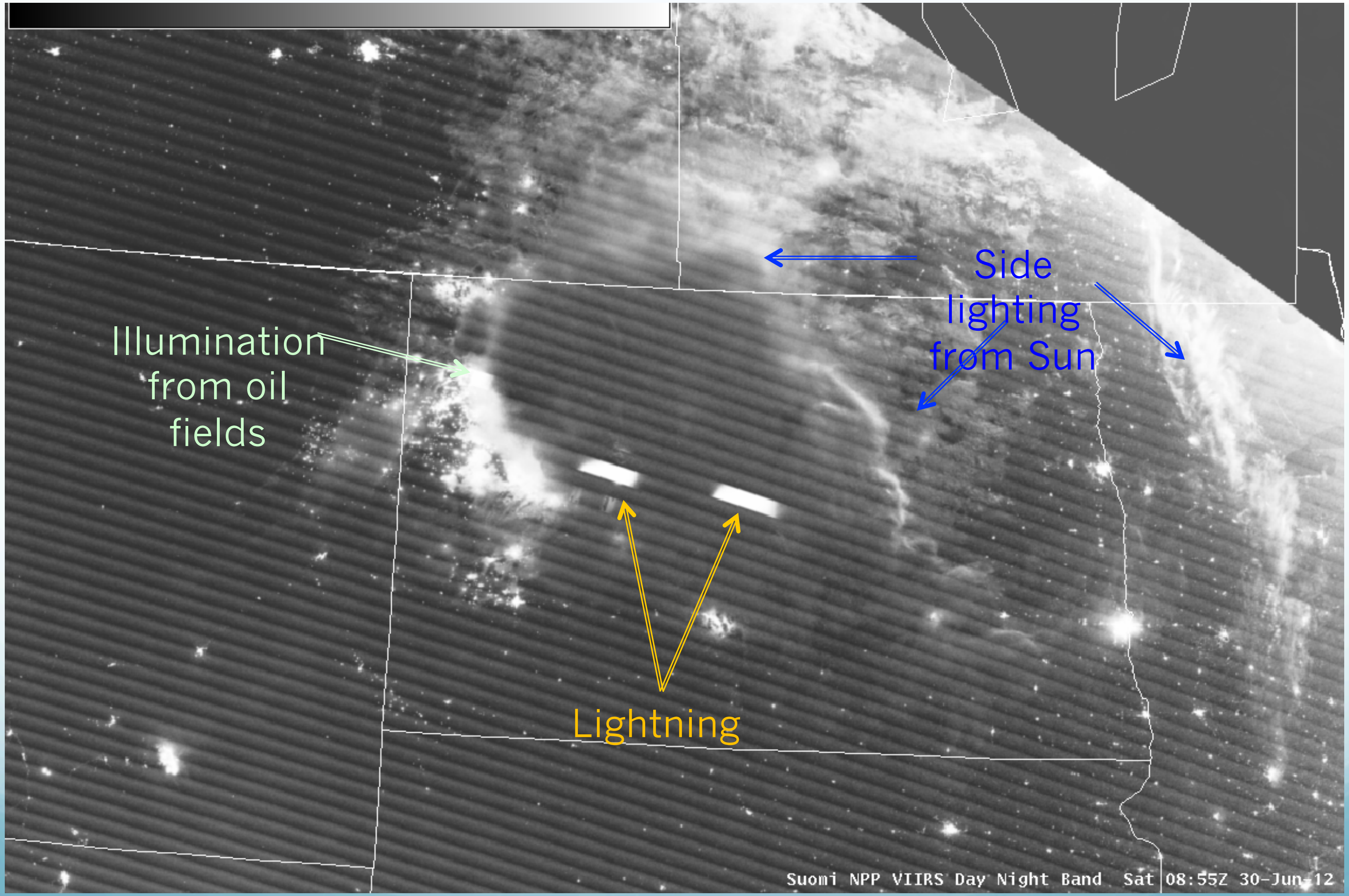
Lunar Reflectance Model



VIIRS Fog Detection Capability Day/Night Band 6 May 2012

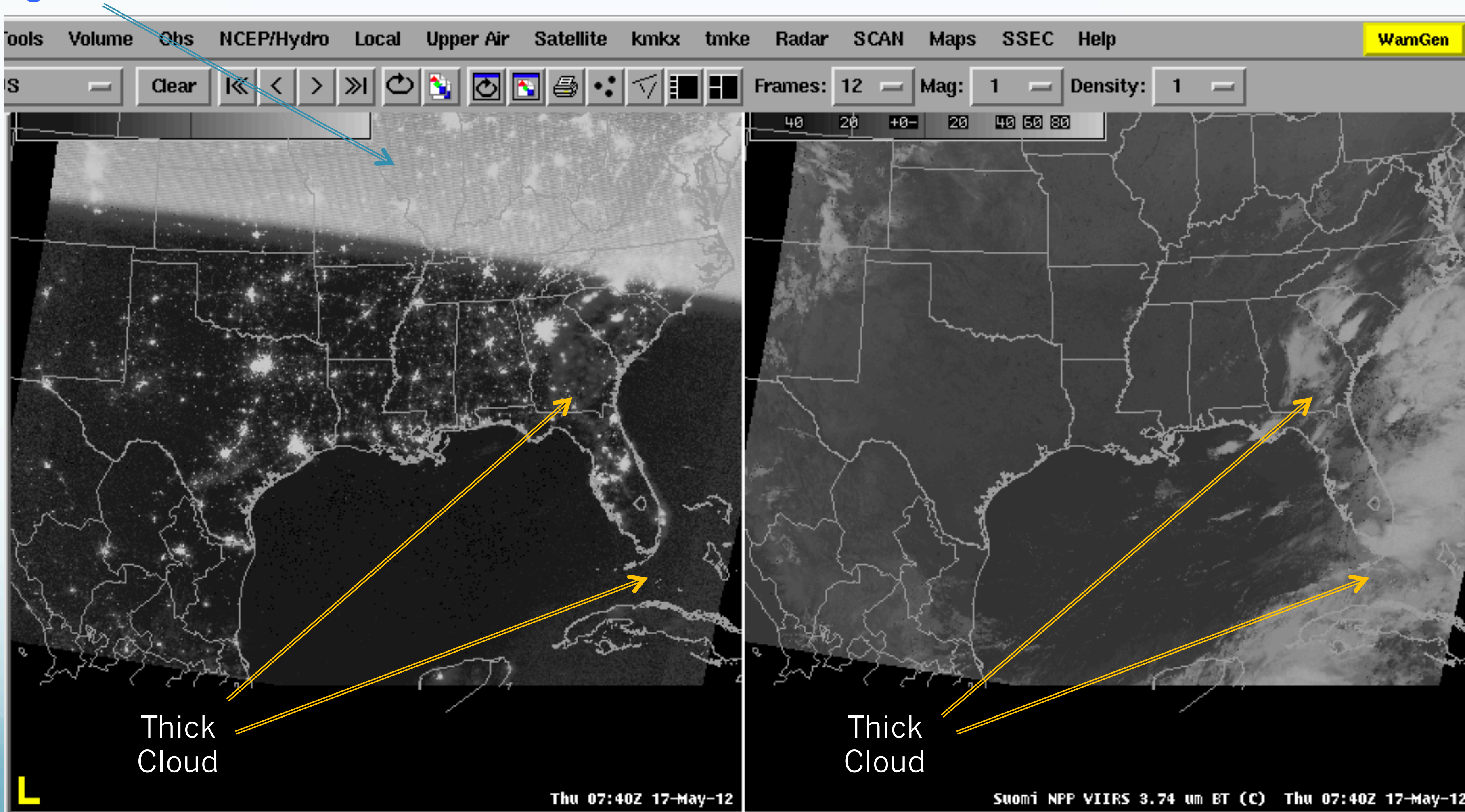


VIIRS in AWIPS Day/Night Band Lightning Detection 30 June 2012



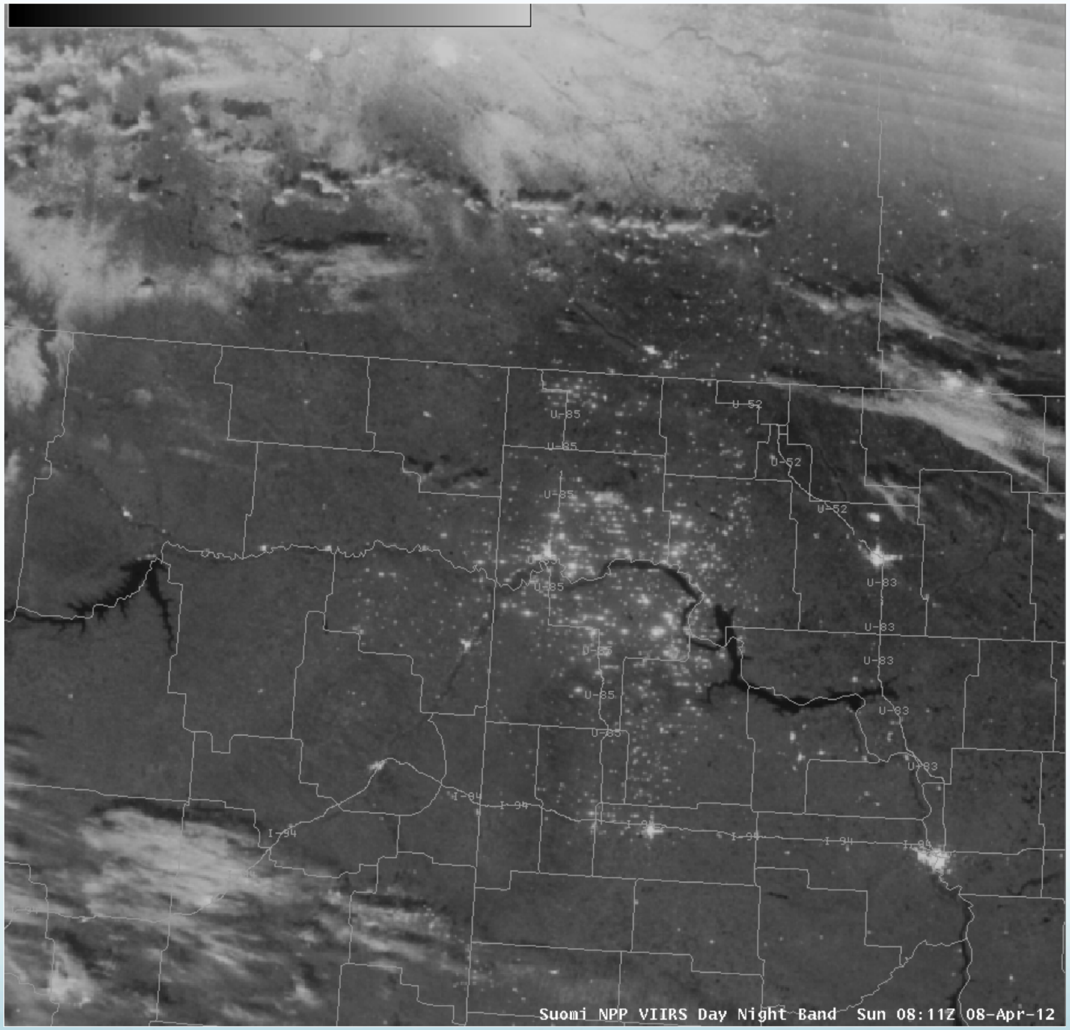
Moon Phase Affects How Much Can be Seen

Stray light region



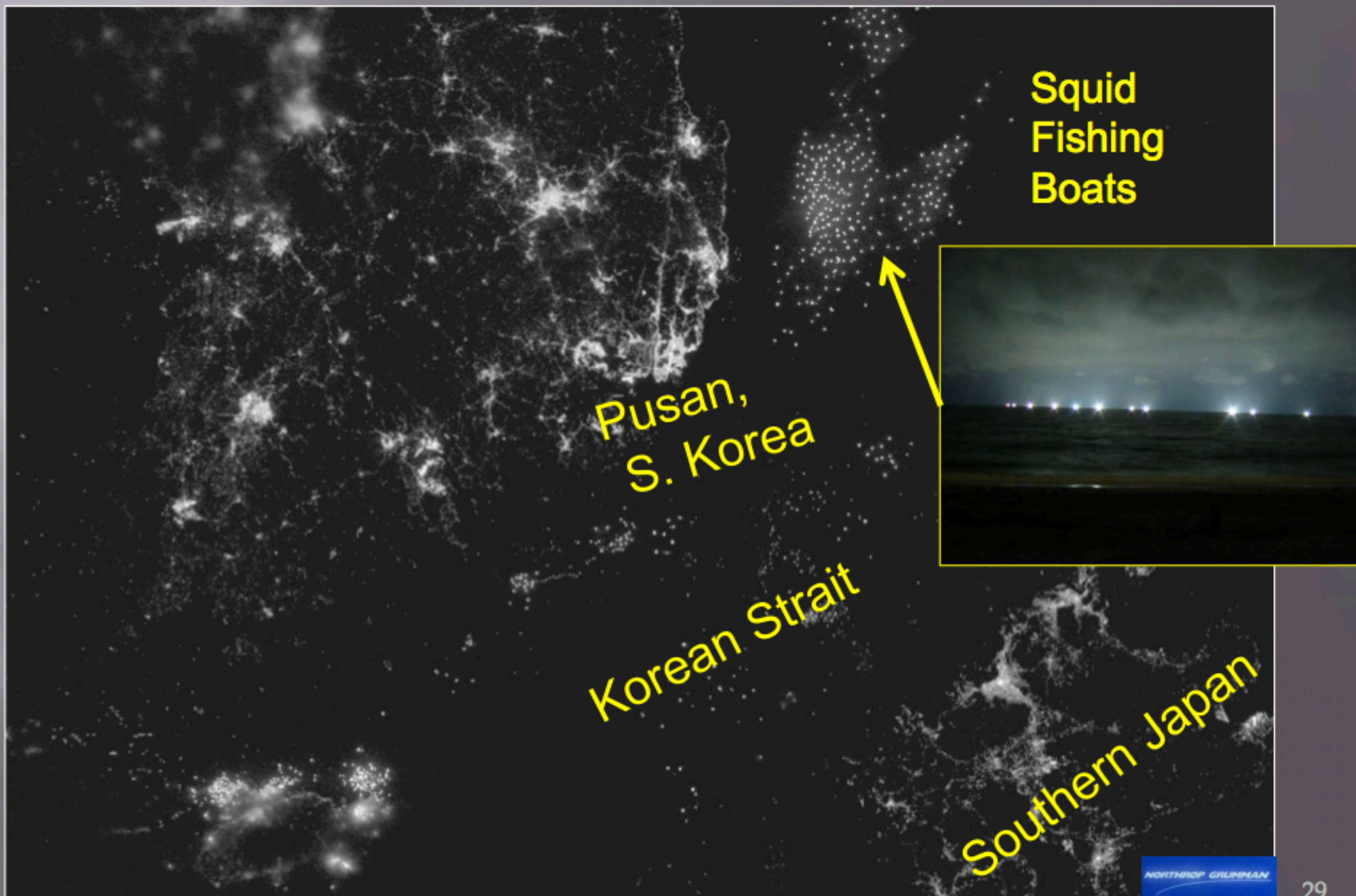
Crescent moon means less illumination making it difficult to identify clouds

VIIRS in AWIPS Day/Night Band Mining Operations 8 April 2012



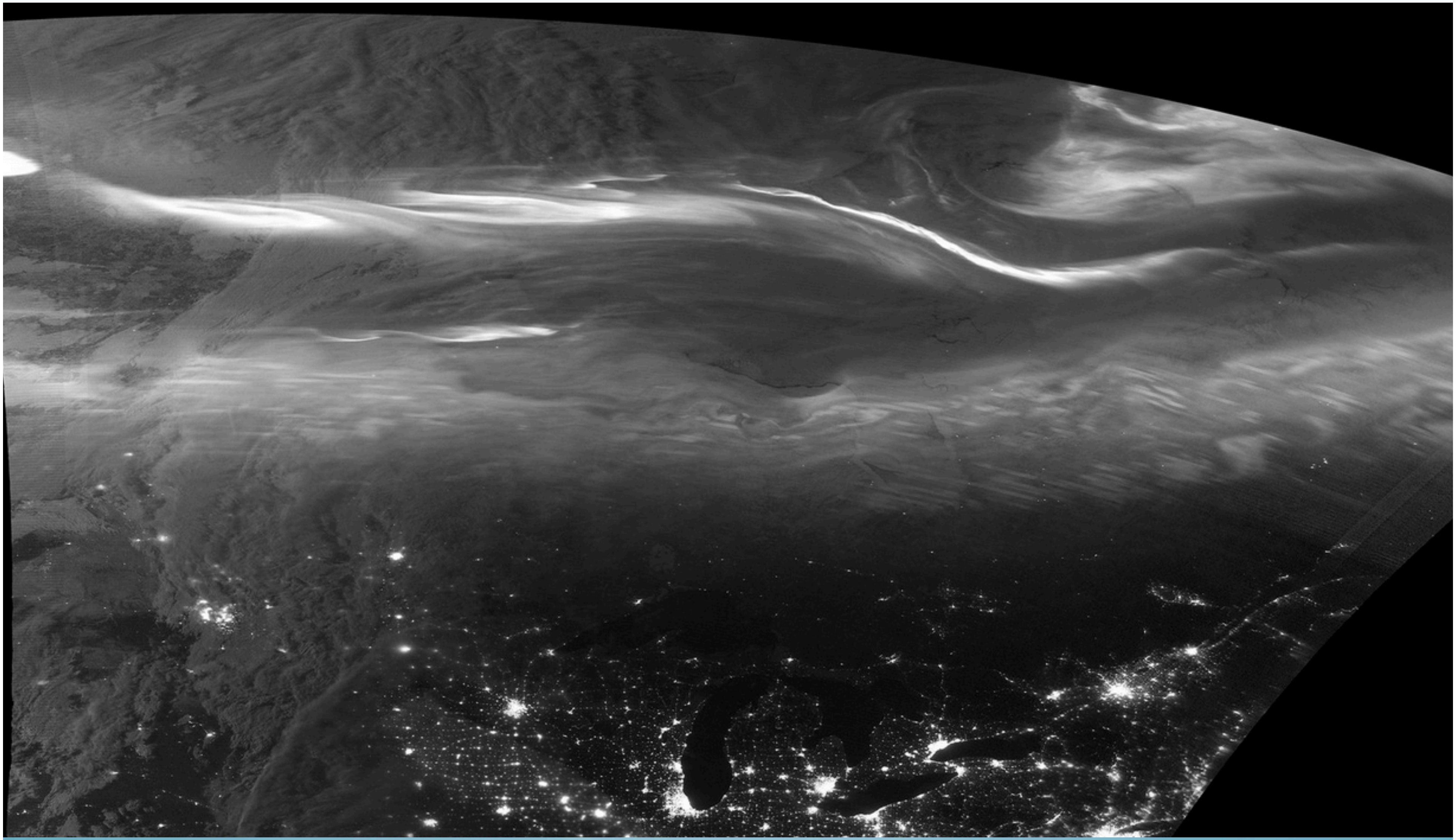
Another example of a Day/Night Band image from 08 April 2012 revealed a large number of natural gas flares and illuminated “man camps” associated with extensive drilling operations in the Bakken Shale Oil Field area of eastern Montana and western North Dakota.

Korean Straight

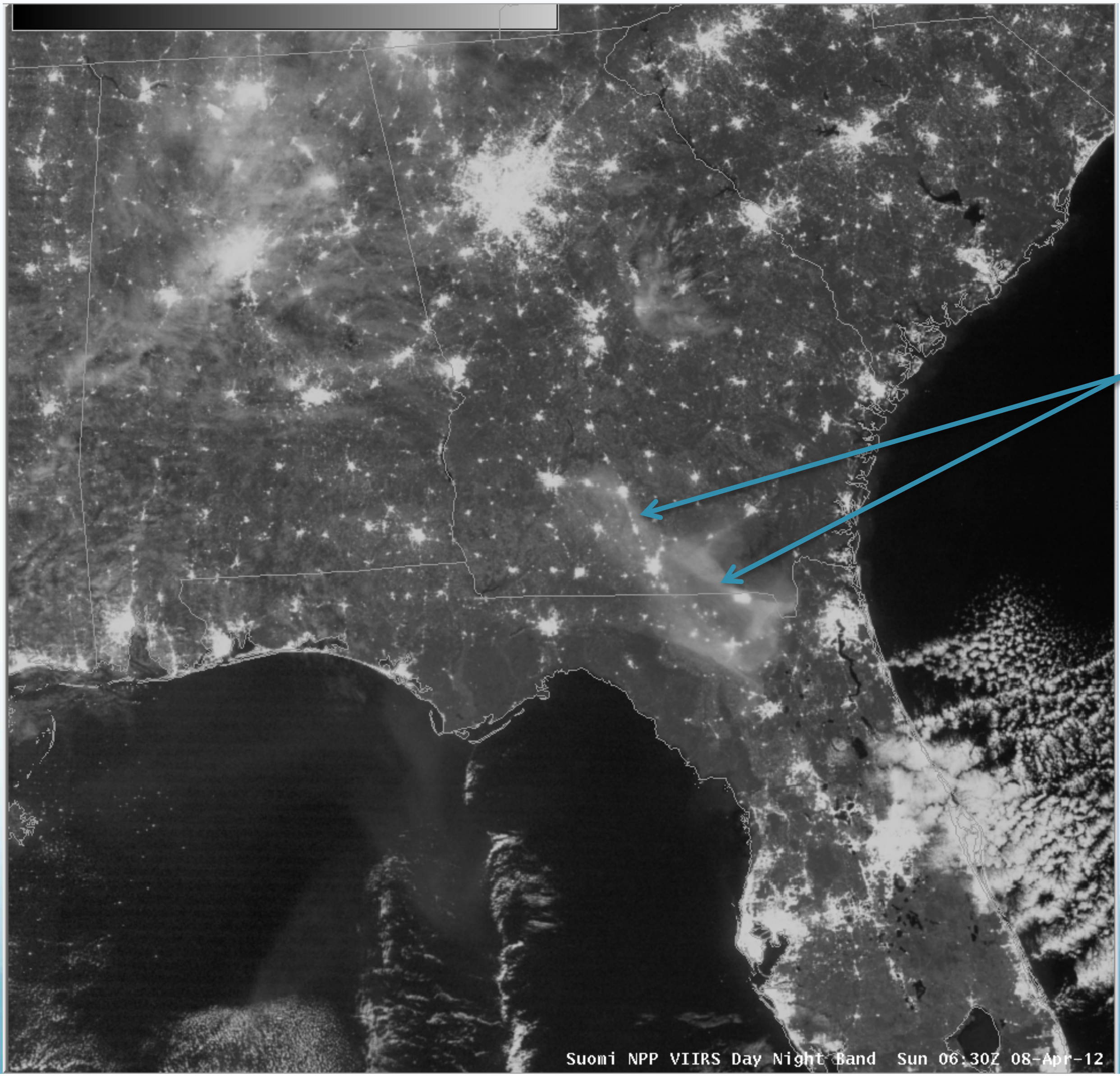


Aurora Borealis

S-NPP VIIRS 25 March 2018



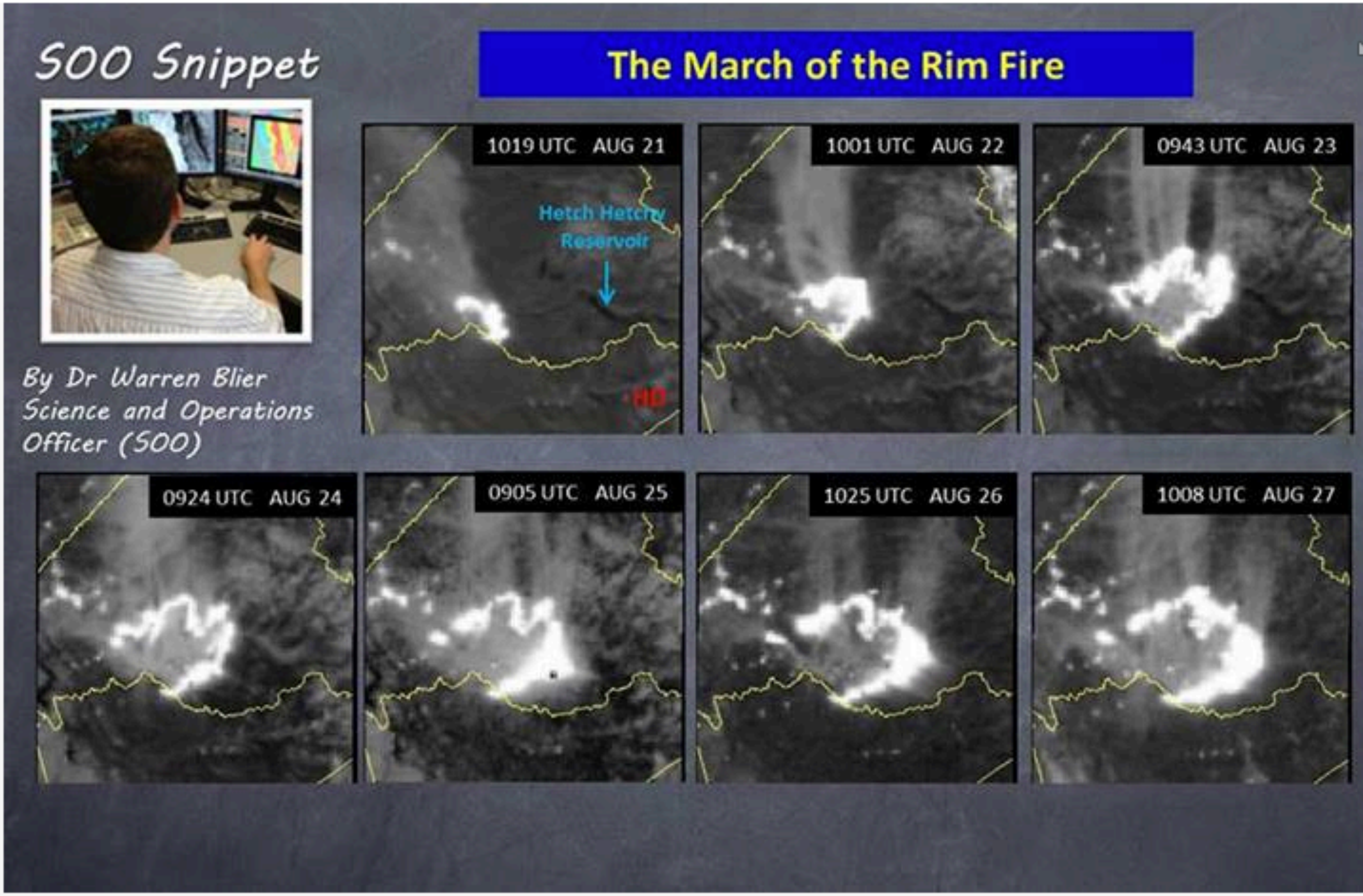
VIIRS in AWIPS Day/Night Band Smoke Detection 8 April 2012



Smoke from County Line Fire in northern Florida

SSEC/CIMSS

Timeline Photos

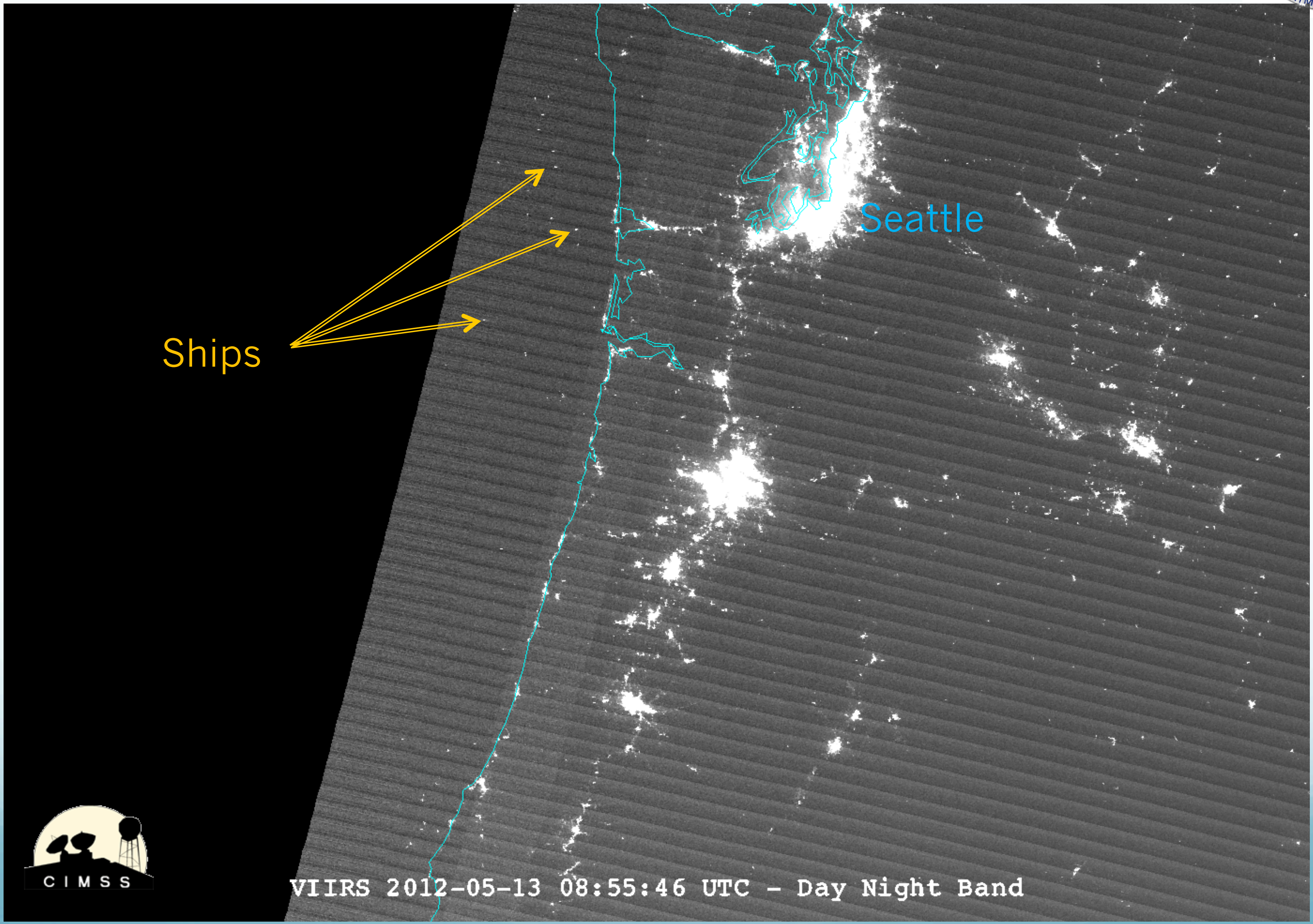


US National Weather Service San Francisco Bay Area/Monterey California

Album: Timeline Photos

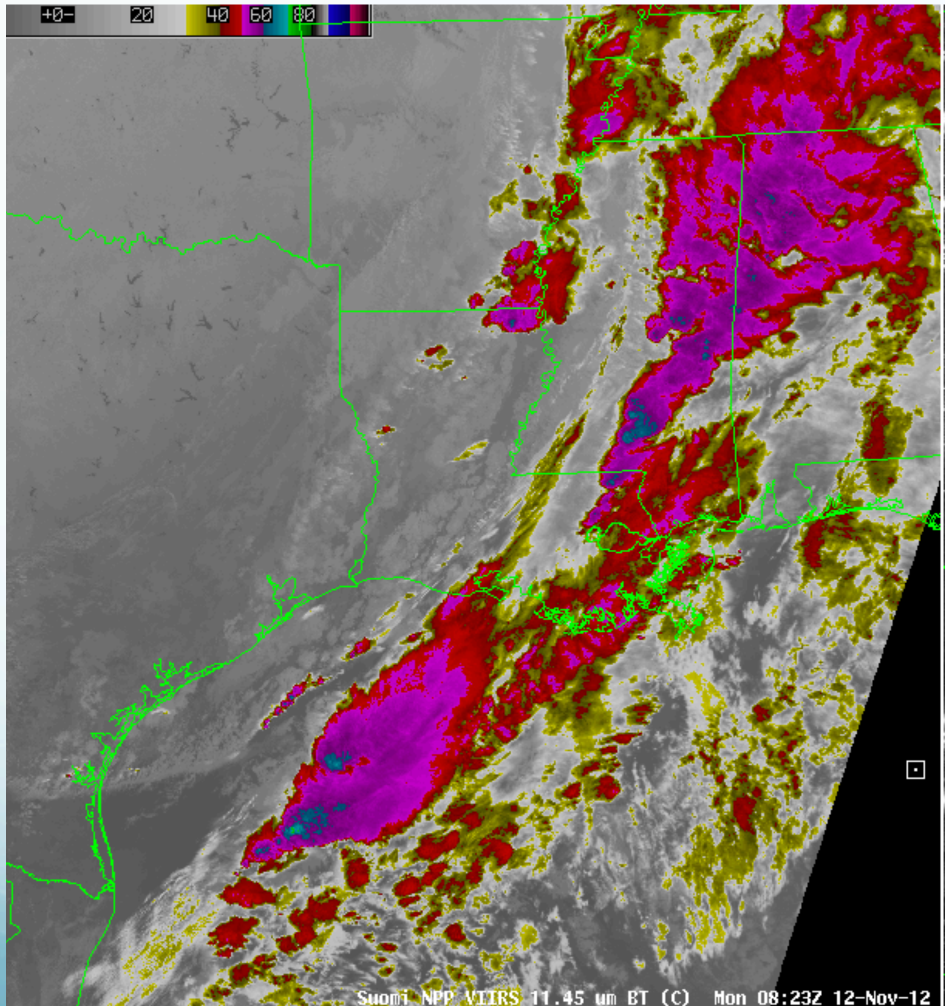
Shared with: Public

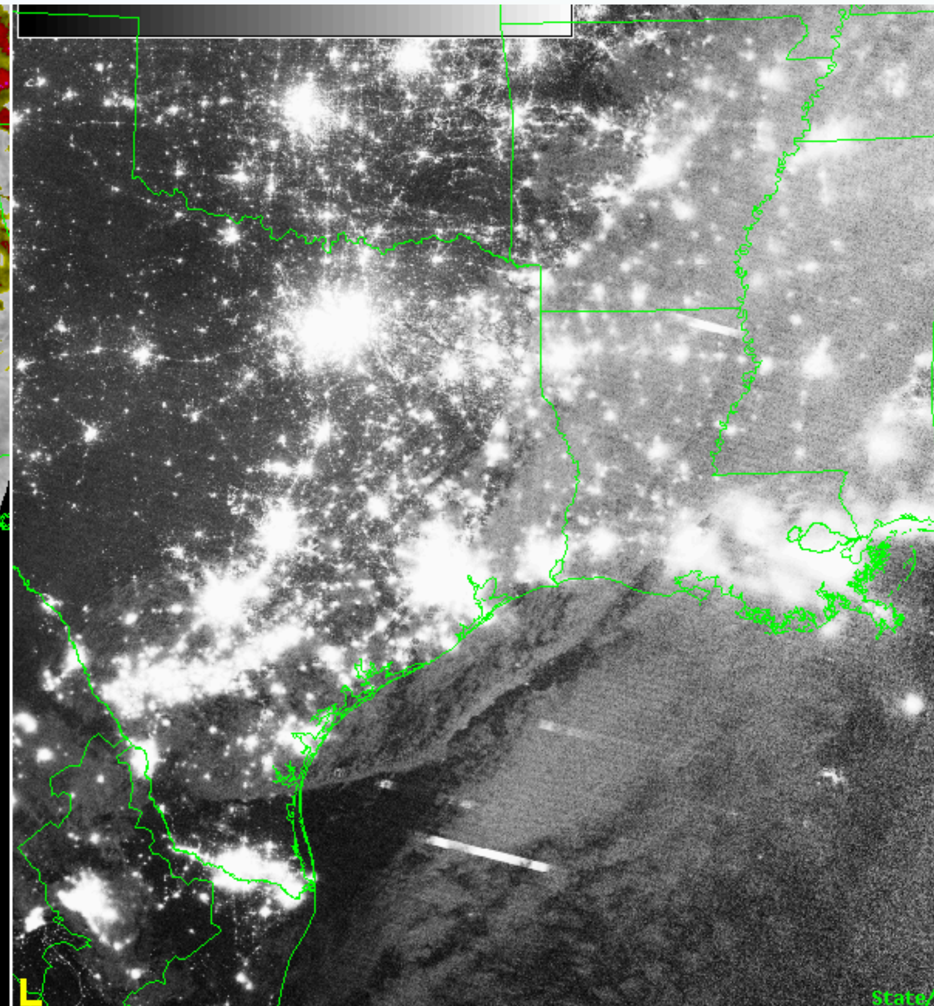
Examples Ships



VIIRS Day/Night Band

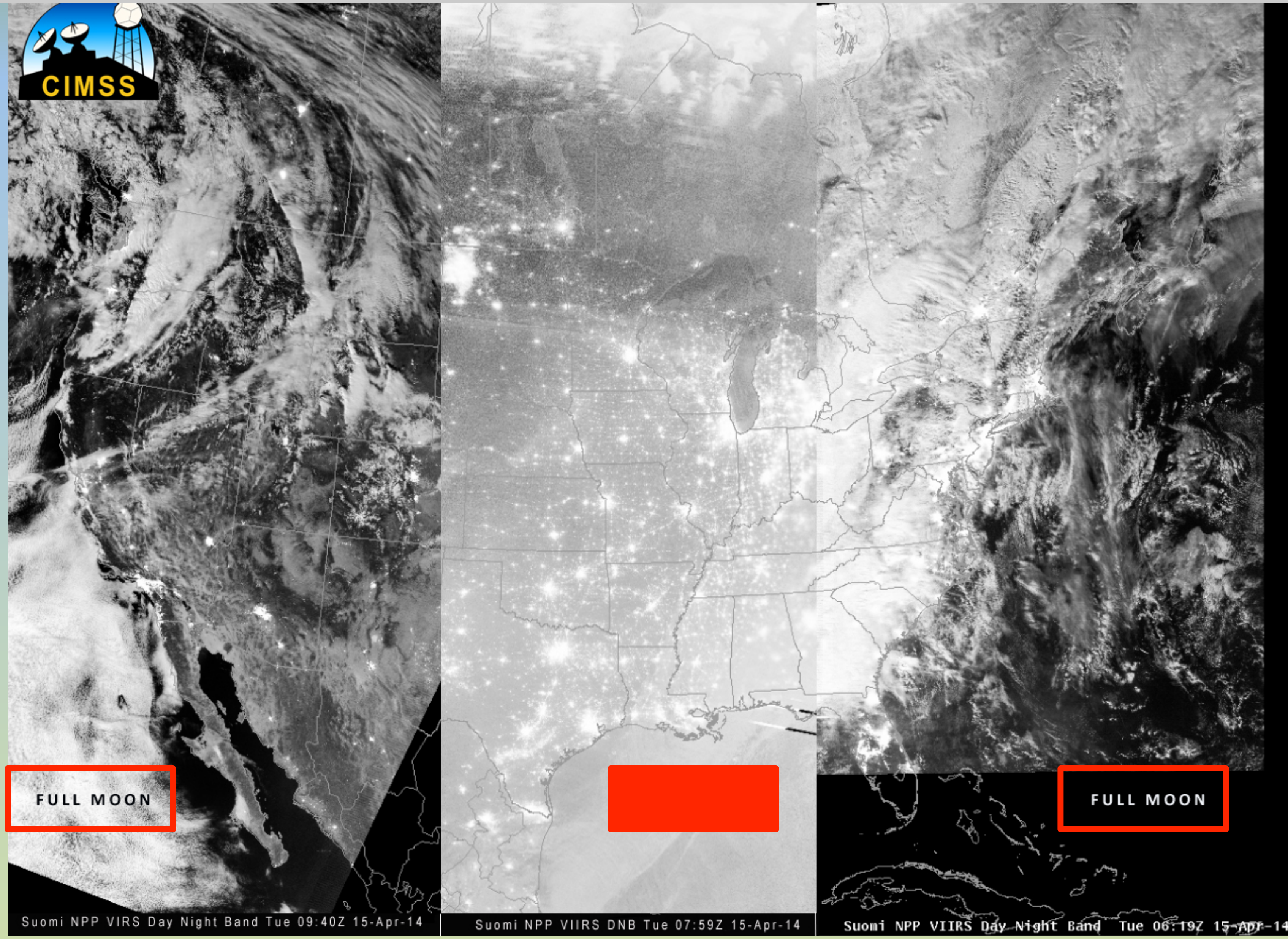
New Moon



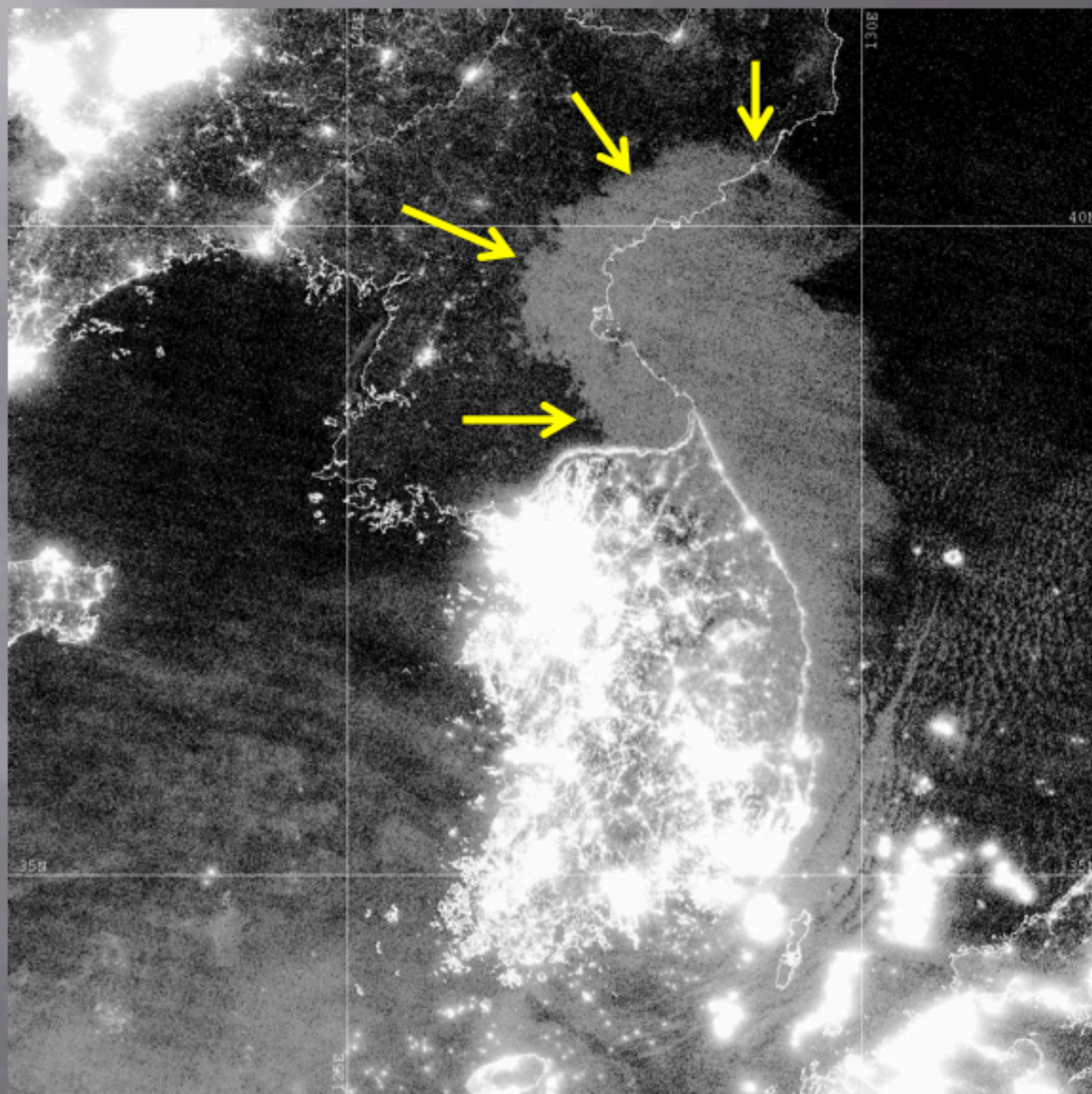


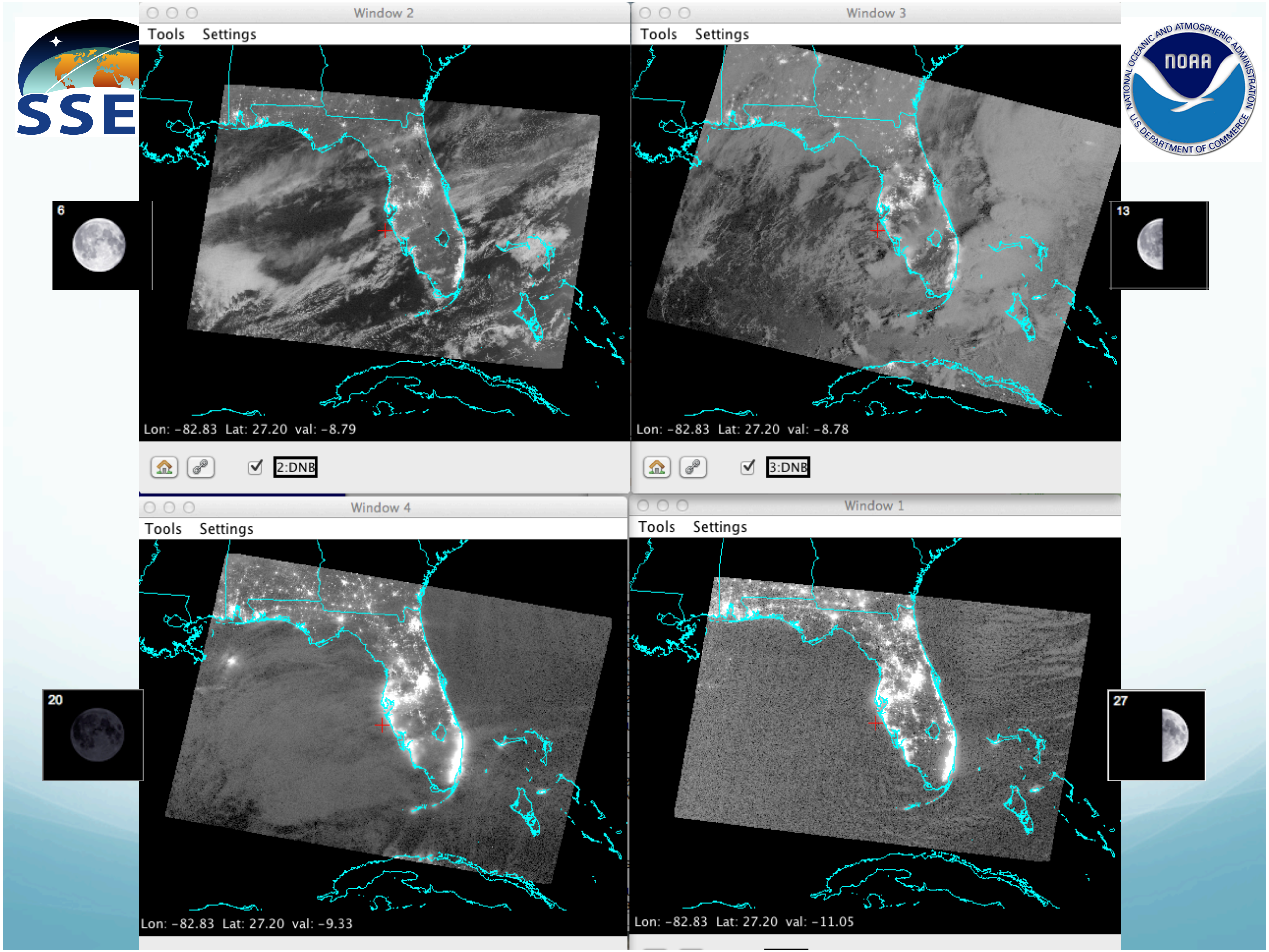
Reminder: It's Moonlight that is illuminating things!

(This shows three successive orbits on 15 April 2014)



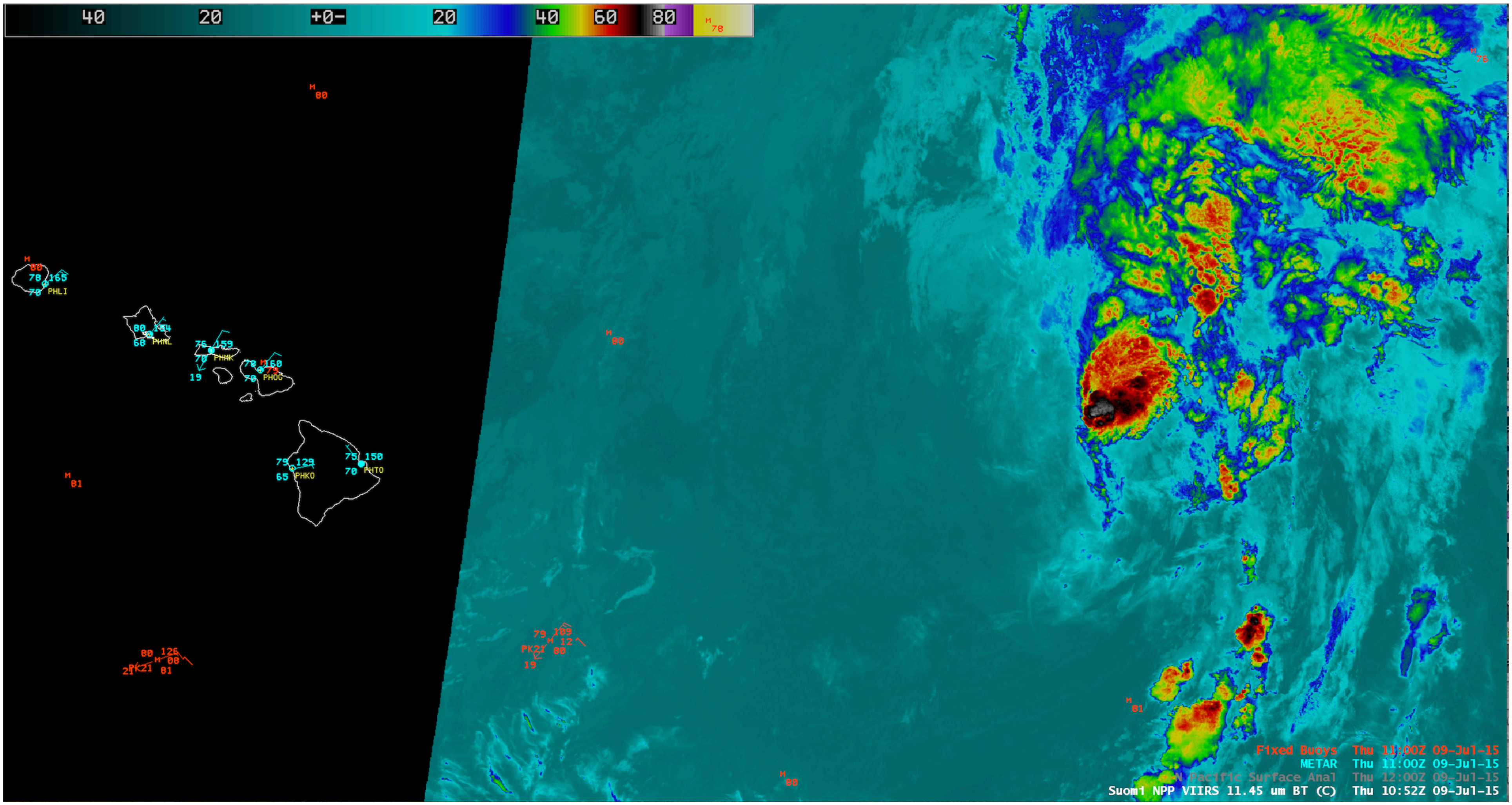
A New Way of Seeing Low Clouds




SSE
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
6
13
20
27
Window 2
Tools Settings
Lon: -82.83 Lat: 27.20 val: -8.79
2:DNB
Window 3
Tools Settings
Lon: -82.83 Lat: 27.20 val: -8.78
3:DNB
Window 4
Tools Settings
Lon: -82.83 Lat: 27.20 val: -9.33
Window 1
Tools Settings
Lon: -82.83 Lat: 27.20 val: -11.05

Tropical Storm Ela in the Pacific

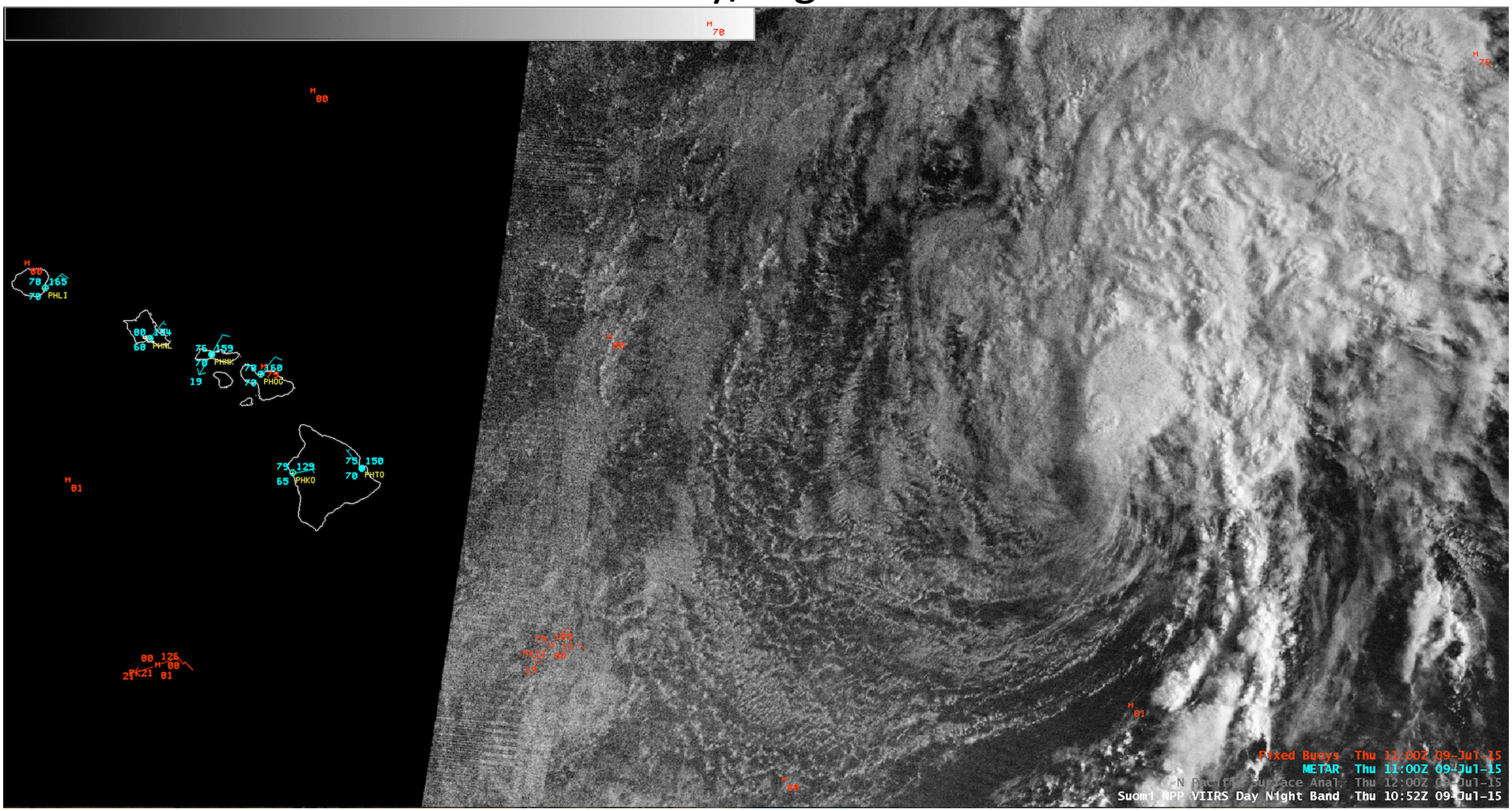
Low Level Circulation Center (LLCC) Located to the Southwest of the Deep Convection associated with the system as seen by the VIIRS Day/Night Band



VIIRS Infrared 11 micron Imagery in AWIPS-II 11:00 UTC 9 July 2015

Tropical Storm Ela in the Pacific

Low Level Circulation Center (LLCC) Located to the Southwest of the Deep Convection associated with the system as seen by the VIIRS Day/Night Band



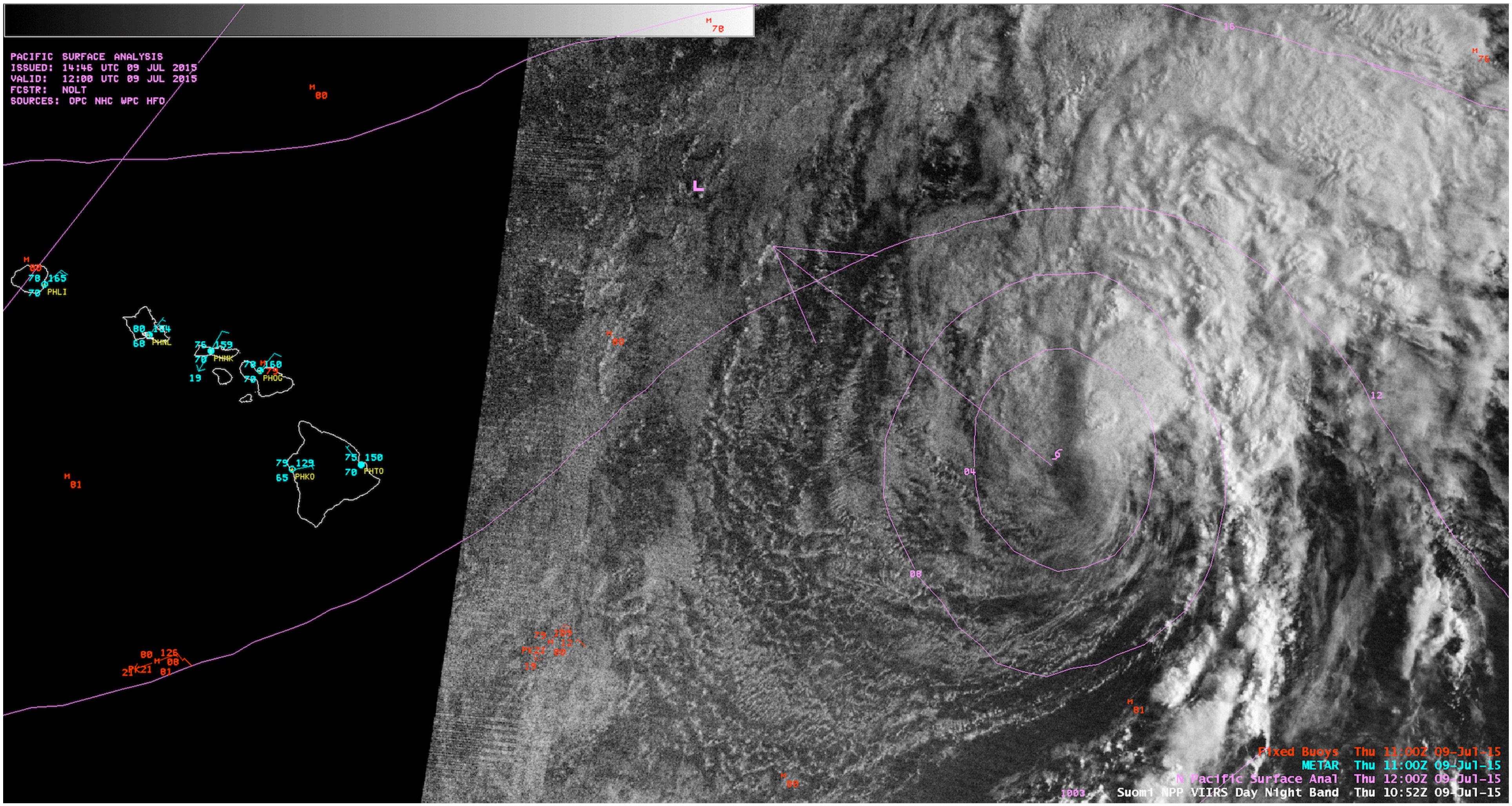
VIIRS Infrared 11 micron Imagery in AWIPS-II   11:00 UTC 9 July 2015

TROPICAL STORM ELA DISCUSSION NUMBER 7

NWS CENTRAL PACIFIC HURRICANE CENTER HONOLULU HI EP042015

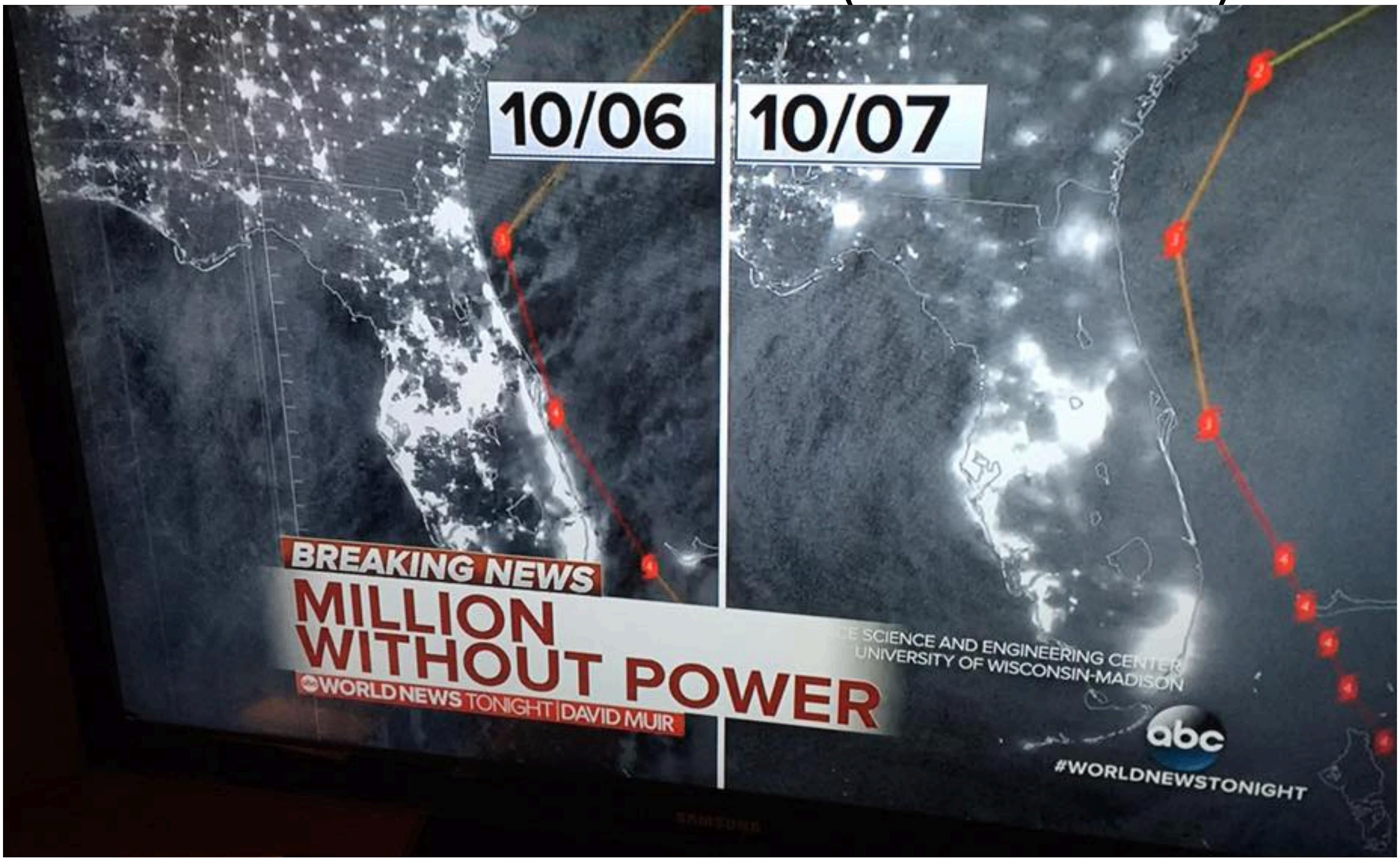
500 AM HST THU JUL 09 2015

A 1052Z VIIRS DAY/NIGHT BAND IMAGE WAS INSTRUMENTAL IN HELPING TO LOCATE THE PARTIALLY EXPOSED CENTER OF ELA THIS MORNING.



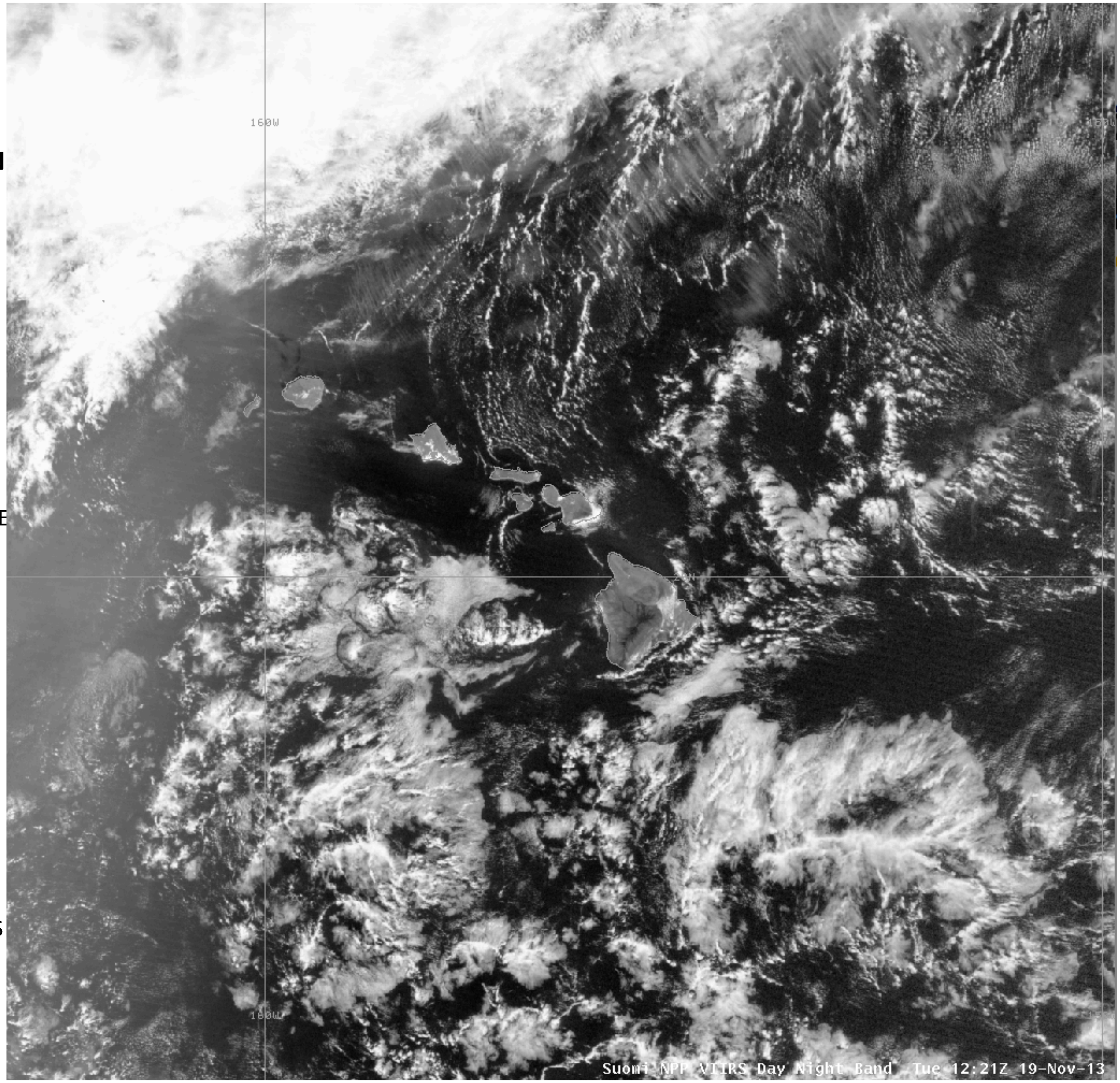
VIIRS Infrared 11 micron Imagery in AWIPS-II Overlaid with 12:00 UTC N Pacific Surface Analysis

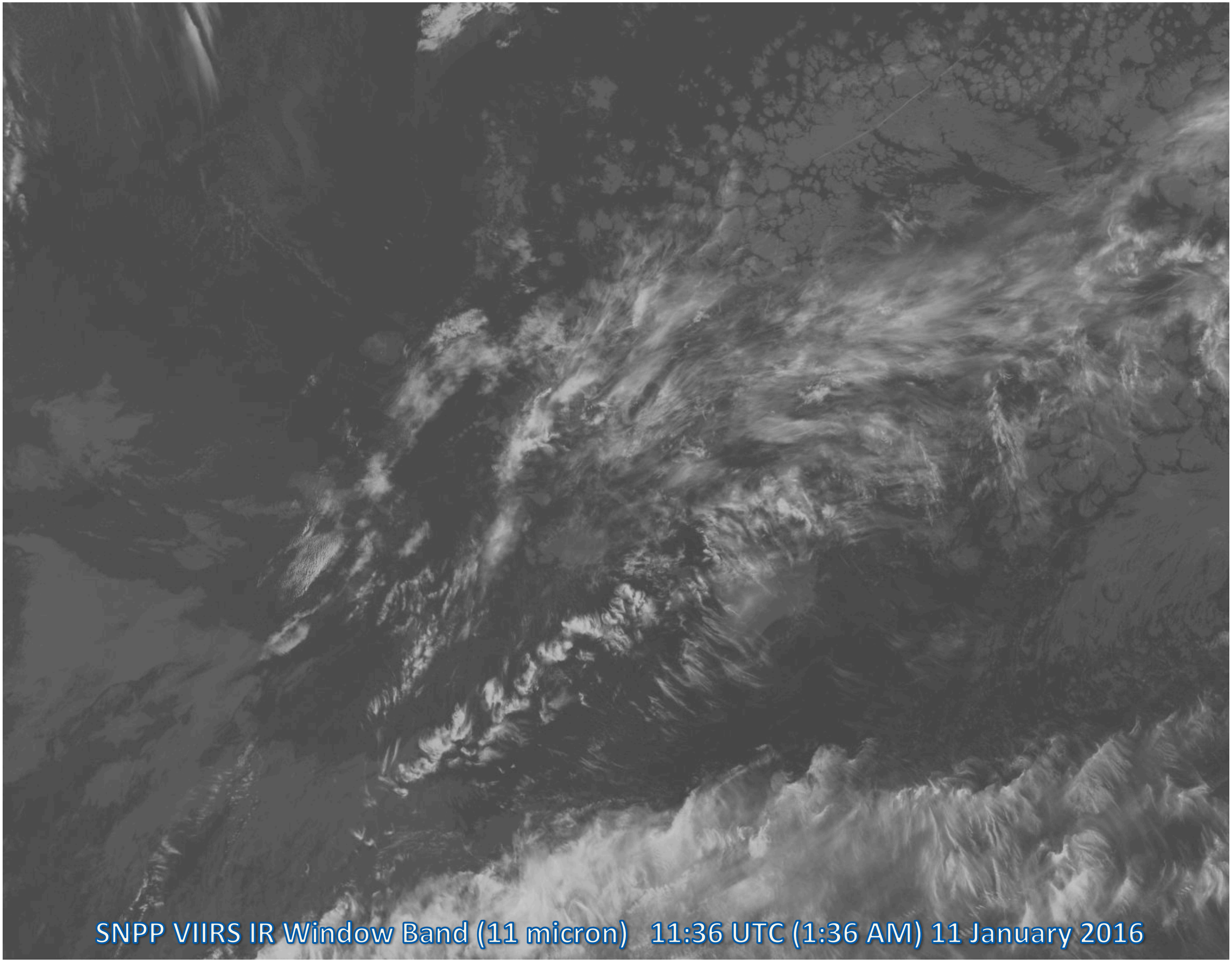
The Effects of Hurricane Matthew as seen in the VIIRS DNB (October 2016)

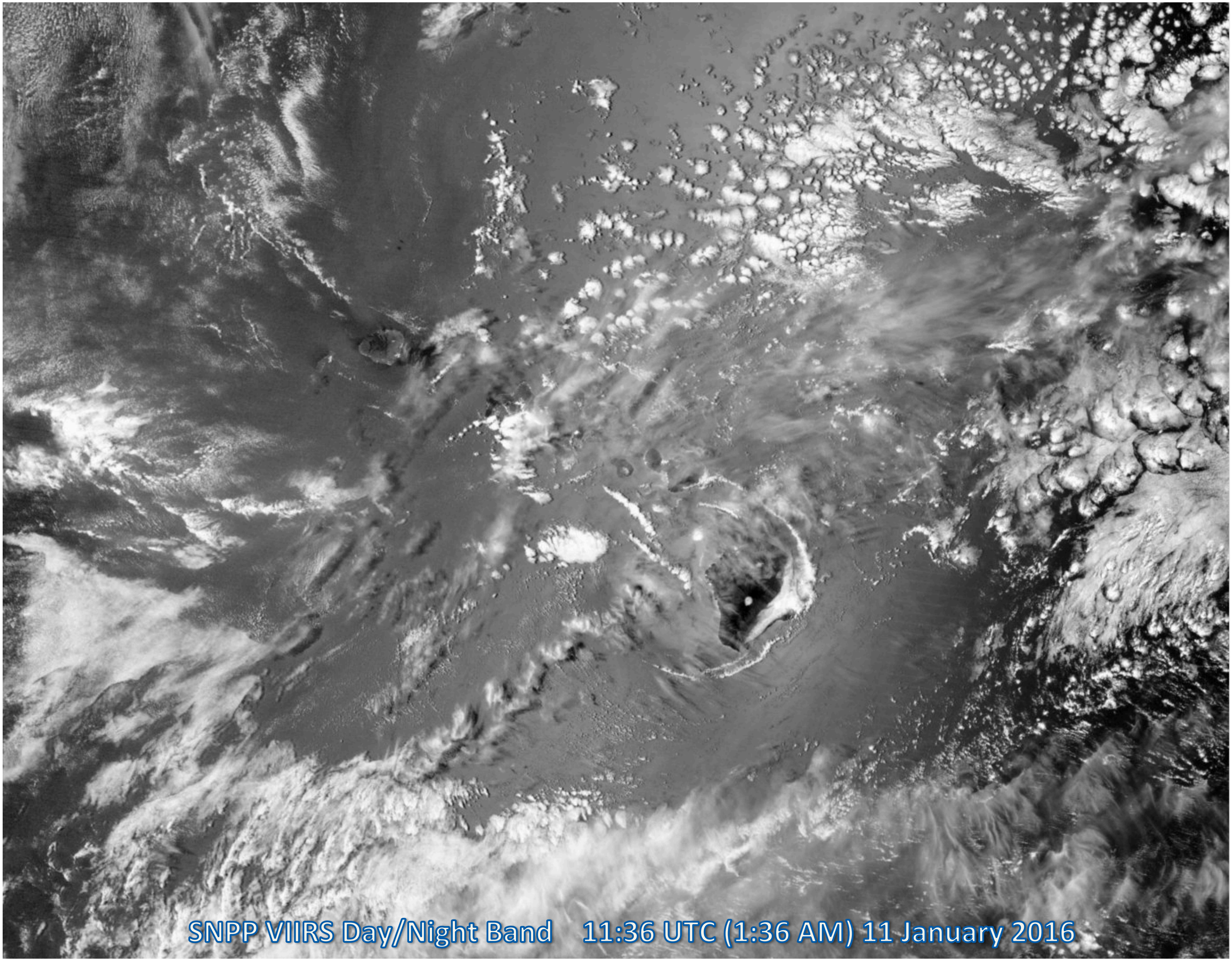


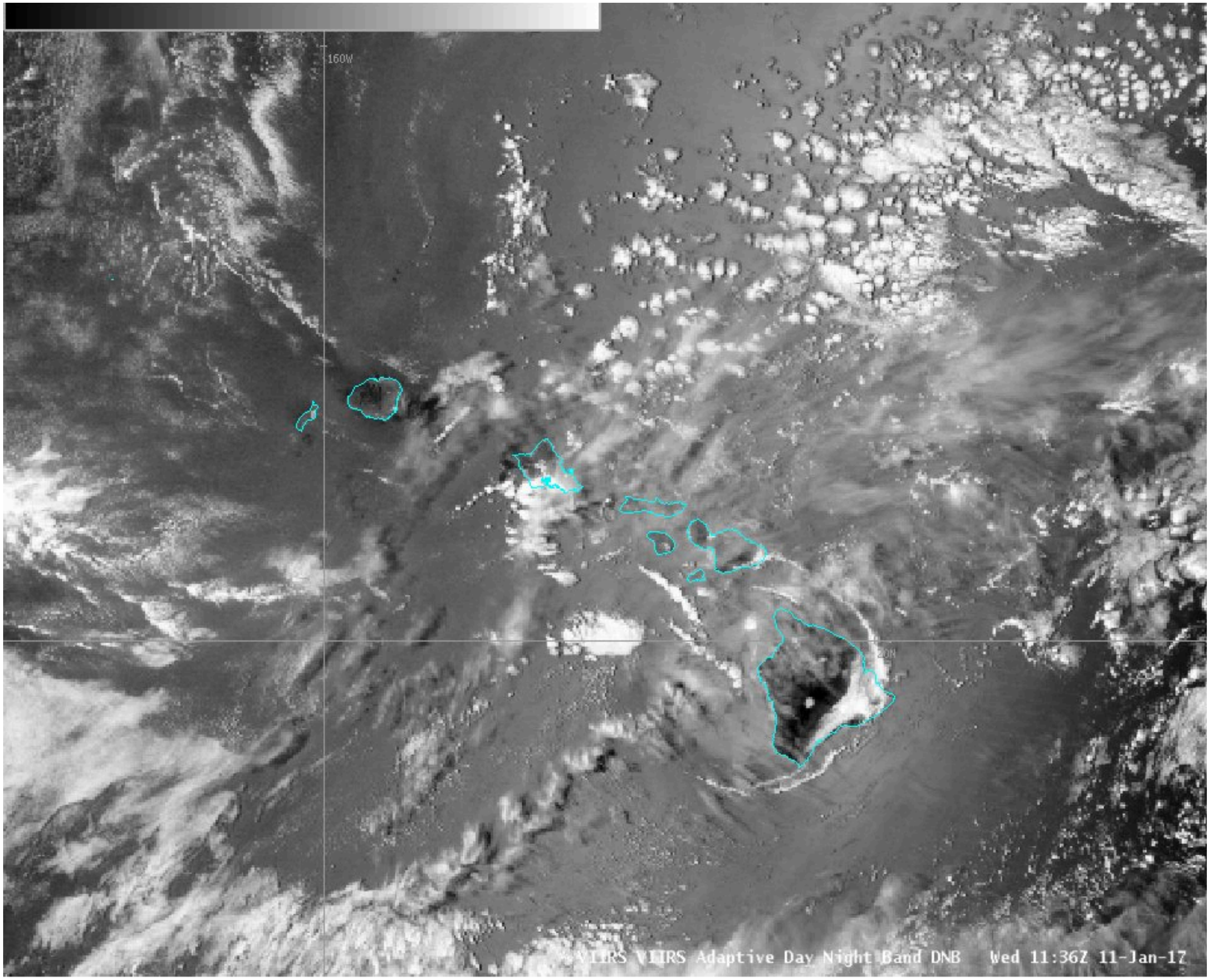
AREA FORECAST DISCUSSION NATIONAL WEATHER SERVICE HONOLULU HI 330 AM HST TUE NOV 19 2013

.DISCUSSION...
CURRENTLY...SKIES OVER THE ISLANDS ARE MOSTLY CLEAR ...AND DRY CONDITIONS PREVAIL IN MOST AREAS...EXCEPT FOR PERSISTENT SHOWERS THAT HAVE BEEN ANCHORED ALONG THE LOWER SLOPES OF WINDWARD HALEAKALA FOR THE PAST SEVERAL HOURS. LOW CLOUDS ARE INCREASING IN COVERAGE OVER WATERS S OF THE ISLANDS FROM KAUAI TO MOLOKAI...BUT RADAR IS THUS FAR NOT DETECTING ANY SHOWERS FALLING FROM THESE STABLE CLOUDS. **A RECENTLY RECEIVED VIIRS NIGHTTIME VISIBLE IMAGE CONFIRMS THAT THESE ARE STABLE STRATOCUMULUS**. LOOKS LIKE A SUNNY START TO THE DAY NEARLY STATEWIDE...WITH INCREASING CLOUDS OVER INTERIOR AND LEEWARD AREAS THIS AFTERNOON.




SNPP VIIRS IR Window Band (11 micron) 11:36 UTC (1:36 AM) 11 January 2016


SNPP VIIRS Day/Night Band 11:36 UTC (1:36 AM) 11 January 2016



NWSHonolulu @NWSHonolulu · 5h
@UWCIMSS Nice capture of HI late tonight w/ the VIIRS day/night band. Broken clouds over parts of Oahu + Big Island, mostly clear elsewhere!

1 4