VIIRS EDR IMAGERY OVERVIEW

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VIIRS EDR Imagery Team
16 August 2017

Outline

VIIRS Imagery Overview

- Cal/Val Team Members
- Sensor/Algorithm (GTM EDRs)
- S-NPP Product(s) / Examples
- JPSS-1 Readiness (12 October 2017 launch)
- Summary and Path Forward

Cal/Val Team Members

PI	Organization	Team Members	Roles and Responsibilities
D. Hillger	**StAR/RAMMB**	D. Lindsey, D. Molenar	Imagery Product Lead, weekly reports, **social media interactions**, data infrastructure
T. Kopp	**Aerospace**		Cal/Val Lead, VIIRS heritage
S. Miller	**CIRA/RAMMB**	C. Seaman, S. Finley, G. Chirokova, J. Torres, L. Grasso, G. Chirokova	Imagery cal/val , VIIRS online, end user support (including tropical cyclones), VIIRS training
D. Santek	**CIMSS/SSEC**	T. Jasmin, T. Rink, W. Straka III	McIDAS-V (display tools) McIDAS-X
K. Richardson	**NRL – Monterrey**	A. Kuciauskas	NexSat, VIIRS web
C. Elvidge	**NCEI – Boulder**	K. Baugh	DNB
JAM	NASA DPE	R. Marley	Algorithm testing
	Noblis	G. Mineart	Requirements
	Raytheon	W. Ibrahim, K. Ahmad	Operations
AIT	StAR	M. Tsidulko	Integration
Alaska users	GINA, NWS	E. Stevens, M. Kreller, others	End users, analysis and forecasting

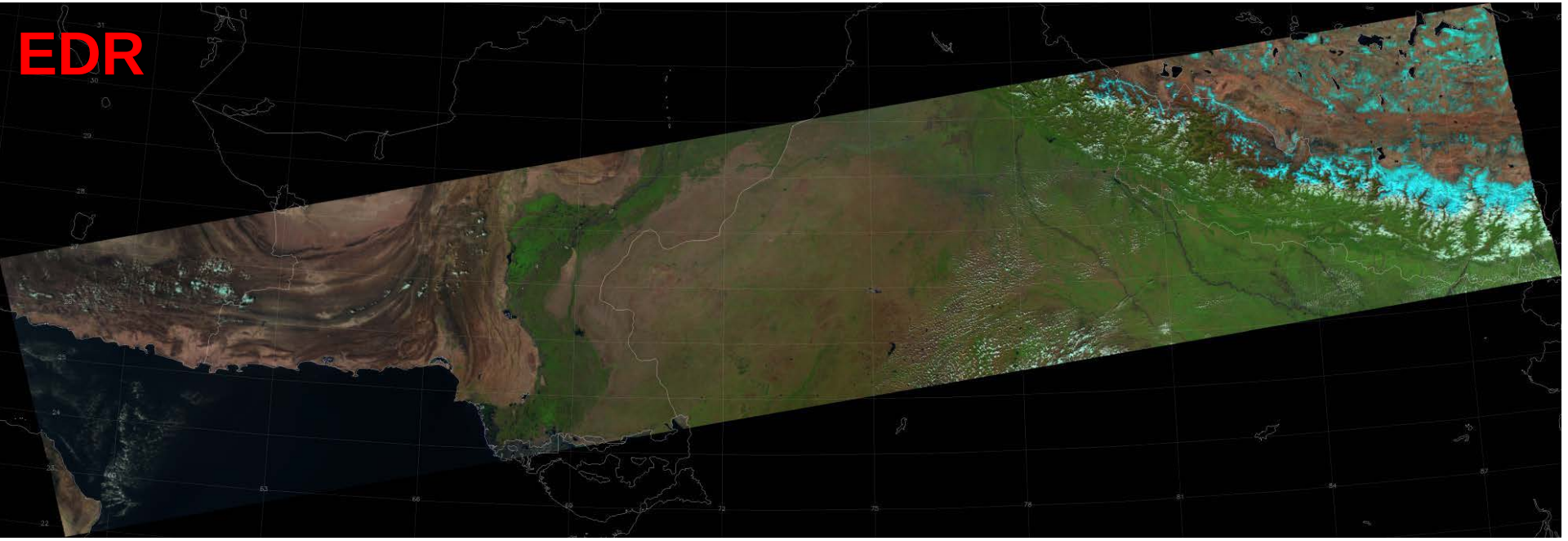
VIIRS EDR Imagery

- **VIIRS Imagery** remapped to the **Ground Track Mercator (GTM**) grid, eliminating overlapping pixels and bowtie deletions.
  - **NCC Imagery** is a pseudo-albedo derived from the DNB by normalizing the large radiance contrast in **DNB** from day to night (7 orders of magnitude)

Characteristic	SDR	EDR
Visible and IR bands	Radiances and/or reflectances	Radiances and/or reflectances (**same** as SDR)
Geo-spatial mapping	**Satellite projection** • Cross-track scans • Bowtie (on spacecraft) deletions • Overlapping pixels	**Ground Track Mercator (GTM)** projection: • Rectangular grid • No imagery gaps • No pixel overlap
Day/night imagery	**DNB** (**radiances**)	**NCC** (**pseudo-albedos**)

VIIRS SDR vs. EDR

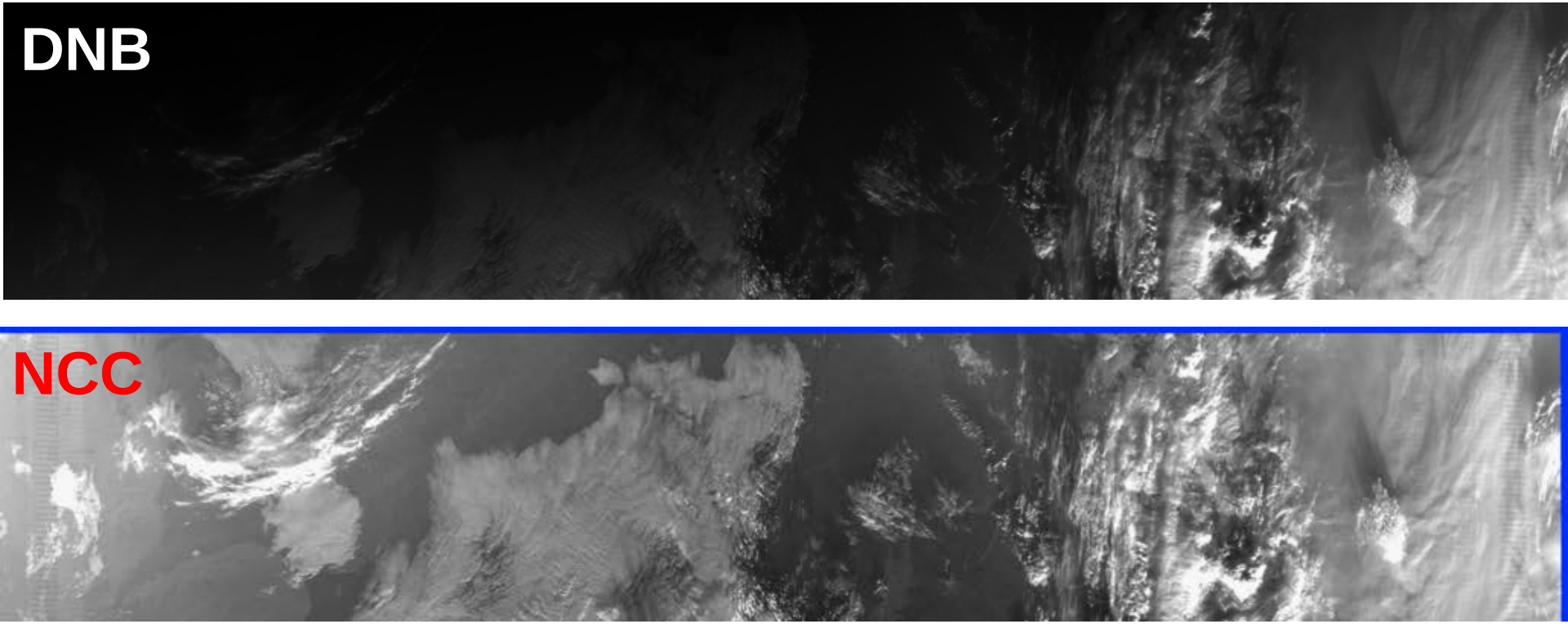




Near Constant Contrast (NCC) vs. Day-Night Band (DNB)

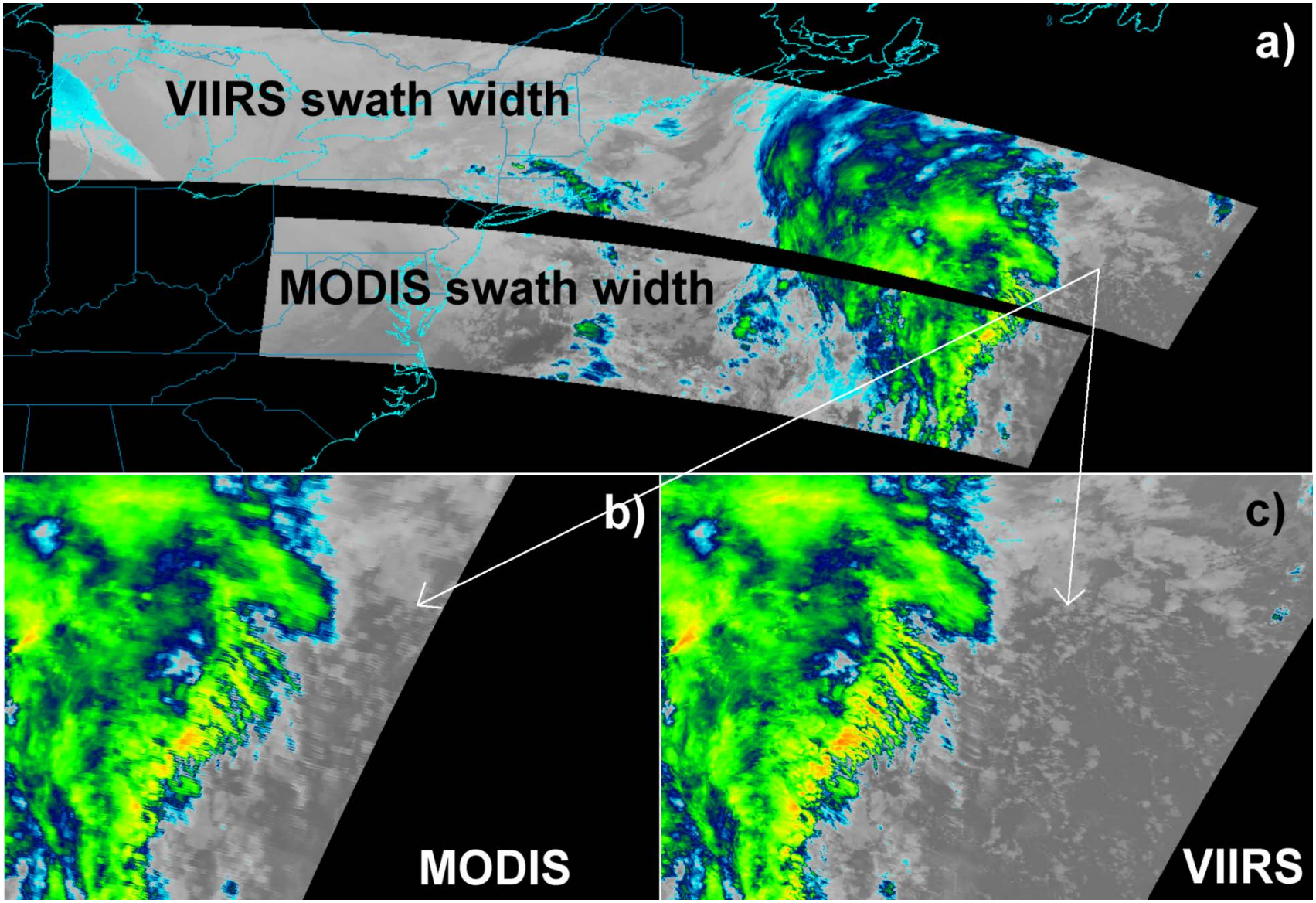
Example of NCC vs. DNB for a day/night terminator (non-lunar) case.

NCC extends constant contrast into the twilight portion of the granule swath.



Curtis Seaman, CIRA

Better spatial resolution at swath edge



VIIRS EDR Imagery

- **EDR Imagery is a Priority 1 VIIRS product**
  - Certain EDR Imagery bands are **Key Performance Parameters (KPPs)**
    - **I1, I4, I5, M14, M15, M16** (6 original L1RD KPPs)
    - **DNB/NCC and I3** are now also KPP bands (new in 2015)
  - The **KPP definition** reads as follows:
    - **For latitudes greater than 60 deg N in the Alaska Region, VIIRS Imagery EDRs** at 0.64 µm (I1), 1.61 µm (I3), 3.74 µm (I4), 11.45 µm (I5), 8.55 µm (M14), 10.763 µm (M15), 12.03 µm (M16), and the 0.7 µm Near-Constant Contrast (NCC) EDR
- **S-NPP Cal/Val Status**
  - Imagery has been **Validated since early 2014** (about 2 years after first light VIIRS imagery)
  - Remaining Imagery issues are minor, except **for long data latency for some (non-Direct Broadcast) granules** (to be minimized with 2 readout sites, resulting in **maximum of ½ orbit latency**)
  - Several **websites** for the Imagery (including **LTM (Long Term Monitoring)**
  - **Engaging users** for validation and feedback (utilizing JPSS liaisons)
  - NESDIS **Social Media** highly receptive of VIIRS Imagery

Table 1: Required Imagery EDR Products

Key Performance Parameters (KPPs) – 8 bands

Imagery EDR Product	VIIRS Band	Wavelength (µm)	Spatial Resolution Nadir/Edge-of-Scan (km)
Daytime Visible	**I1**	0.60 – 0.68	0.4/0.8
Short Wave IR (SWIR)	**I3**	1.58 – 1.64	0.4/0.8
Mid-Wave IR (MWIR)	**I4**	3.55 – 3.93	0.4/0.8
Long-Wave IR (LWIR)	**I5**	10.5 – 12.4	0.4/0.8
LWIR	**M14**	8.4 – 8.7	0.8/1.6
LWIR	**M15**	10.263 – 11.263	0.8/1.6
LWIR	**M16**	11.538 – 12.488	0.8/1.6
NCC	**DNB**	0.5 – 0.9	0.8

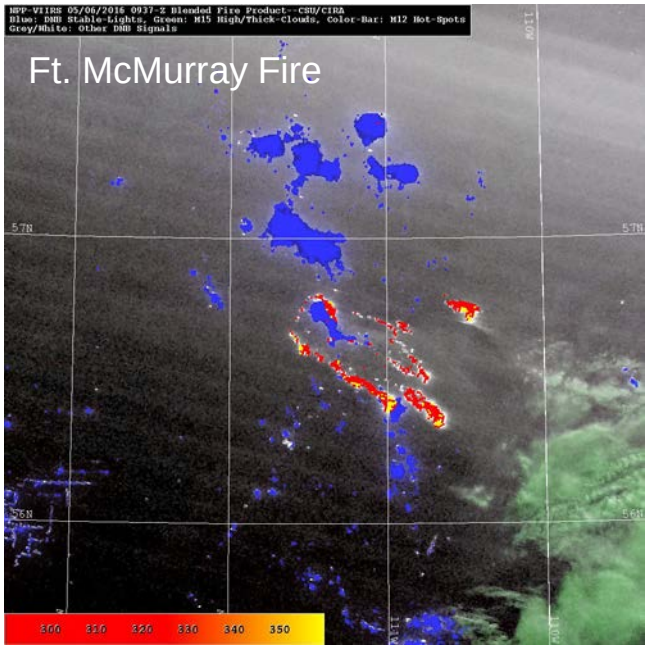
Table 2: Other IDPS-generated Imagery EDRs

Other Priority 1 (non-KPP) EDRs – 4 more bands

Imagery EDR Product	VIIRS Band	Wavelength (μm)	Spatial Resolution Nadir/Edge-of-Scan (km)
Near Infrared (NIR)	**I2**	0.846 – 0.885	0.4/0.8
Visible	**M1**	0.402 – 0.422	0.8/1.6
Visible	**M4**	0.545 – 0.565	0.8/1.6
SWIR	**M9**	1.371 – 1.386	0.8/1.6

KPPs	EDRs	Total VIIRS bands
8	12	22

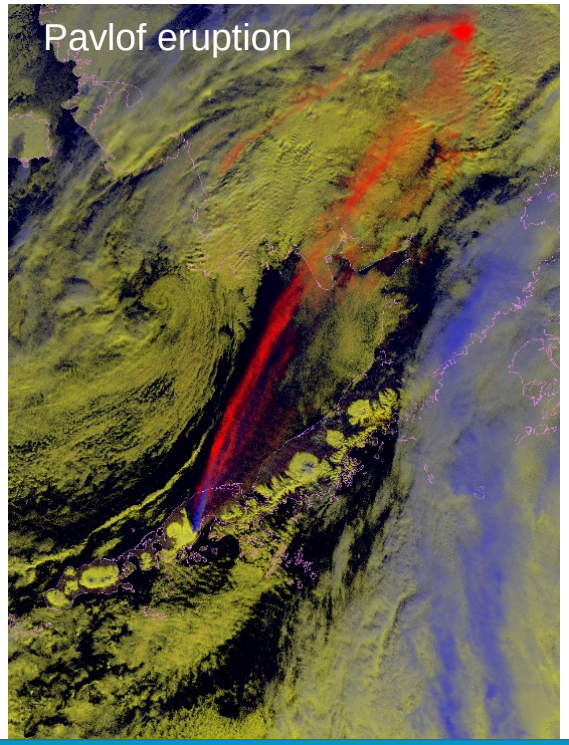
Multi-spectral Applications (with DNB)



09:37 UTC 6 May 2016

- Through the use of a City Lights Mask (Chris Elvidge/Kim Baugh, NCEI) we can better quantify where fires were detected by the Day/Night Band in the Ft. McMurray Fire

- A hot spot mask applied to M-13 shows where the Day/Night Band detected light emissions from fires that were difficult to detect in M-13



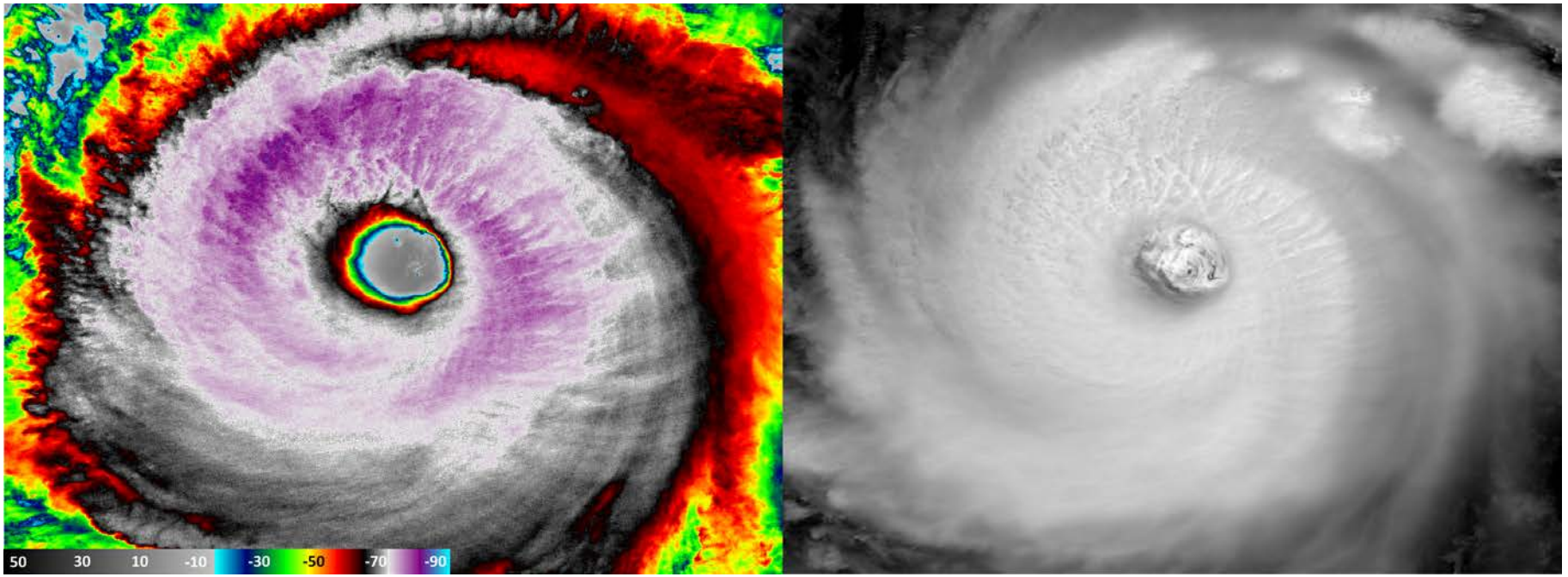
13:25 UTC 28 March 2016

- The eruption of the Pavlof volcano in Alaska was seen by M-13

- An RGB composite using the Day/Night Band better highlights the ash plume

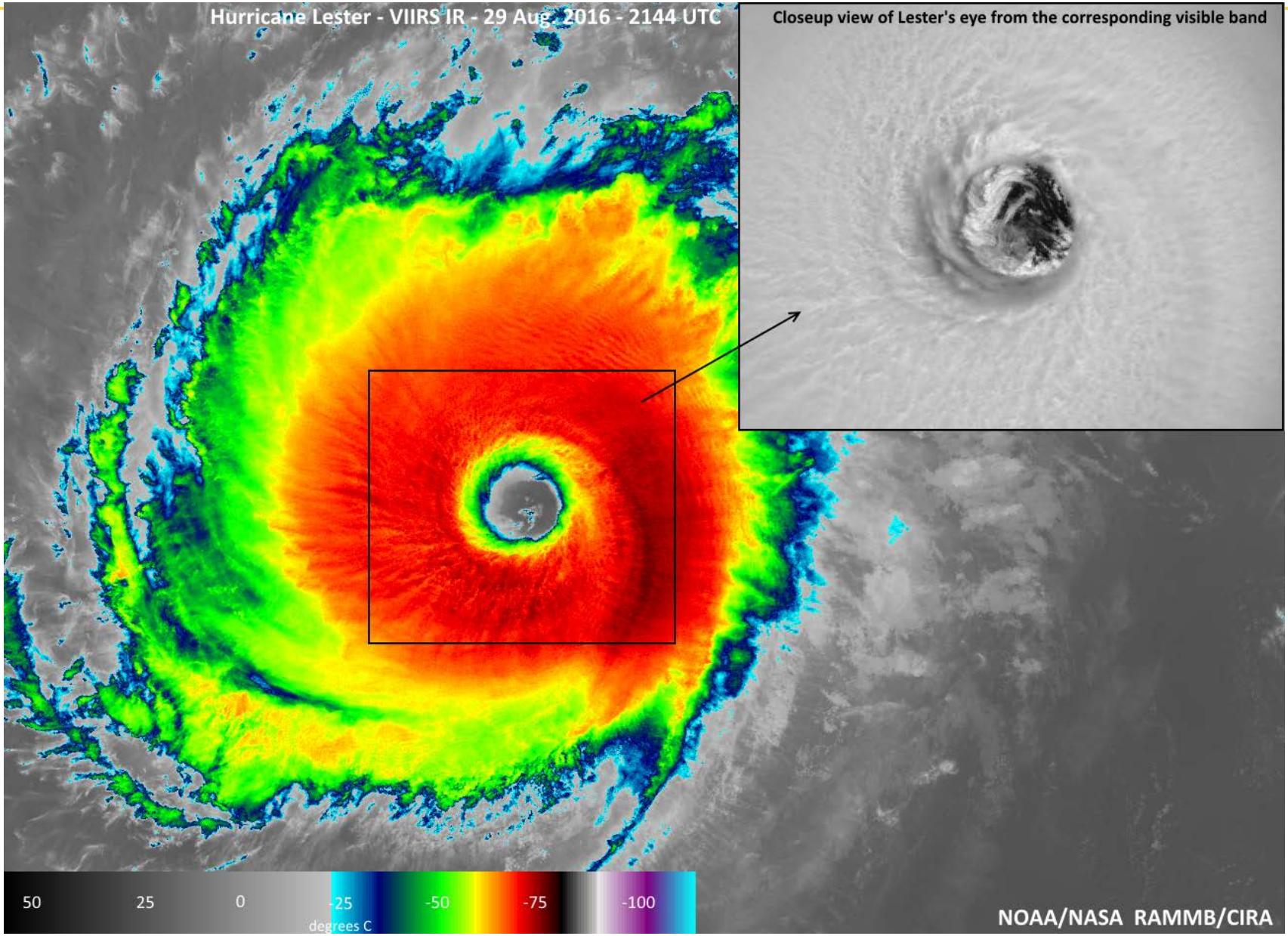
Courtesy: Curtis Seaman

Image of the Month – Super Typhoon Noru 2017



Suomi NPP passed over Super Typhoon Noru at 0310 UTC on 31 July 2017 as it churned in the west Pacific Ocean. The image on the left is a VIIRS I-band-5 IR image and the one on the right is I-band-1 Visible. At the time of these images, the storm was estimated to have maximum sustained winds of 130 knots, a category 4 storm on the Saffir-Simpson scale. (D. Lindsey, StAR)

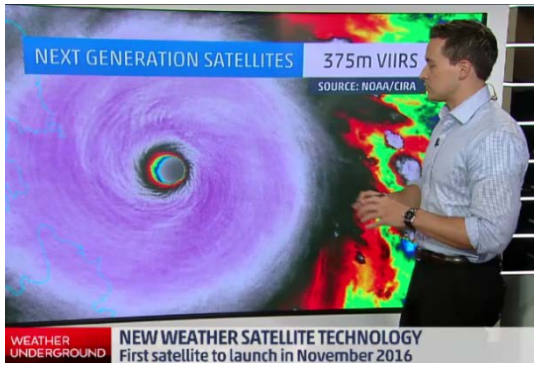
Hurricane Lester 2016



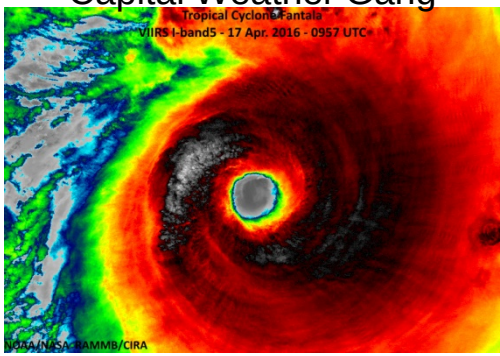
Spreading the Word

- CIRA VIIRS images have been delivered to a variety of **standard media and social media outlets**
  - The Weather Channel
  - CNN
  - BBC
  - WagTV (producer of shows for *Discovery* and *Science Channel*)
  - *Washington Post*/ Capital Weather Gang
  - @NOAASatellites on Twitter
  - And many more…

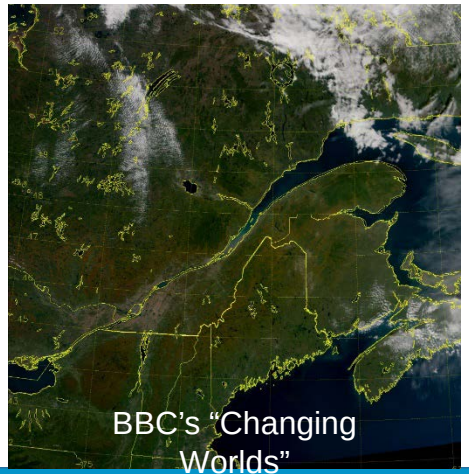
Courtesy: Curtis Seaman

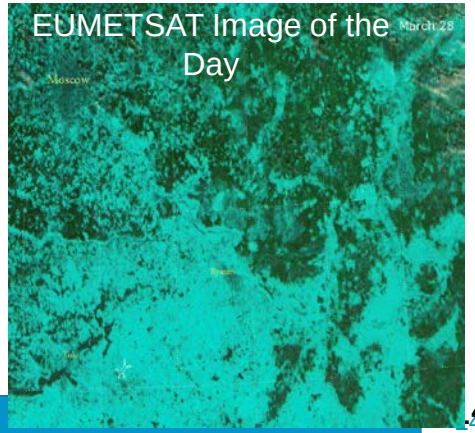


Capital Weather Gang









For the User Community

- Imagery **EDR User's Guide** for all users
  - Guide to using VIIRS EDRs and differences with SDRs
- **Quick Guides** for forecasters
  - NCC in AWIPS
  - Contributed to several GINA Quick Guides
  - More to come!

Courtesy: Curtis Seaman



GINA ALASKA DIRECT BROADCAST QUICK GUIDES
The 3.74 µm "Fog and Fire" Band

OVERVIEW

The 3.74 µm channel is in the mid-wave portion of the infrared spectrum and has utility in identifying areas of fog and low stratus when combined with longwave infrared imagery and also in identifying wildfires when used as a stand-alone image.

FINDING FOG WITH THE 3.74 µm CHANNEL

The three images below are from a VIIRS pass at 1128Z on September 3, 2015, over Alaska's North Slope; a star has been placed over Barrow for reference. At 1127Z WSO Barrow took a SPECI observation indicating a ceiling of 300 ft vertical visibility and ¾ mile visibility in mist. The stand-alone 3.74 µm image at top does not offer enough contrast or detail to allow an accurate analysis of the stratus and fog. The low clouds appear much more distinct in the Day Night Band image at middle. Note the sharp line running across the Day Night Band from the upper left to the middle right of the image—the area northeast of this line is illuminated by daylight, and consequently a different processing scheme must be used in that area. At bottom is the traditional "fog product" highlighting the difference in brightness temperatures between the 11 µm longwave IR and the 3.74 µm channel, and here the low clouds and fog are easier to identify.

The channel differencing approach (bottom image) works because liquid water cloud droplets, even super-cooled droplets, exhibit different emissivity at 11 µm and 3.74 µm. Areas with large differences in brightness temperature in this product are thus assumed to be covered by low stratus or fog.

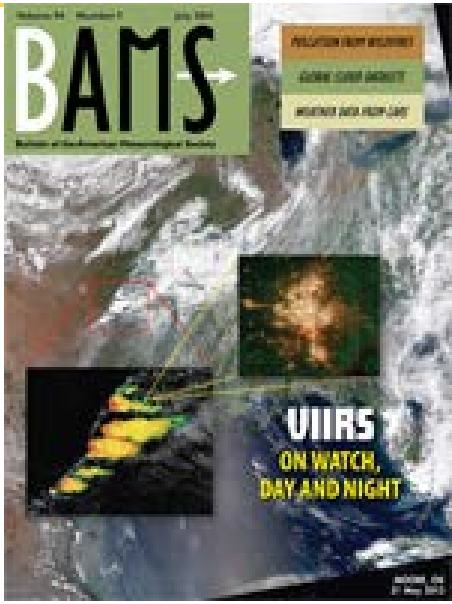
Weaknesses of the channel differencing product include vulnerability to blockage by higher clouds above the stratus and fog, as well as a restriction to the hours of darkness. Note how the fog product at bottom includes no data over the area covered by sunshine in the Day Night Band. The 3.74 µm channel, while still being in the infrared, is of a short enough wavelength that any sunshine reflecting off of clouds overwhelms the emissivity signal at 3.74 µm, with the result that the channel differencing is overly noisy and unusable during daylight hours.

ADDITIONAL REFERENCES

- Blog entry from CIRA about 3.74 µm and other wavelengths used to detect fires in Alaska: http://rammb.cira.colostate.edu/projects/alaska/blog/index.php/uncategorized/the-land-of-10000-fires/
- Quick guides to channels on the GOES-R Advanced Baseline Imager (ABI). ABI Band 7 is centered at 3.9 µm http://www.goes-r.gov/education/ABI-bands-quick-info.html
- Eric Stevens: eric@gina.alaska.edu | Carl Dierking: cfdierking@alaska.edu | GINA Staff: www.gina.alaska.edu/people

References

- **Hillger, D.,** T. Kopp, T. Lee, D. Lindsey, C. Seaman, S. Miller, J. Solbrig, S. Kidder, S. Bachmeier, T. Jasmin, and T. Rink, 2013: **First-Light Imagery from Suomi NPP VIIRS, *BAMS*, 94, 1019-1029:** http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-12-00097.1
- **Beginner's Guide to VIIRS Imagery Data:** http://rammb.cira.colostate.edu/projects/npp/Beginner_Guide_to_VIIRS_Imagery_Data.pdf
- **VIIRS Imagery EDR User's Guide:** https://www.star.nesdis.noaa.gov/jpss/documents/UserGuides/VIIRS_Imagery_EDR_Users_Guide_TR_NESDIS_150.pdf





VIIRS Imagery at other sites

- **NRL-Monterey** uses of VIIRS:
  - **NexSat** http://www.nrlmry.navy.mil/NEXSAT.html
  - **VIIRS** http://www.nrlmry.navy.mil/VIIRS.html
- **NEIC-Boulder Earth Observation Group (EOG):**
  - **VIIRS** http://ngdc.noaa.gov/eog/viirs.html

- **StAR JPSS VIIRS "Image of the Month"**
  - http://www.star.nesdis.noaa.gov/jpss/
- **StAR ICVS Long Term Monitoring:**
  - http://www.star.nesdis.noaa.gov/icvs/status_NPP_VIIRS.php (select "EDR Imagery Over Alaska")

JPSS-1 Cal/Val Plan

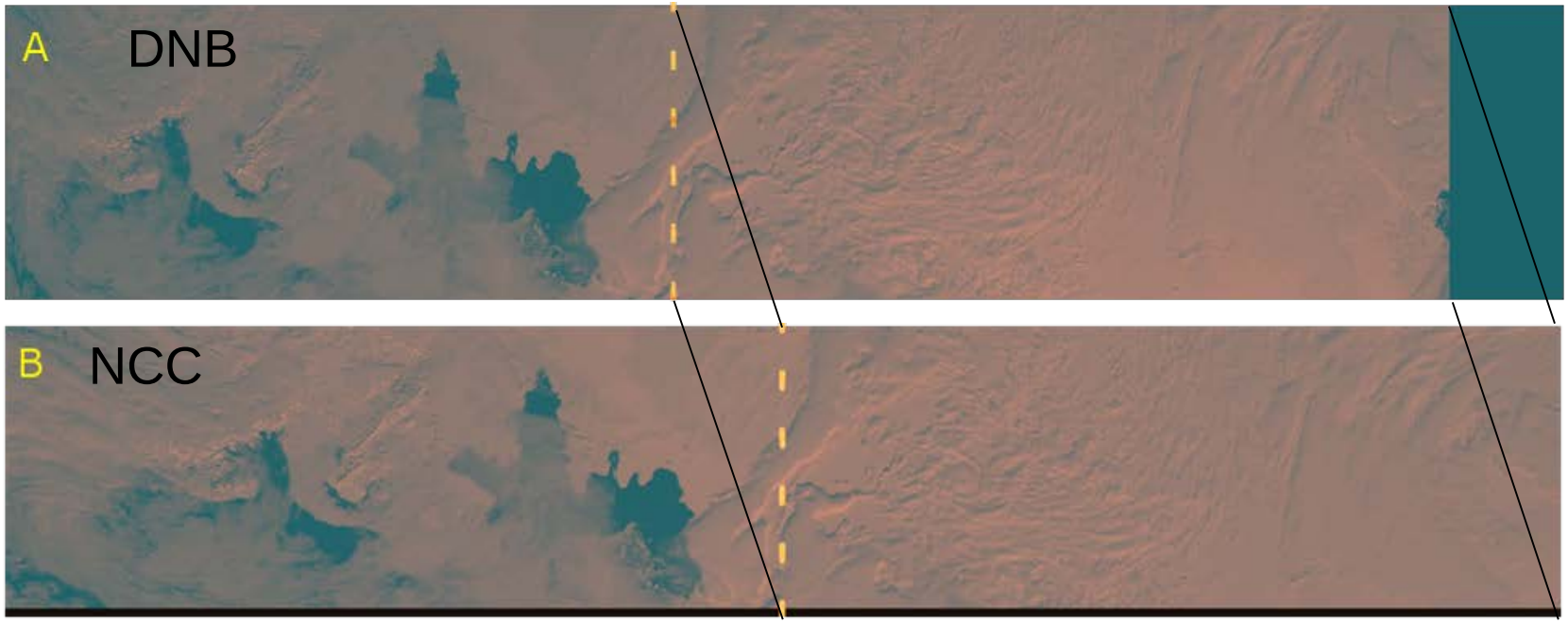
- JPSS-1 Image Cal/Val Plan
  - **Quantitative calibration** (radiances/reflectances) at SDR level
  - **Qualitative validation** of Imagery by end users
- Preparations for JPSS-1 VIIRS Imagery
  - **DNB** changes due to increased pixel aggregation at edge of scan and extended swath width
    - This was tested using simulated data for JPSS-1
    - No changes to **NCC** software/product needed

EDR Imagery Team J1 L+90 actions

From EDR Imagery (KPP)

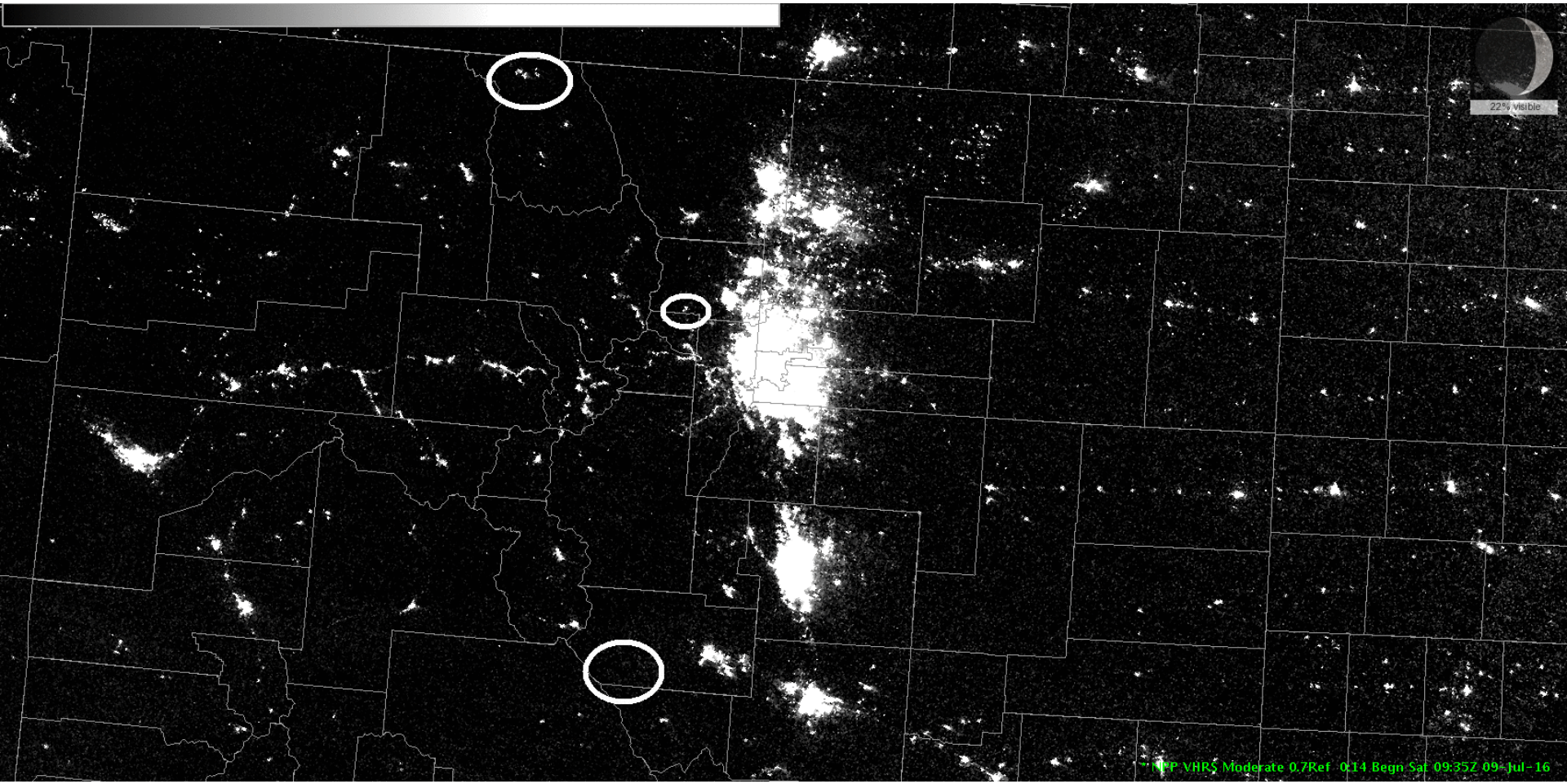
- NCC Imagery is dependent on the **stray light and other DNB fixes from the VIIRS SDR Team**.
- The **NCC LUT that may require adjustment**, but it is a **long-term need** and it would **NOT** require an update in the first 90 days
- Need to **visualize Imagery as soon as possible**, given we have to reach validation by L+90 days
  - Imagery to users
  - Feedback from users
  - Particularly NWS/AWIPS and Alaska
- **Extended granule for DNB** due to increased aggregation of J-1 data at end of swath (see next slide)

Simulation of increased aggregation at edge of swath and extended granule and offset of nadir for JPSS-1 DNB



A) DNB from S-NPP used to display how DNB will look from JPSS-1, with the **blue area on the right filled with extended scene imagery (currently missing in this simulation**)
B) The DNB remapped into the GTM mapping used for NCC, showing that the **NCC shifts the DNB imagery to the right, placing nadir at the center and ignoring the extended scene data on the right**. In each image, the dashed line shows the approximate location of nadir.

NCC in AWIPS - Fires



Do the fires move? Or does the ground move?

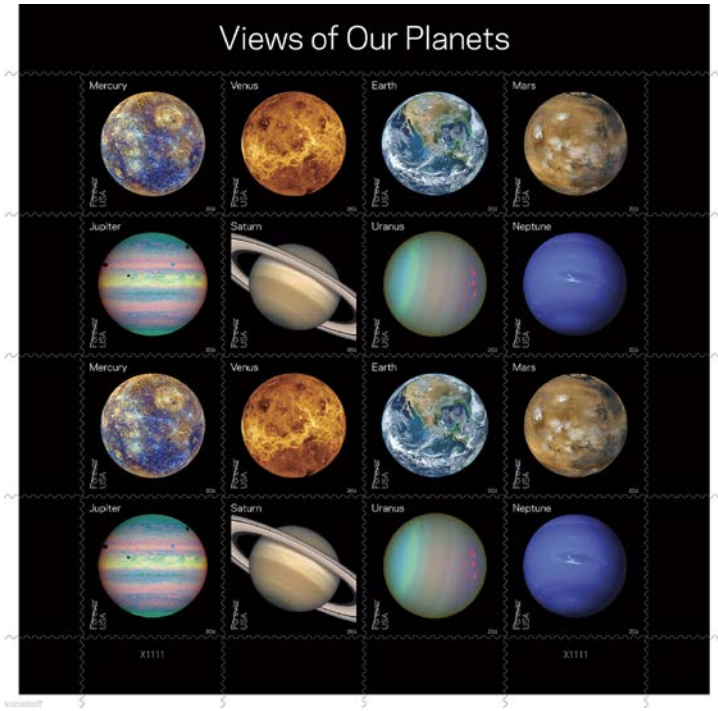
Terrain Correction needed (and required in Block 3.0) for NCC and other Imagery EDRs! (an ongoing effort)

FY17 Accomplishments and FY18 Plans

- **VIIRS Imagery is Excellent:**
  - Visible/IR are **especially high quality** (and best spatial resolution among operational satellites, at 375 m)
  - **DNB/NCC is the innovative product** from VIIRS that is not available from any geostationary satellite/orbit (or will be for many years!)
  - **Interactions with users vital for Validation** (particularly Alaska and other NWS users)
  - **Social Media outlets** highly receptive of VIIRS Imagery. Good publicity for NOAA/NESDIS and JPSS/VIIRS
- **Path Forward with JPSS-1**
  - **NCC Terrain-Corrected Geo-locations needed** (shifts of several kilometers at higher elevations with ellipsoid geo-locations)
  - **New DNB aggregation modes** for end of swath pixels, resulting in extended swath and offset of nadir
  - **Imagery from 2 satellites with 50 minute separation**, to be able to do temporal analysis of imagery features (clouds, fires, smoke, ash, etc.)

VIIRS true-color on US postage stamp 2016





US postage stamp (2016) showing the "Blue Marble" composite image created from VIIRS true-color imagery from 2012.

VIIRS DNB on postage stamp 2016



Netherlands postage stamps (2016) showing the DNB imagery in the background of this souvenir sheet.

VIIRS Imagery: Transitioning Novel Ideas into Operations

Curtis Seaman[1], Steven Miller[1] and Jorel Torres[1]

Carl Dierking[2], Jay Cable[2] and Eric Stevens[2]

Kathy Strabala[3] and the CSPP Development Team[3]

Don Hillger[4]

Anita Leroy[5], Emily Berndt[5] and Kevin Fuell[5]



4th Annual STAR JPSS Science Team Meeting, College Park, MD

14-18 August 2017

Outline

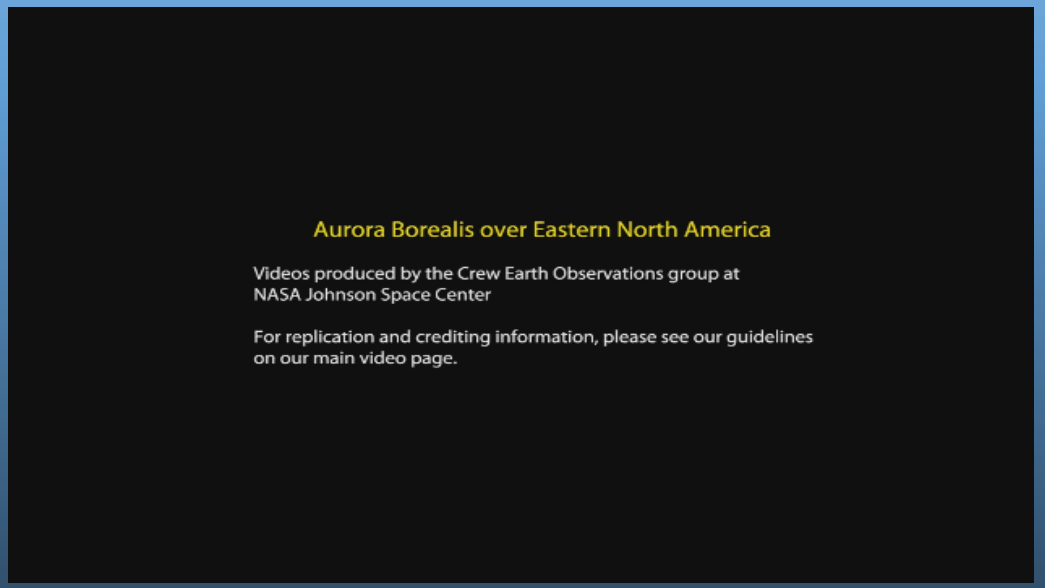
- Making the most out of the Day/Night Band
- VIIRS imagery for fire weather monitoring
- The Snow/Cloud Discriminator
- Summary

Making the Most of the Day/Night Band

Wielding the Power



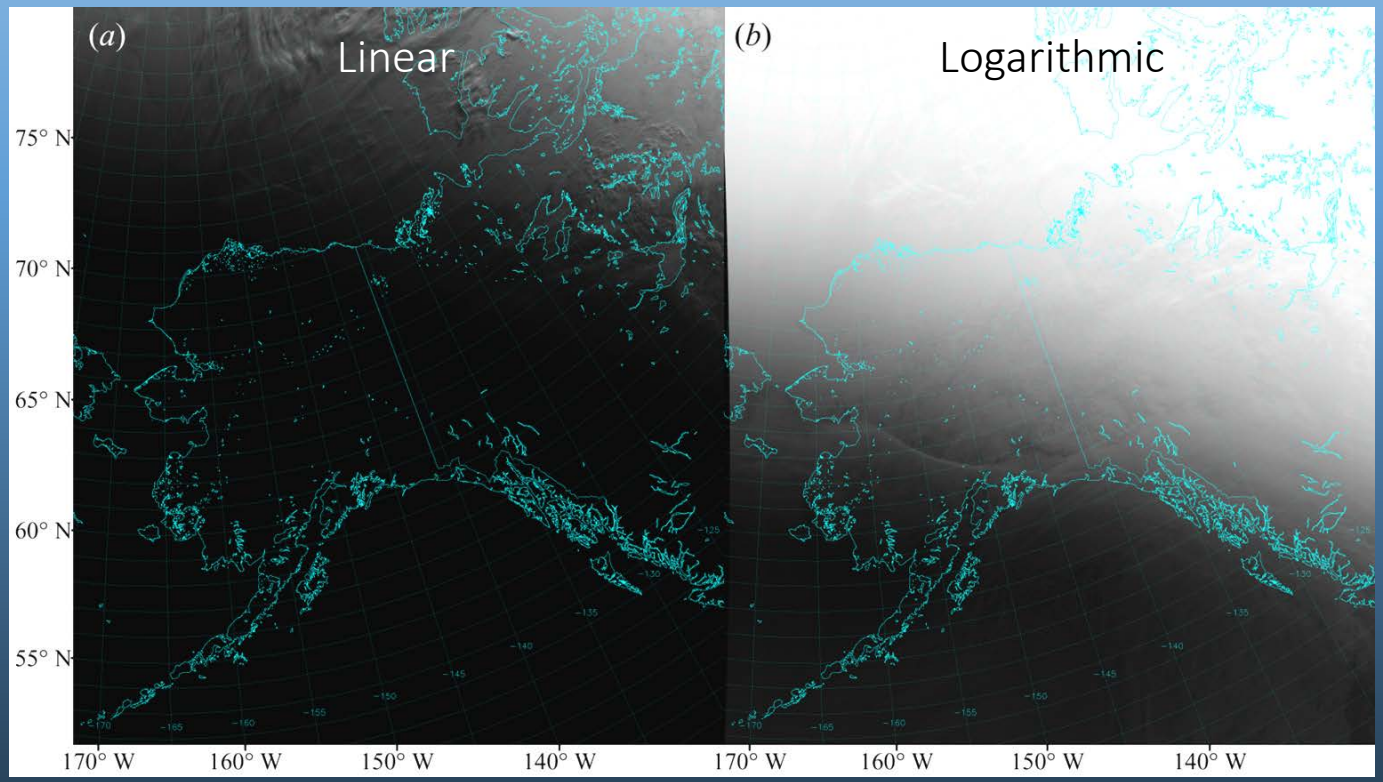
Credit: Robert Simmon (NASA)



- The Day/Night Band is sensitive to radiation over a range of intensity spanning 8-orders of magnitude from sunlight to new moon (airglow)
- This presents a particular challenge for Imagery

Global Nighttime Lights of the World (Chris Elvidge; NOAA/NGDC), Baugh et al. (2013)

Displaying 8 orders of magnitude in 256 colors

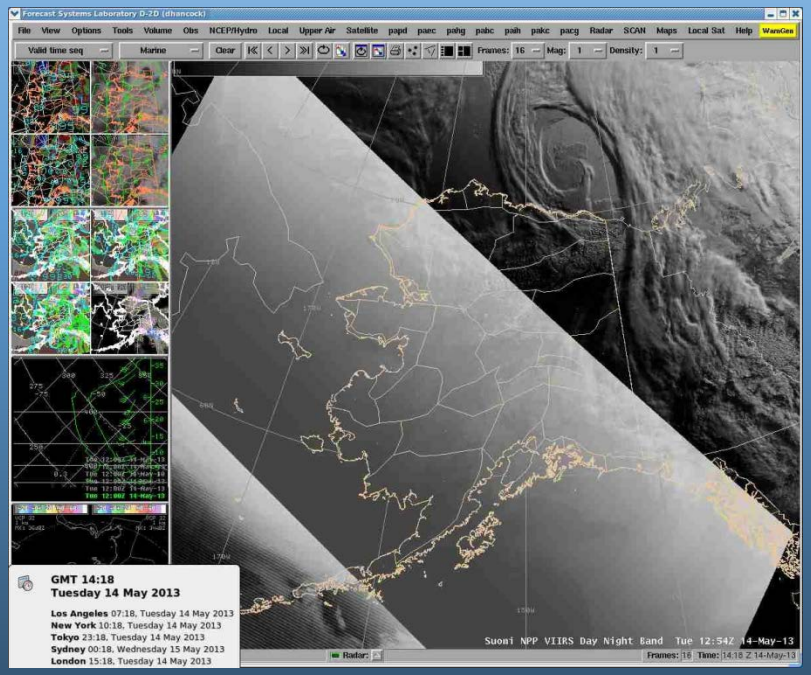


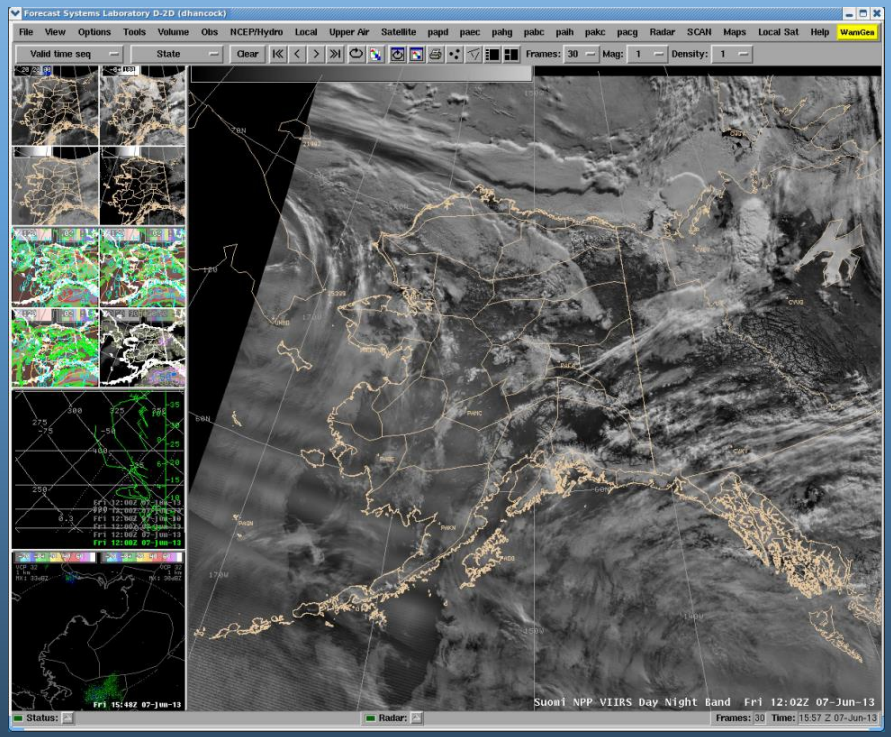
1 May 2013

- DNB radiance values vary between ~10^{-2} and ~10^{-10} W cm^{-2} sr^{-1}
- Simple scaling methods fail to capture the full range of the data
- What is the best way to capture the full range in 256 colors?

Old Scaling for Alaska Region WFOs

Image Credits: Eric Stevens, Alaska Region Satellite Liaison





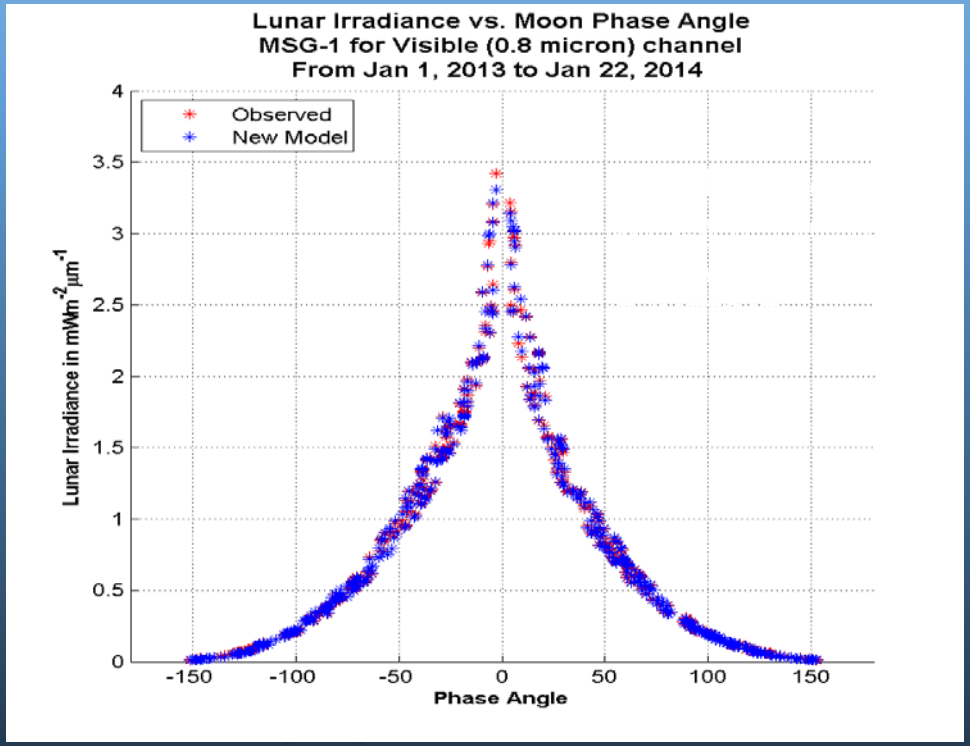
Forecasters in the Alaska Region have been using imagery in AWIPS that have been provided to them with a variety of scaling algorithms

These algorithms have artifacts near the terminator

Remember: the terminator is always present in Alaska for “daytime” overpasses in Winter, “nighttime” overpasses in Summer

Lunar Irradiance Modeling





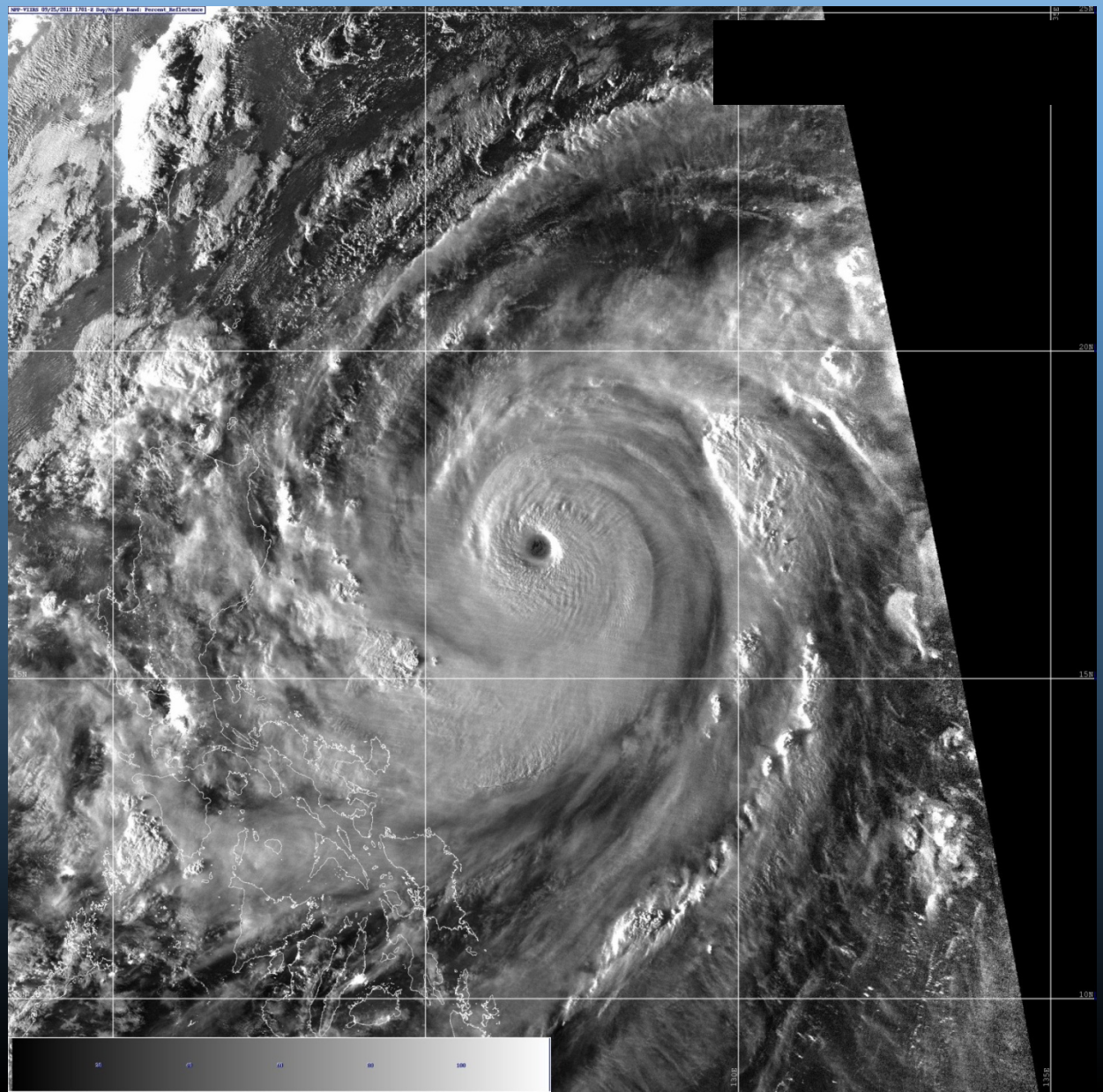
Enables Calculation of Lunar Reflectance:

$$R_m = \pi I_m / (\mu_m F_m)$$

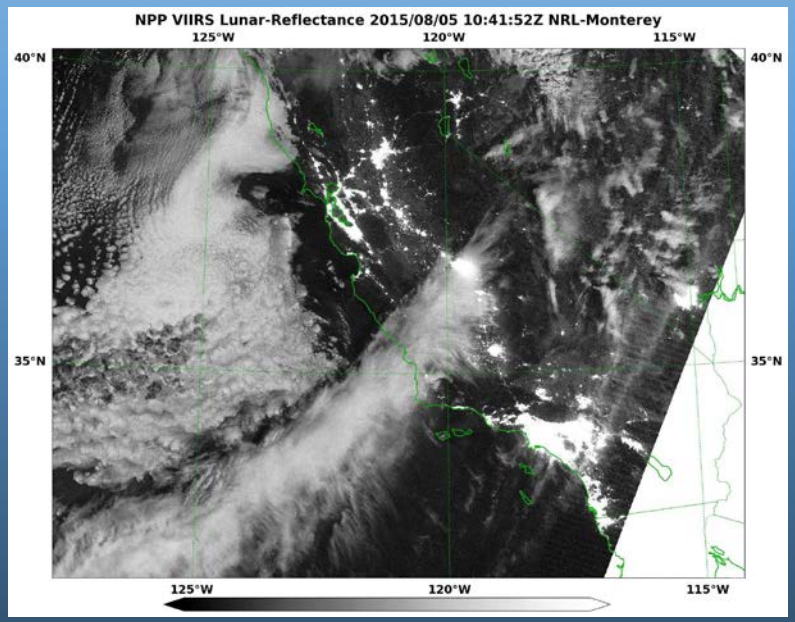
- → *Reduces 8 orders of magnitude range in radiance to <1 order of magnitude range in reflectance*
- → *Opens the door to possible quantitative applications involving the calibrated DNB observations of moonlight*

From Irradiance to Reflectance

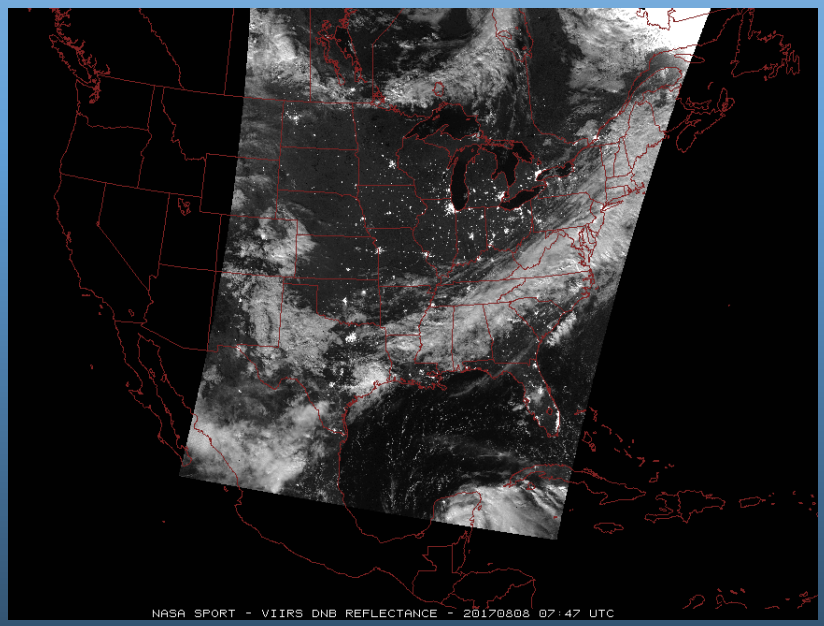
Typhoon Jelawat: 9/25/2012 ~1700Z



Lunar Reflectance in Operations



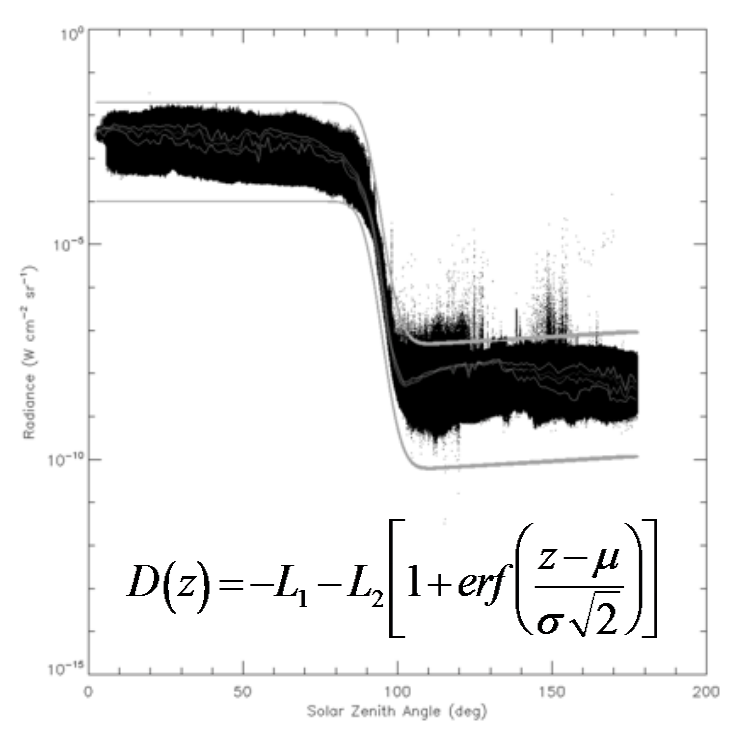
http://www.nrlmry.navy.mil/NEXSAT.html



https://weather.msfc.nasa.gov/sport/

- *Used by NRL and distributed to users via FNMOC*
- *NASA SPoRT provides Lunar Reflectance to NWS WFOs that request it through AWIPS LDM*

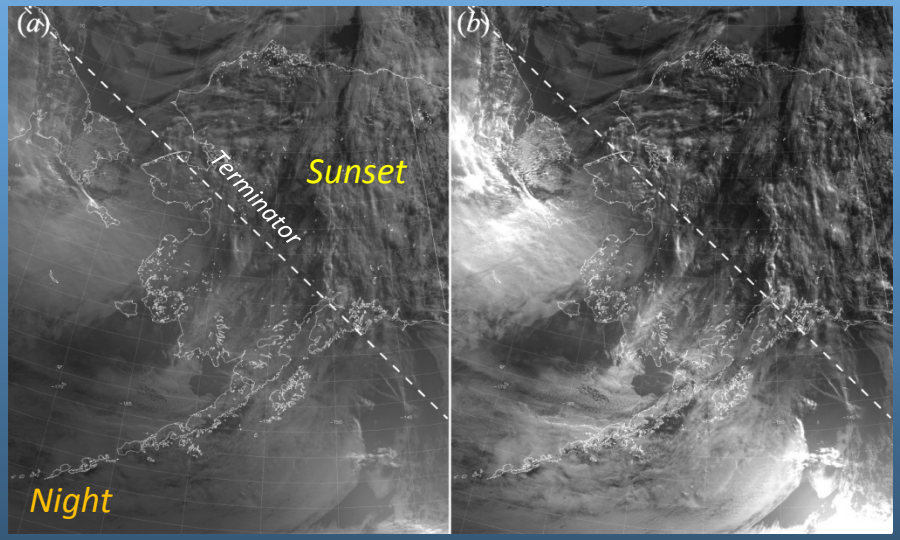
ERF-Dynamic Scaling



Seaman and Miller (2015) describe a non-linear log scaling based on the structure of the 'error function' (*erf*).

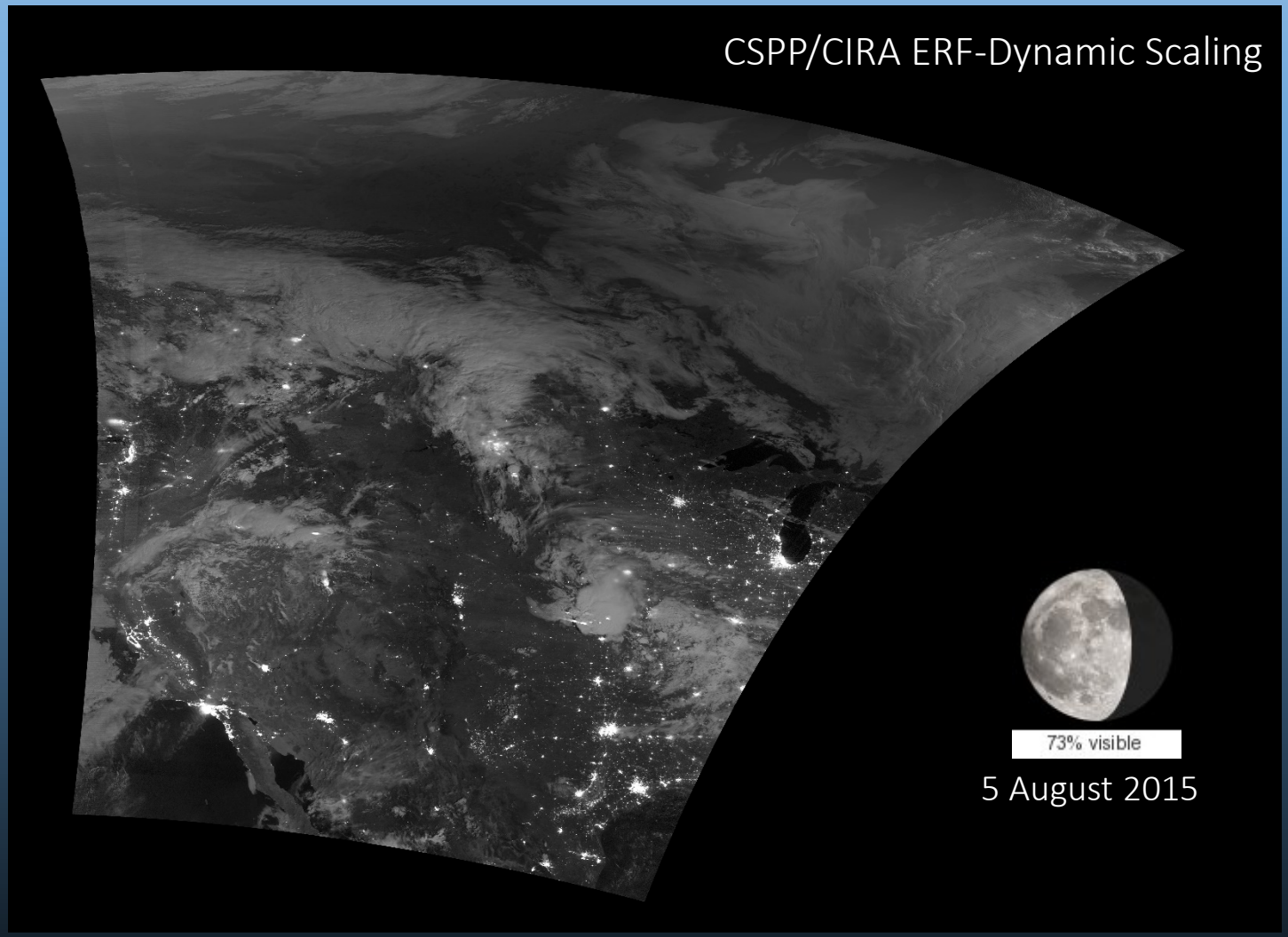
ERF Scaling

NCC Product



Strength: produces imagery with nearly constant contrast across the day/night terminator. (ERF-Dynamic Scaling is as good as, or better, than NCC in these cases.)

CSPP Polar2Grid



CSPP: Community Satellite Processing Package

http://cimss.ssec.wisc.edu/cspp/

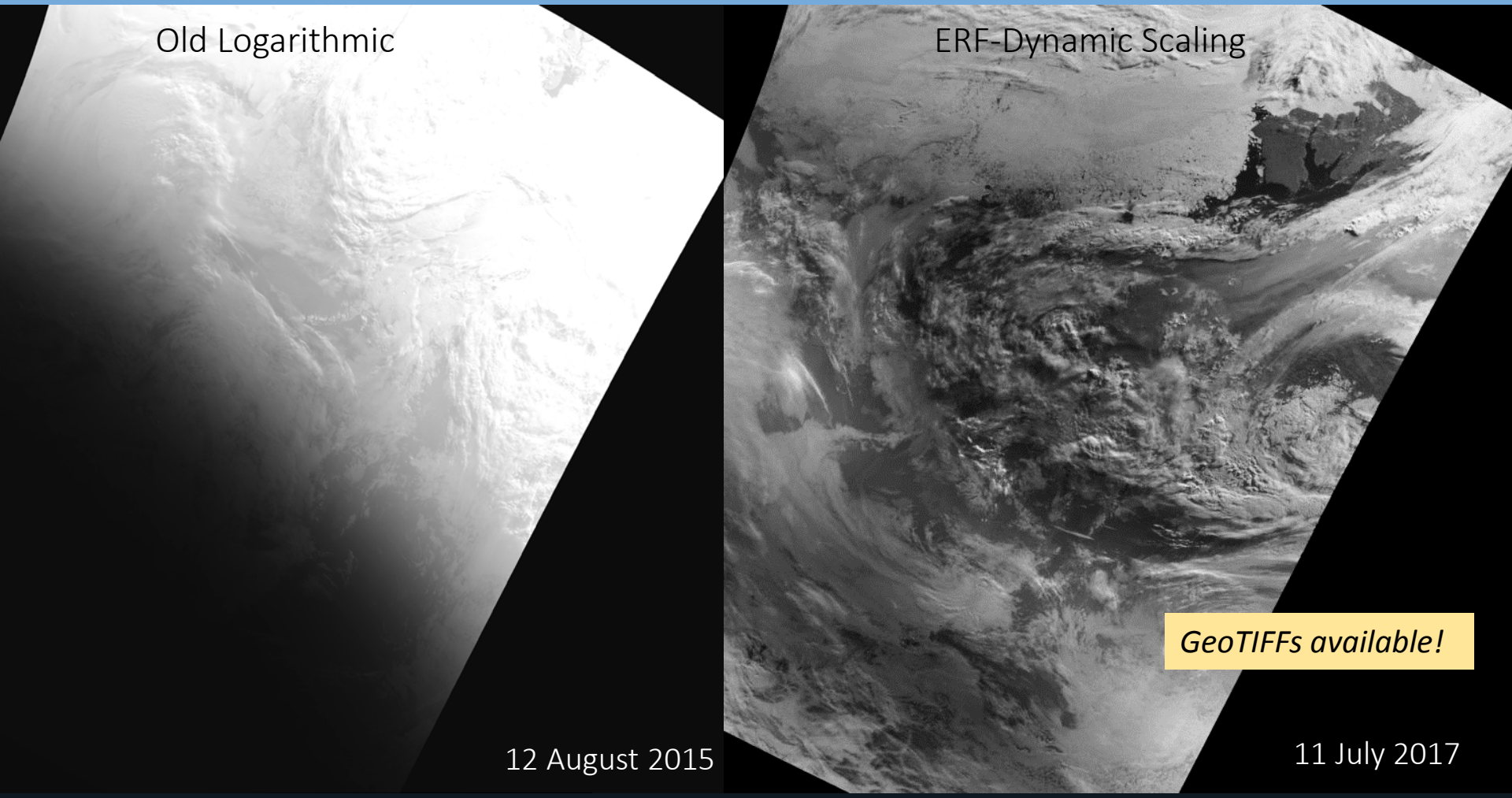
ERF Scaling for Alaska Region WFOs



Just talking informally with a couple of the forecasters there earlier this week, I get the impression they are very happy with this scaling approach.

Eric Stevens (GINA)

ERF-Dynamic Scaling now on Puffin Feeder



http://feeder.gina.alaska.edu/

Near Constant Contrast in AWIPS

The Near Constant Contrast (NCC) EDR has been delivered to AWIPS through the SBN since December 2015.

We have developed training on NCC (Thanks, Jorel!) and look forward to implementing our Auto Contrast algorithm to optimize the display of the NCC.

VIIRS Near Constant Contrast
Quick Guide For Imagery Enhancement in AWIPS 2

The NPP polar-orbiting satellite passes twice per day, once around 1:30 pm and again around 1:30 am local time. Its VIIRS instrument has a Day/Night Band (DNB) that is very sensitive to low levels of light and provides unique visible imagery at night. The DNB can detect a broad range of light intensities, ranging from full sunlight in the day down to faint atmospheric glow on moonless nights (the focus here will be on the nighttime imagery). This 8-order of magnitude range in radiance space is difficult to display as an image without losing detail at either end of the radiance scale, so a product called **Near Constant Contrast (NCC)** was developed in order to mitigate enhancement issues by using a model of the sun and moon to convert the DNB radiance values into a reflectance-like value. Doing so reduces the dynamic range from 8 orders of magnitude down to 3, which is much easier to display in AWIPS and other software. **But, beware! The NCC *does not* provide a true reflectance value like other visible imagery or the DNB Lunar Reflectance product!**

NCC "pseudo-albedo" values vary throughout the lunar cycle. The DNB instrument is sensitive to reflected light from the sun and moon as well as many other sources of emitted light – cities, the aurora, gas flares and fires, lightning, nightglow and even boats! These sources may be 2-3 orders of magnitude brighter than the moon, particularly when the moon is below the horizon when VIIRS is passing overhead. As a result, NCC pseudo-albedo values can vary from -10 to 1000. Most meteorological features of interest have pseudo-albedo values between 0 and 1.5. Side illumination of clouds near the terminator may result in NCC values of 2 or more, like the bright areas in the example at right.

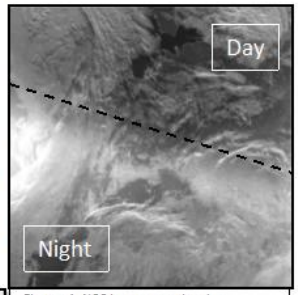
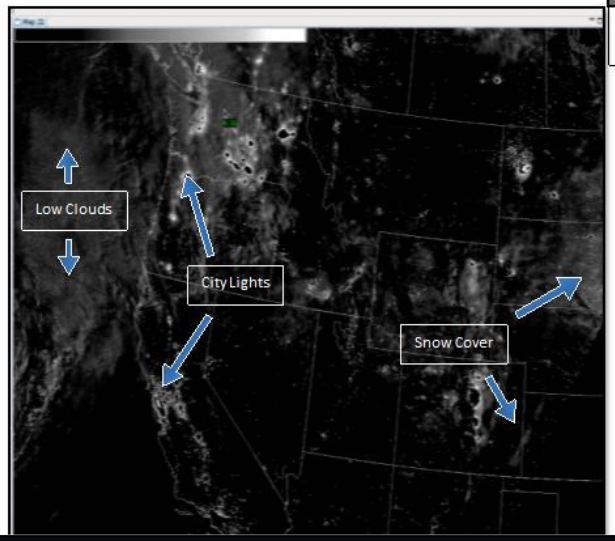
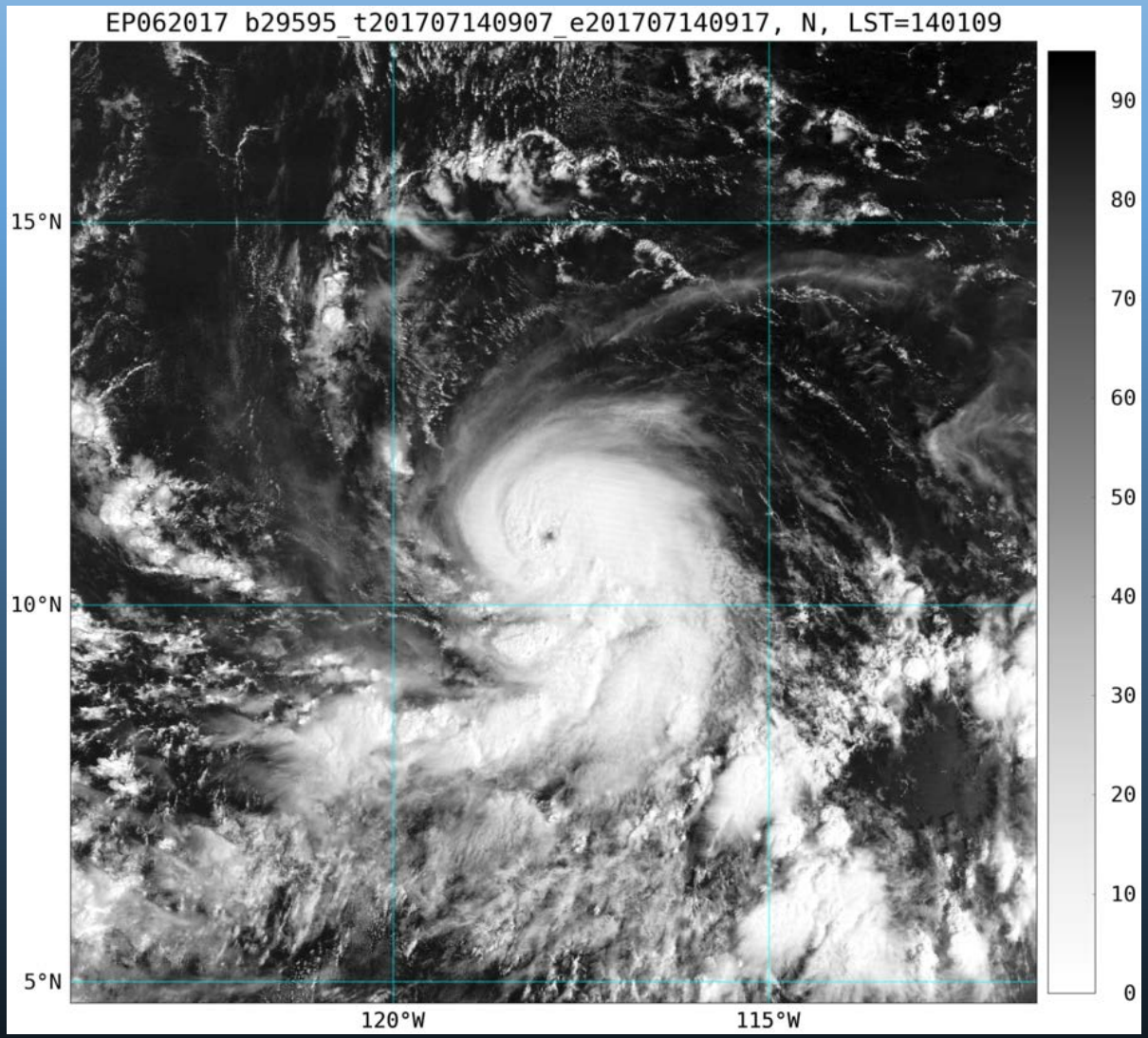


Figure. 1. NCC image spanning the terminator. Clouds are clearly seen on both day and night sides.



AWIPS 2 scales NCC values from 0 to 1.6 by default. Many clouds are moderately bright while areas where there should be bright city lights are black. These "black" lights have values > 1.6 and are a result of the default color table, as seen in Figure 2. Using the color table editor, change the Colormap size to the maximum 2048 colors. Stretch the values between 0 and 1 by making the top arrow point to the minimum value (0.0), then set the red, green, and blue bars to 0 (black). Set the bottom arrow to a value of 1, and the red, green, and blue values to 255 (white). Click 'Interpolate.' Finally

Optimizing DNB for NHC/CPHC/JTWC



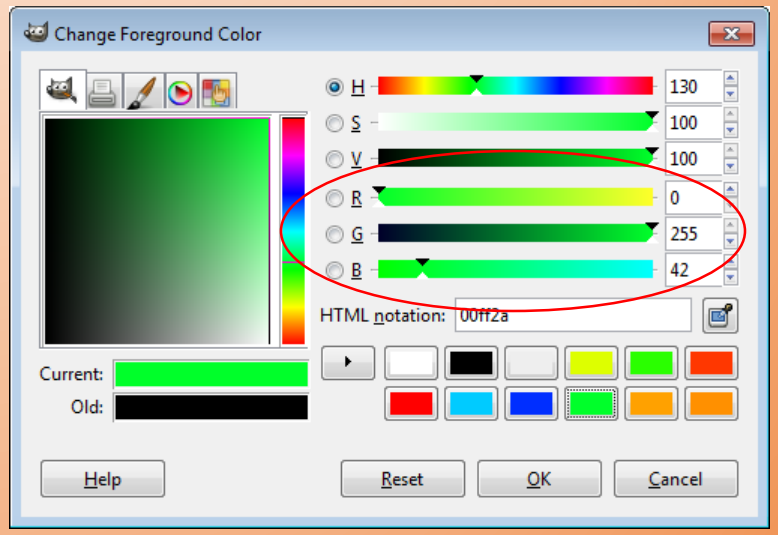
Stay tuned for Galina Chirokova's talk…

VIIRS Imagery for Fire Weather Monitoring

Introduction to RGB Composites

- Every color on a computer monitor may be expressed as 1-byte (8-bit) values of red, green and blue (0-255)

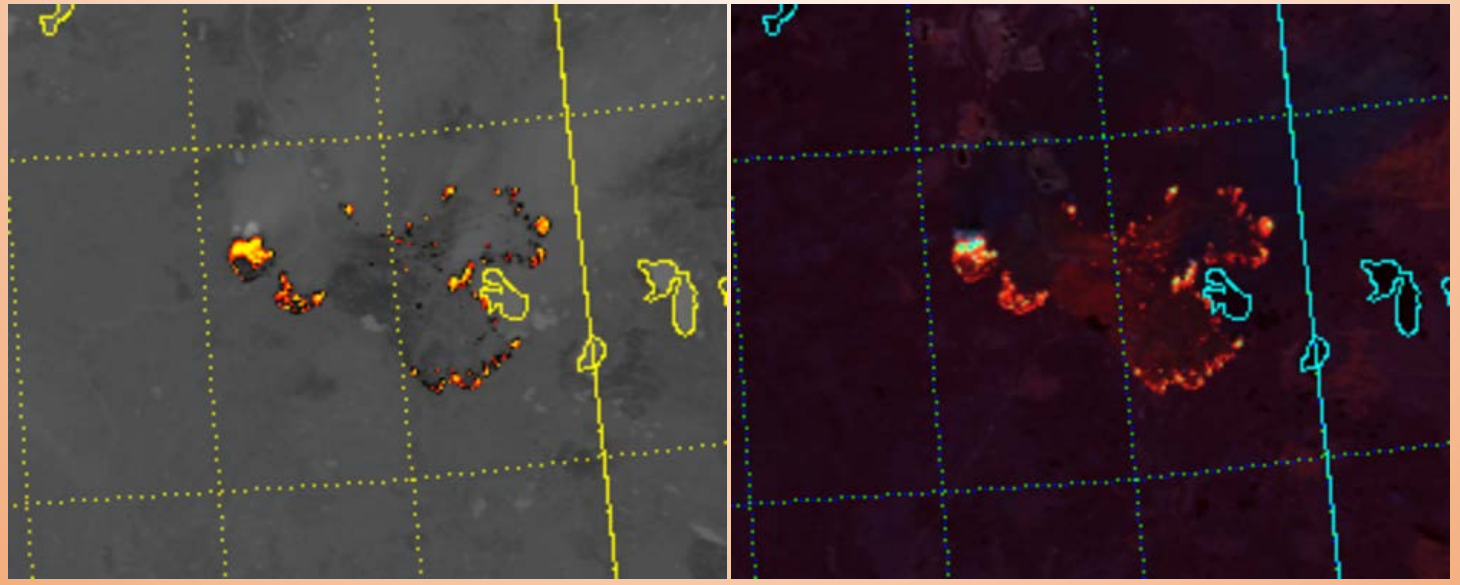
- RGB composites take three different values (raw channels, channel differences, Rayleigh corrected values, etc.), scale them from 0-255 and assign them to red, green or blue



- In this way, three different images are combined to produce one color image

Fire Temperature RGB

M-13 (3.9 μm) "Fire Temperature" RGB

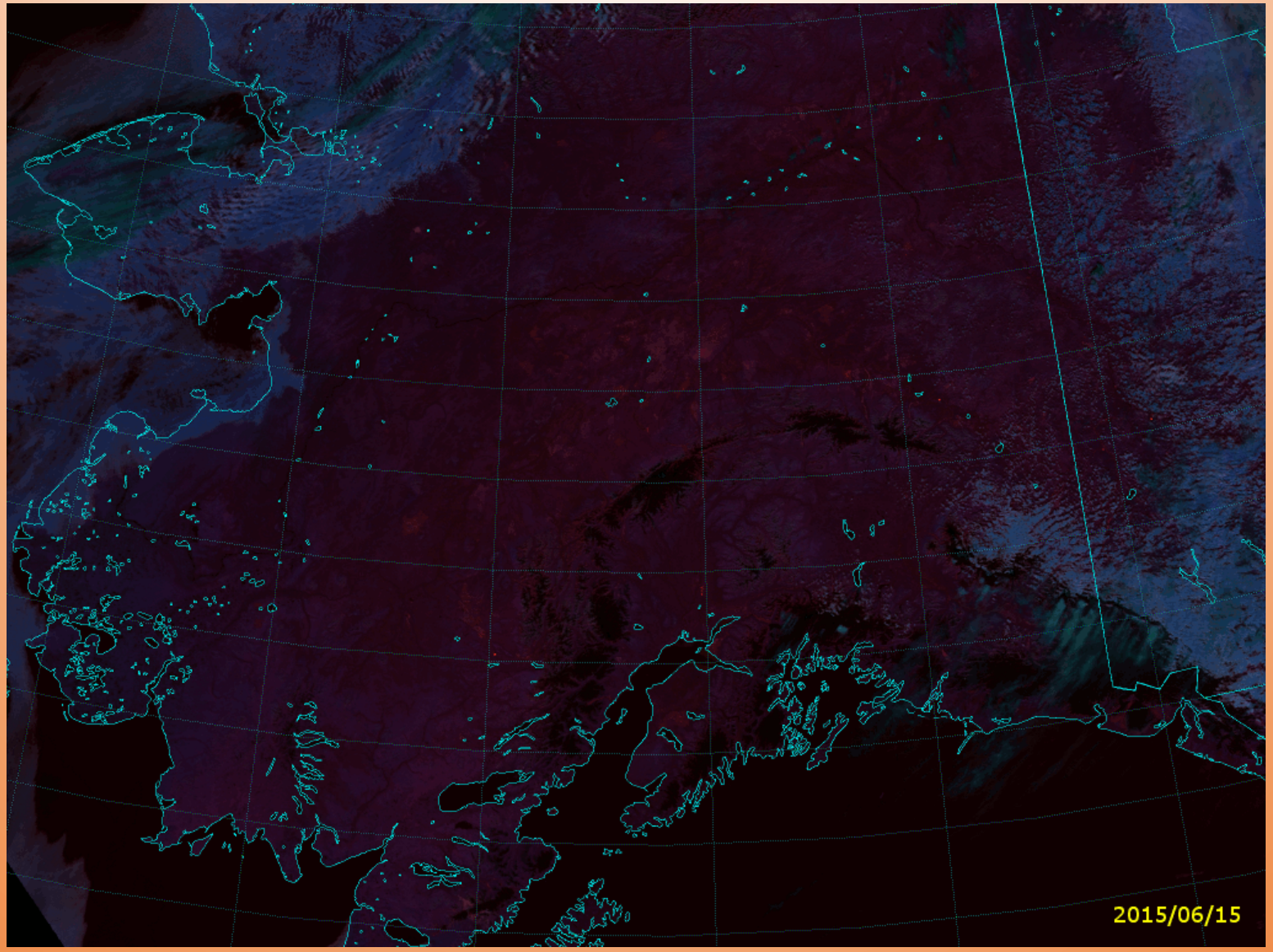


Fort McMurray Fire 19:42 UTC 16 May 2016

- CIRA's "Fire Temperature" RGB uses M-10/1.61 μm, M-11/2.25 μm and M-12/3.7 μm
- Smaller/cooler fires only show up at 3.7 μm and appear red
- Moderate fires show up at 3.7 μm and 2.25 μm and appear orange/yellow
- Intense fires show up in all three bands and appear white (or cyan if saturation/fold-over occur in M-12)
- Sees through smoke and makes fires look like fires!

CIRA Connecting Models and Observations

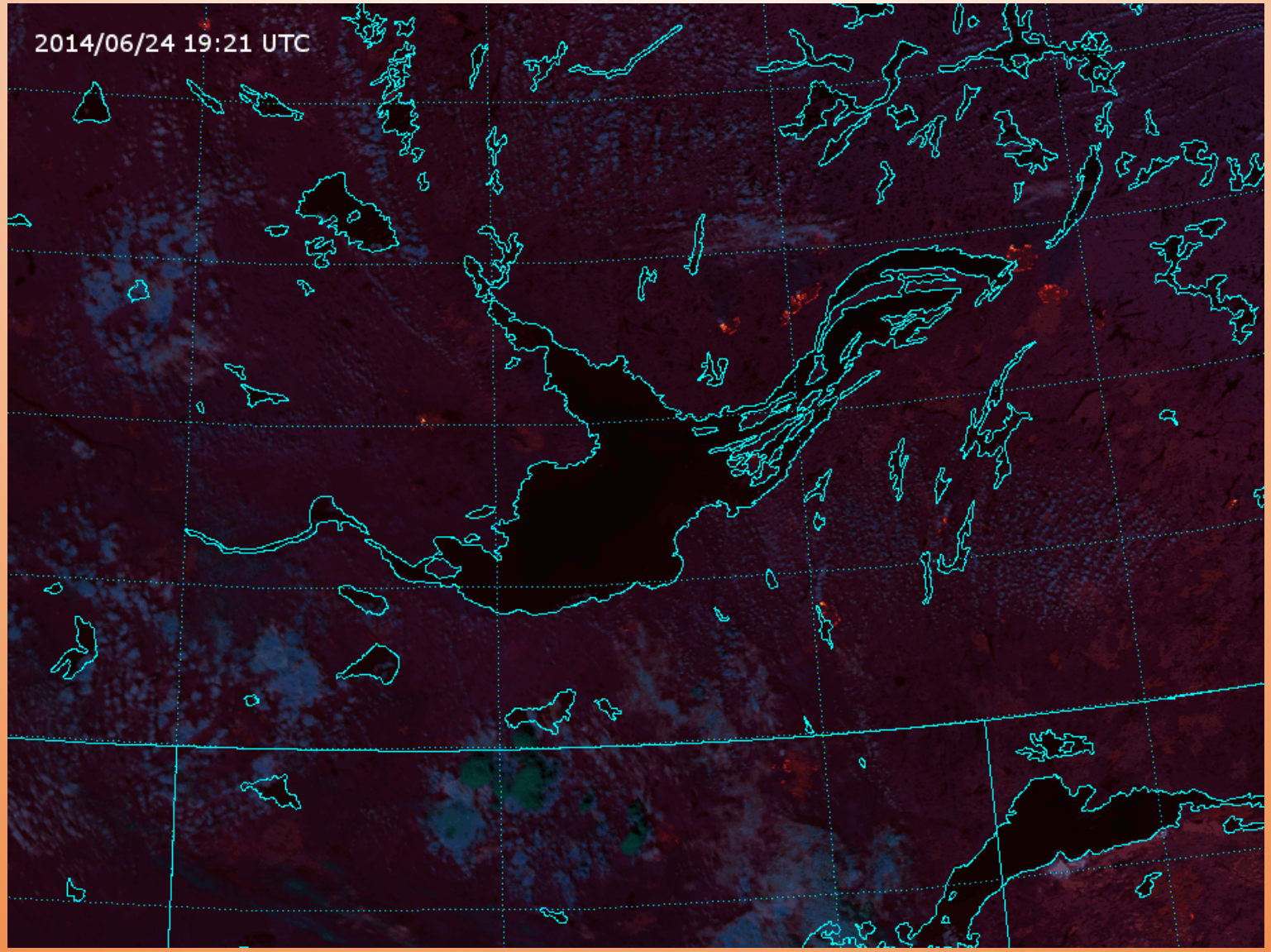
An “active” fire season



Animation (15-25 June 2015)

CIRA
Connecting Models and Observations

Northwest Territories (2014)



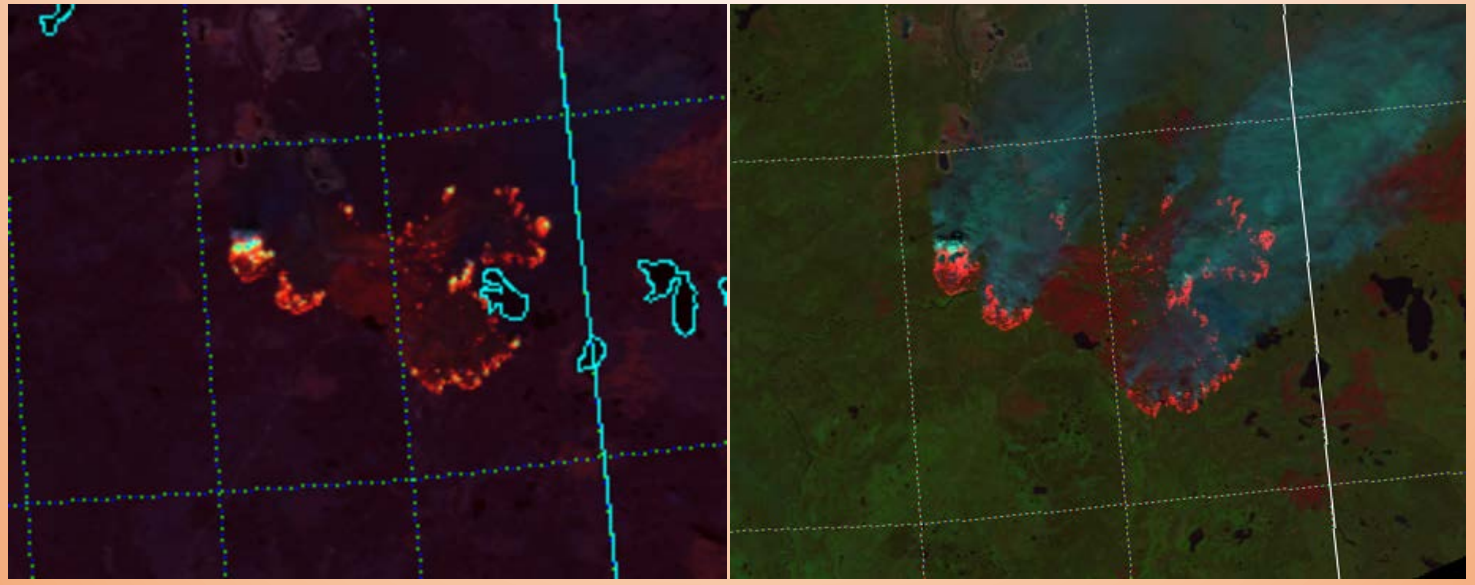
Animation (June/July 2014)

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Natural Fire Color RGB

"Fire Temperature" RGB

"Natural Fire Color" RGB

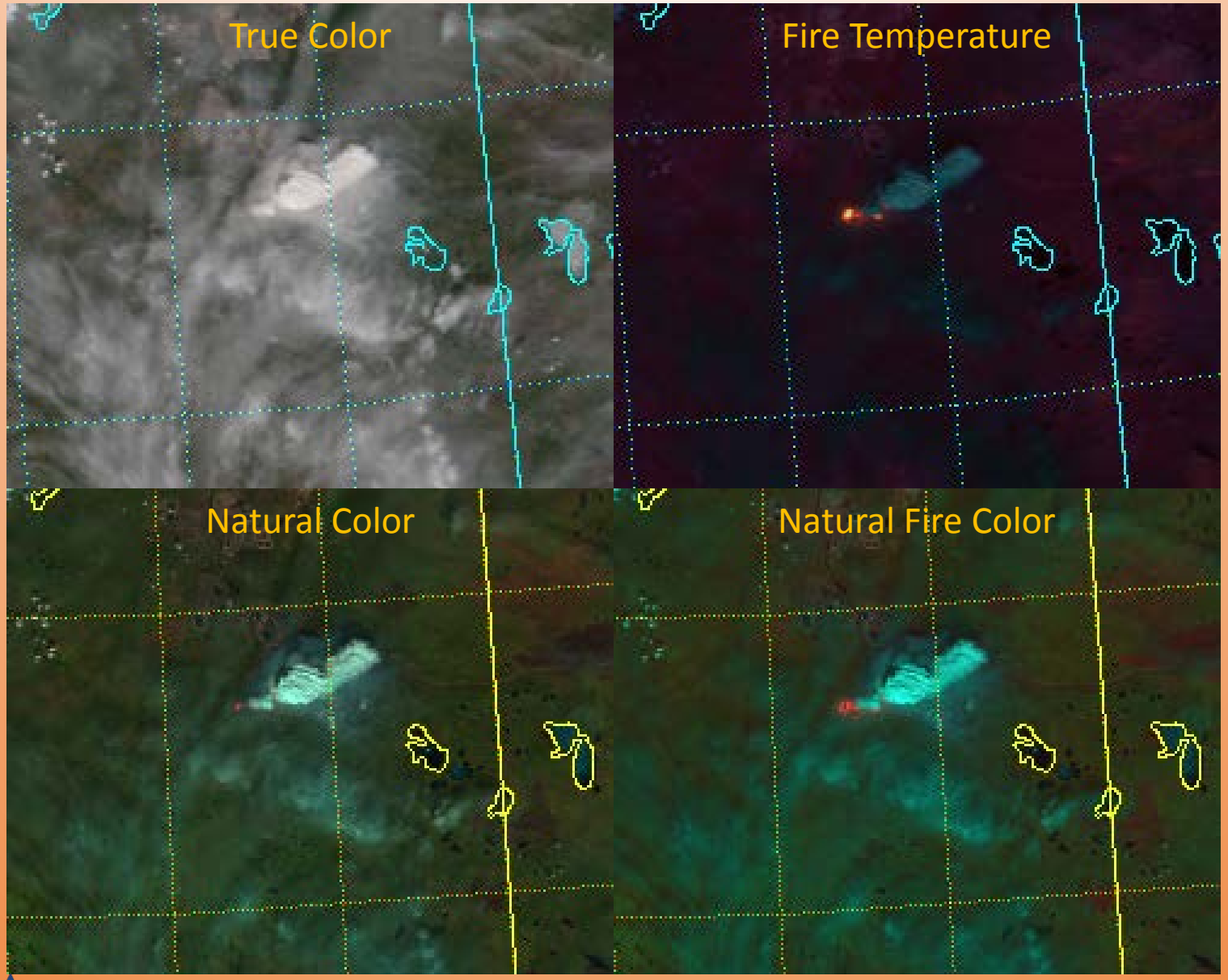


Fort McMurray Fire 19:42 UTC 16 May 2016

- CIRA's "Natural Fire Color" RGB uses I-1/0.64 µm, I-2/0.86 µm and I-4/3.7 µm (375 m resolution!)
- Looks similar to the "Natural Color" RGB, except fires show up as bright red pixels (unless saturation/fold-over occurs in I-4)
- More sensitive to smoke than Fire Temperature RGB; smoke appears blue/cyan
  - Not good for people who are red-green colorblind!

CIRA
Connecting Models and Observations

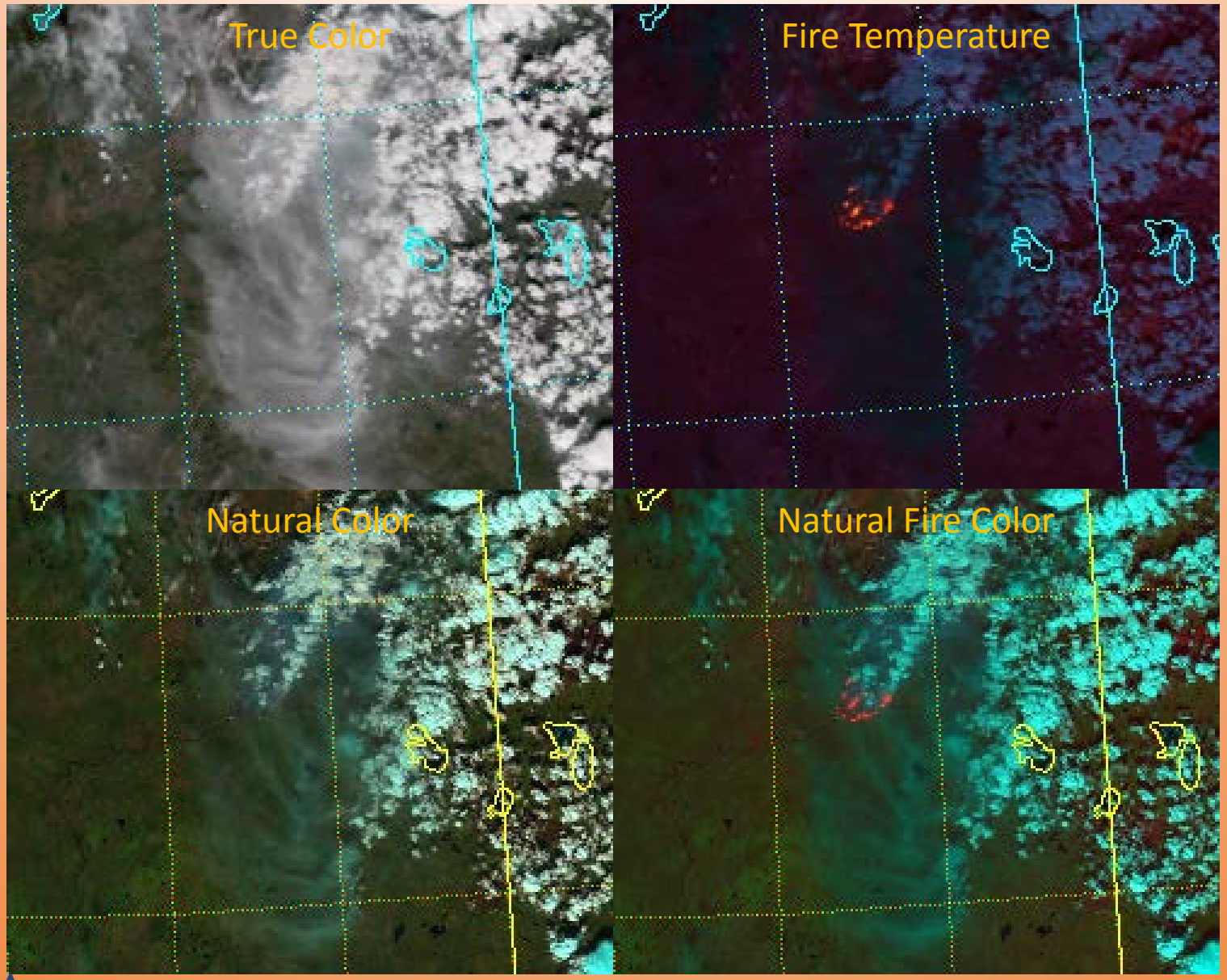
Fort McMurray Fire (2016)



20:25 UTC 3 May 2016

CIRA
Connecting Models and Observations

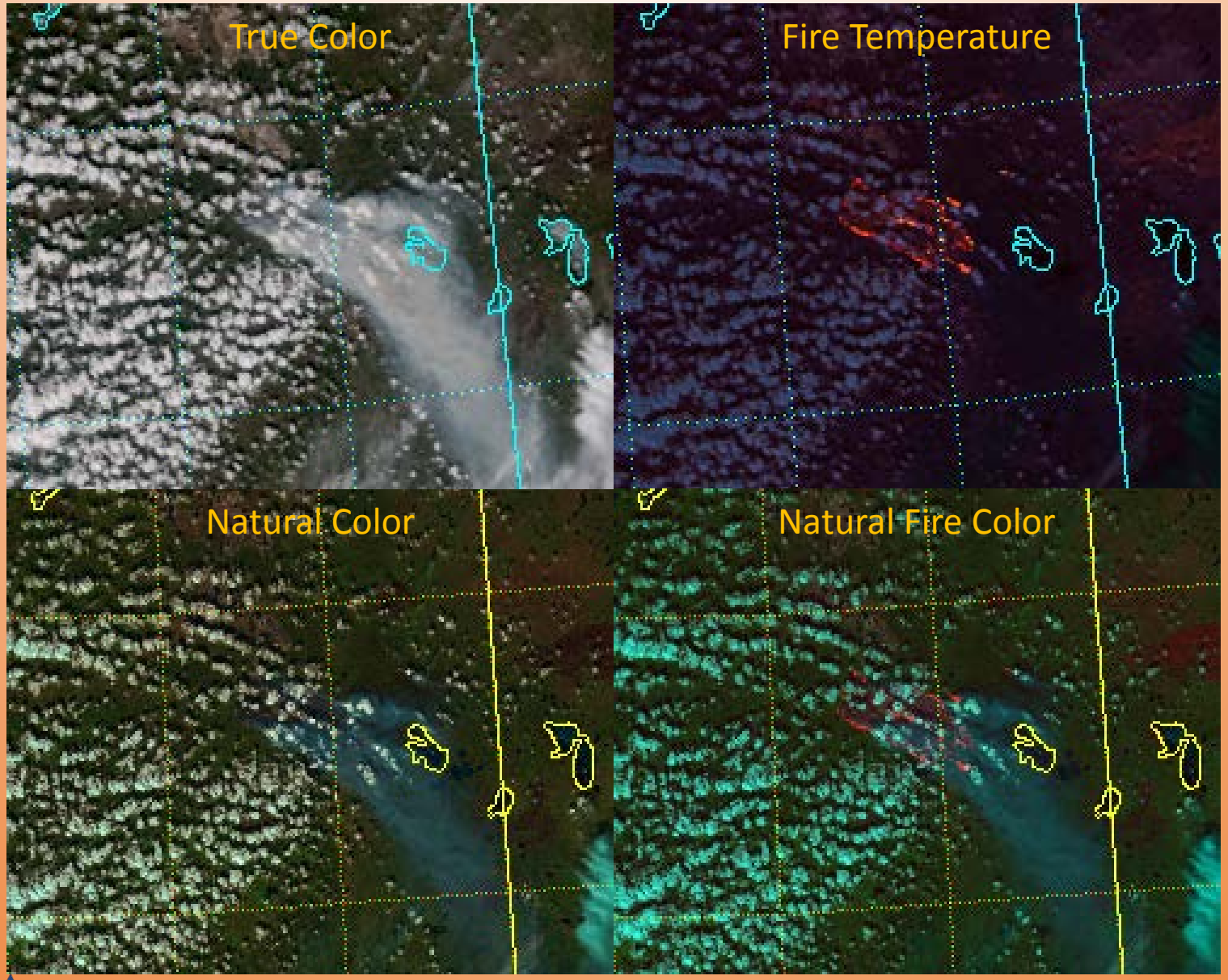
Fort McMurray Fire (2016)



20:05 UTC 4 May 2016

CIRA
Connecting Models and Observations

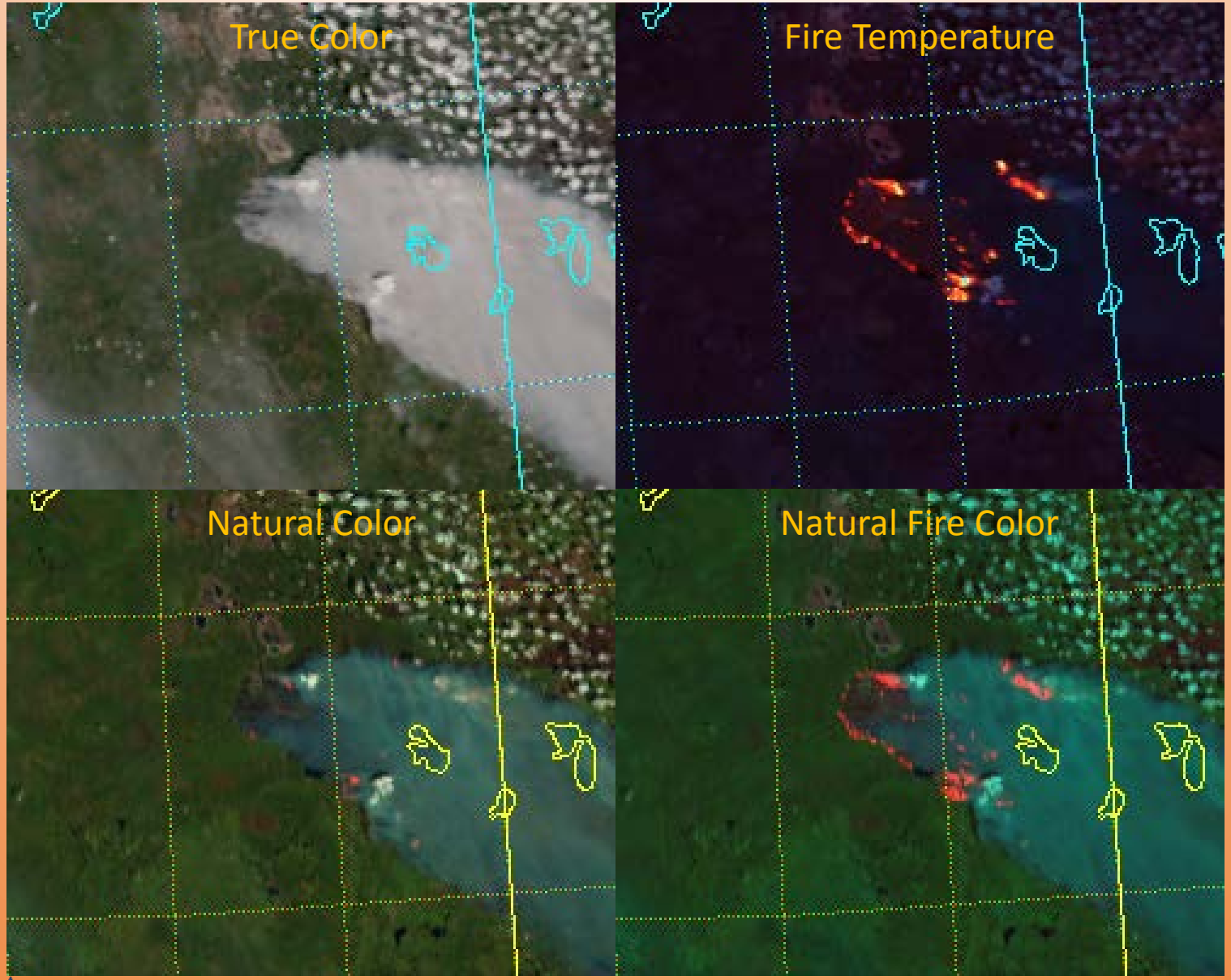
Fort McMurray Fire (2016)



19:47 UTC 5 May 2016

CIRA
Connecting Models and Observations

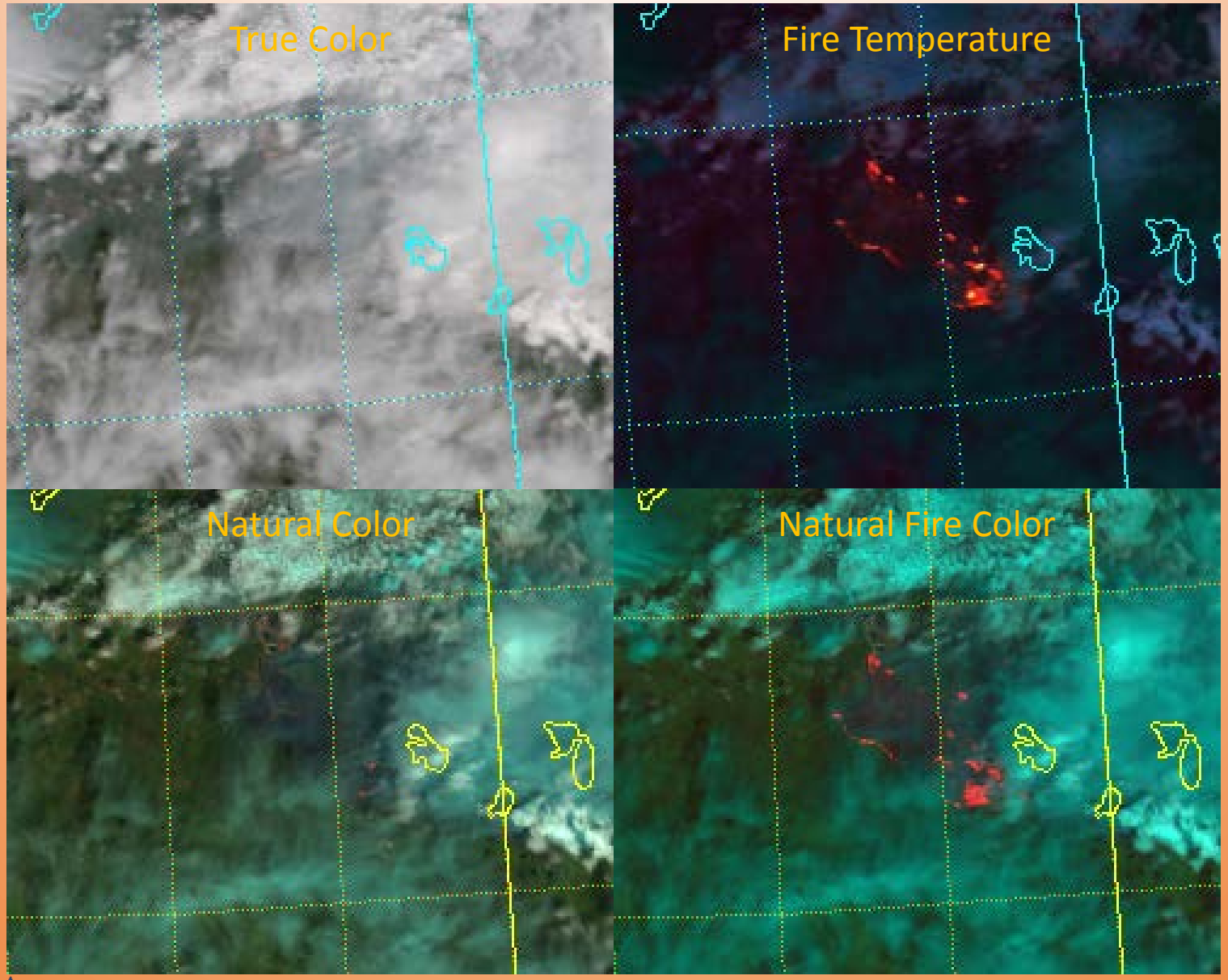
Fort McMurray Fire (2016)



21:06 UTC 6 May 2016

CIRA
Connecting Models and Observations

Fort McMurray Fire (2016)



20:48 UTC 7 May 2016

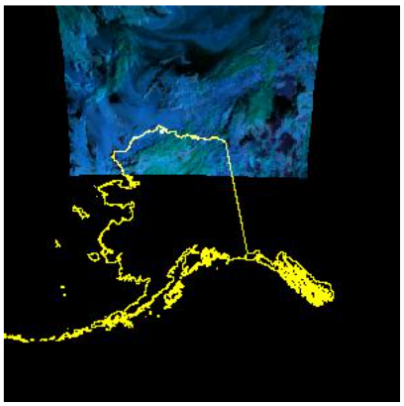
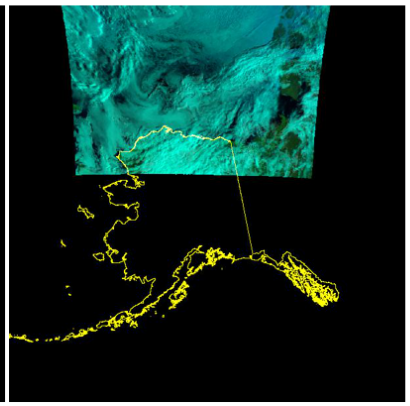
CIRA
Connecting Models and Observations

Fire RGBs for Alaska Fire Service (AFS)

hippy.gina.alaska.edu/firecolor

This page presents VIIRS fire color products .

A KML feed of this data is available here.

Date	Age	M band combo	I band combo
08/03/17 17:39:00 UTC	1h, 40m		
		TIFF (25 Mb)	TIFF (92 Mb)
		JPEG compressed TIFF (3 Mb)	JPEG compressed TIFF (13 Mb)
		KML	KML

We have been using it and we are HUGE fans!!! Seriously, it is just about the closest thing we have to real-time information on fire growth and behavior. Over the past few days we (AFS GIS) have been checking the page multiple times a day and grabbing new images. I am partial to the I-Band combo due to the better resolution..

Jenn Jenkins (BLM/AFS)

M-band combo = Fire Temperature RGB

I-band combo = Natural Fire Color RGB

CIRA Connecting Models and Observations

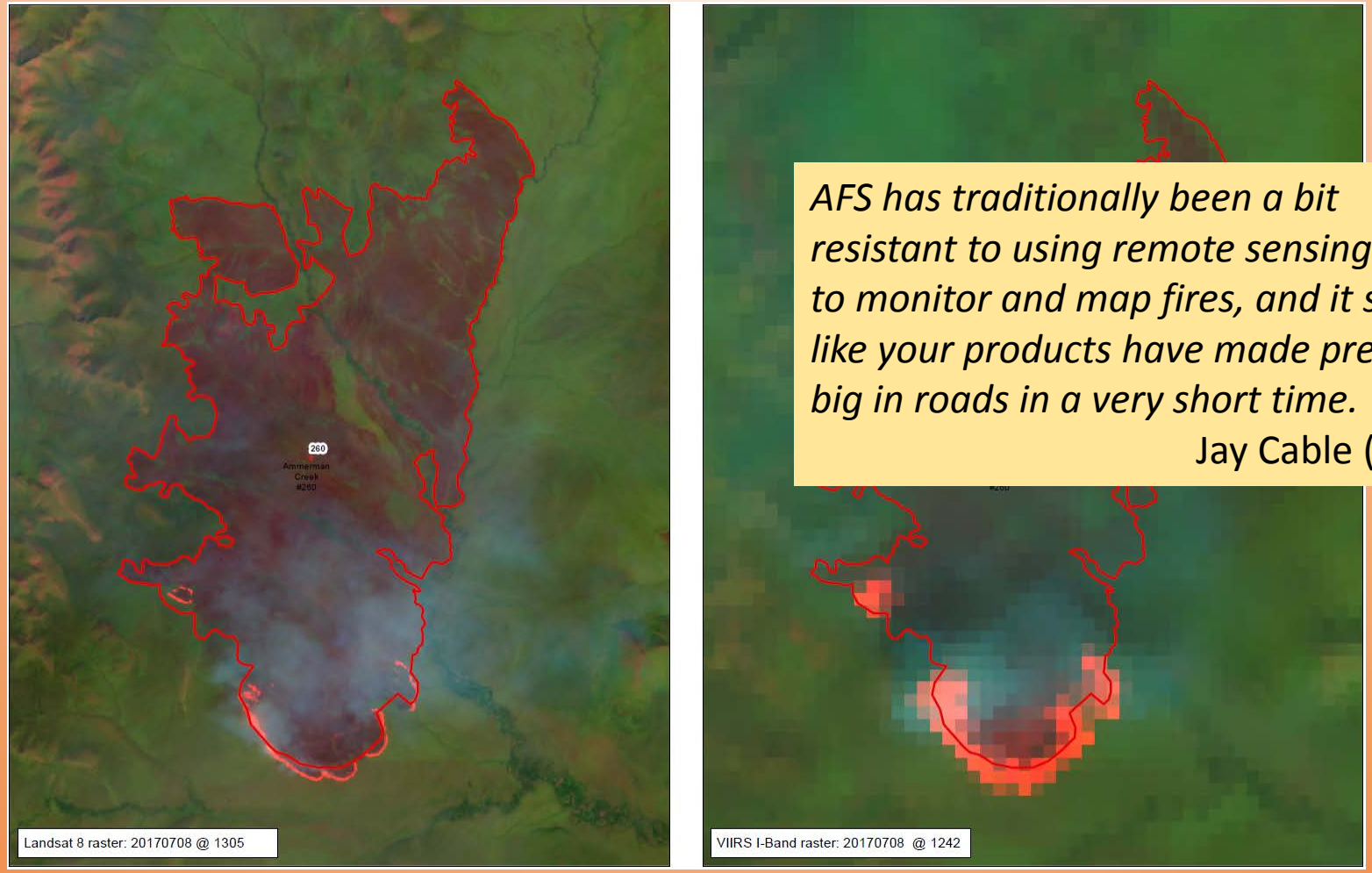
GINA www.gina.alaska.edu

URL above is temporary. Check for updates at:

http://feeder.gina.alaska.edu/

Natural Fire Color: CIRA to GINA to AFS

Images courtesy AFS

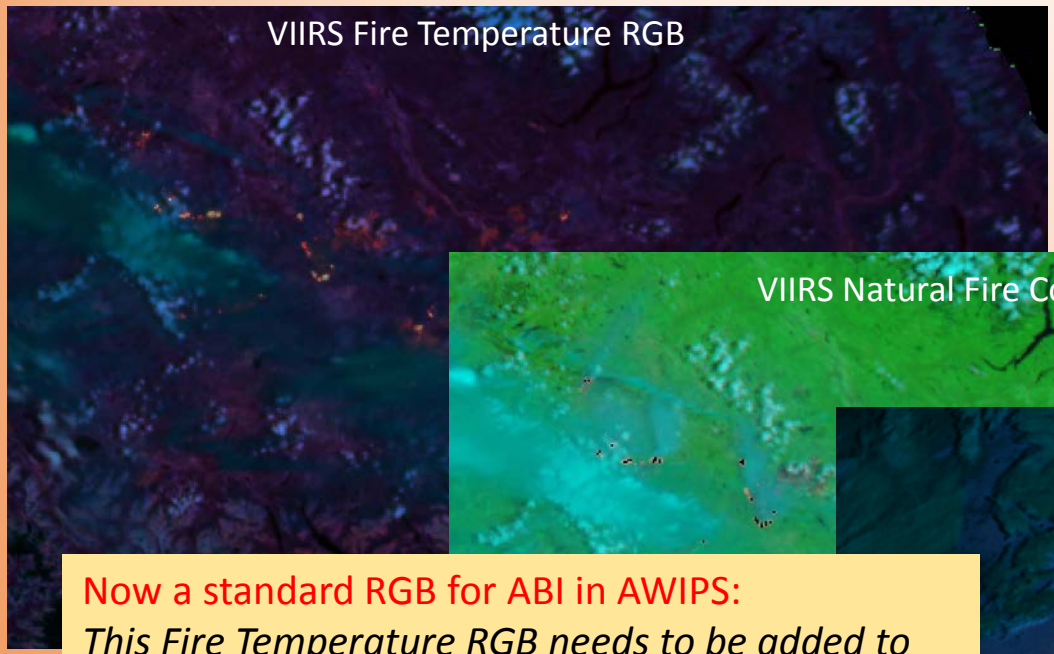


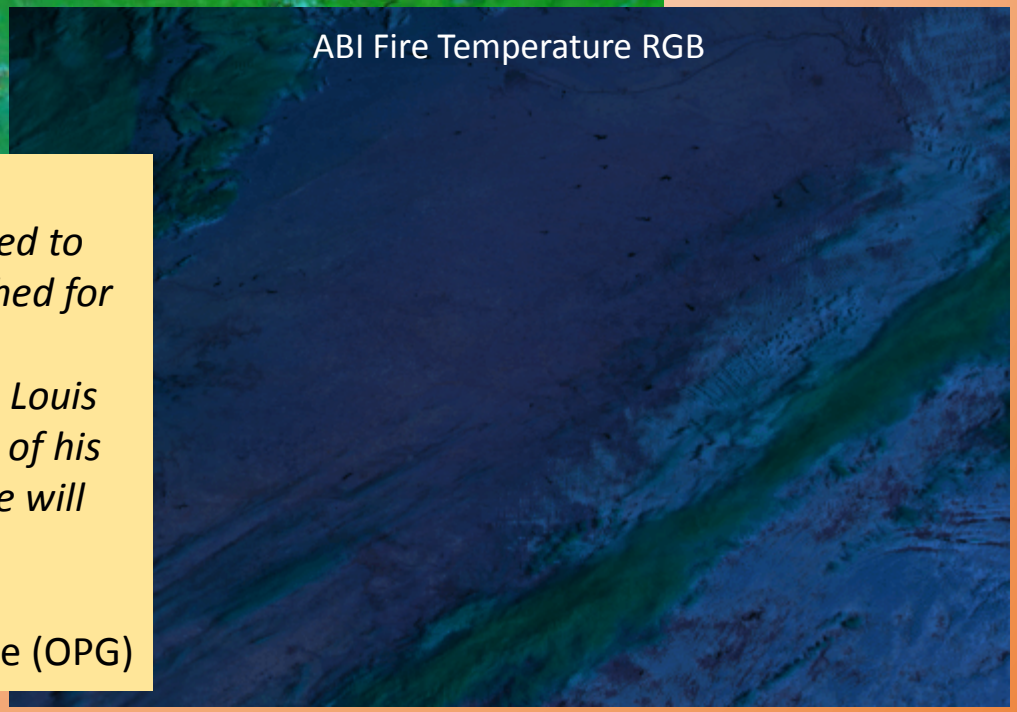
AFS has traditionally been a bit resistant to using remote sensing data to monitor and map fires, and it seems like your products have made pretty big in roads in a very short time.

Jay Cable (GINA)

Comparing Landsat with VIIRS for the Ammerman Creek Fire (2017/07/08)

Fire RGBs in AWIPS





VIIRS Fire RGBs now sent from GINA to Alaska Region WFOs through the AWIPS LDM

Now a standard RGB for ABI in AWIPS:

This Fire Temperature RGB needs to be added to the list. It's a simple RGB, has been researched for a while, and is far superior to the other fire detection/monitoring RGBs. On top of that, Louis (Uccellini) is going to be showing it in a few of his upcoming high-profile presentations that he will be giving. Including one to the Senate Appropriations Committee.

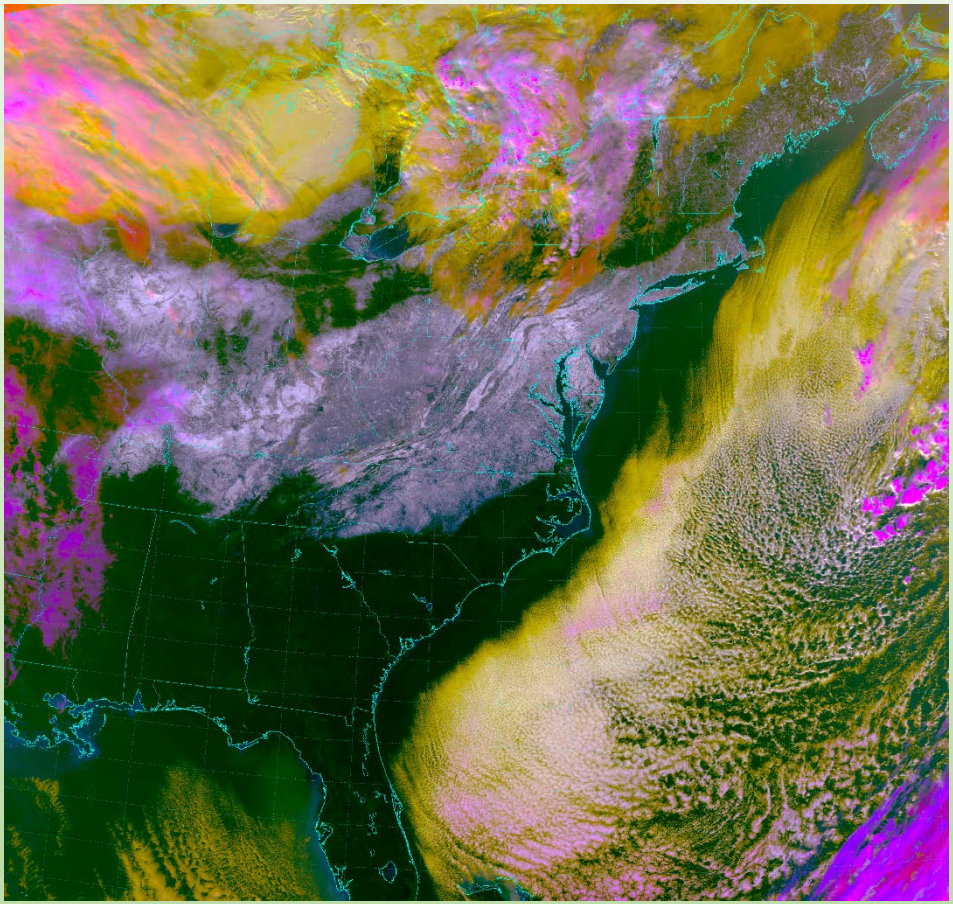
Chad Gravelle (OPG)

NASA SPoRT has agreed to send the Fire Temperature RGB to non-AWIPS users!

The Snow/Cloud Discriminator

The Great Blizzard of ‘16

- Can you tell what is cloud and what is snow in the True Color RGB (M-3, M-4, M-5)?
- EUMETSAT Natural Color RGB (M-5, M-7, M-10) discriminates low clouds from snow and ice
- Variation of EUMETSAT Snow RGB (M-11, M-10, M-7) highlights snow in pink/red
- Snow RGB from Météo France produced upon request from UK Met Office (M-7 through M-11)
- CIRA’s Snow/Cloud Discriminator (uses up to 11 bands) keeps snow white and highlights low, mid and high clouds

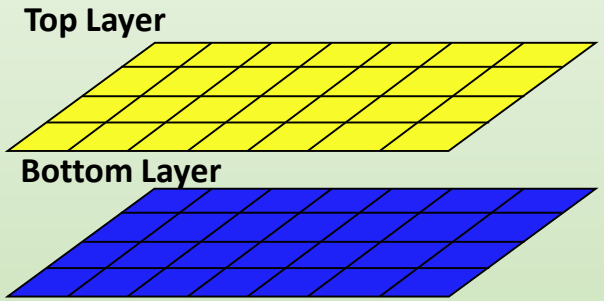


18:12 UTC 24 January 2016

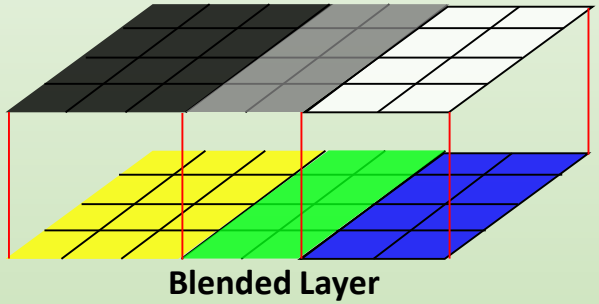
CIRA
Connecting Models and Observations

Multilayer Blending: A Novel RGB Concept

Layers of Information (2 layer example)



Spatial Opacity Rules for Top Layer (Black= Opaque, White=Transparent)

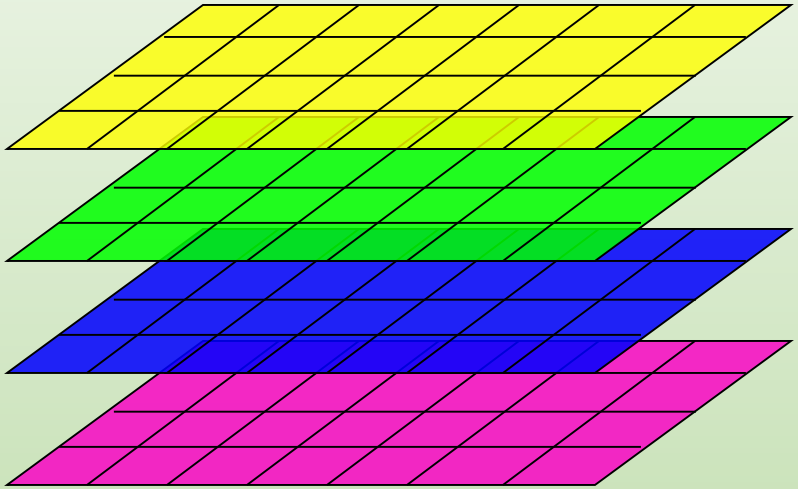


- Each layer of information is assigned a 2D transparency field (defined at every pixel location).
- A separate blend can be done for each color gun (R/G/B), achieving realistic ‘color bleed-through’ effects.
- Allows for the simultaneous display of multiple semi-transparent layers and blending in both the horizontal and vertical dimensions.

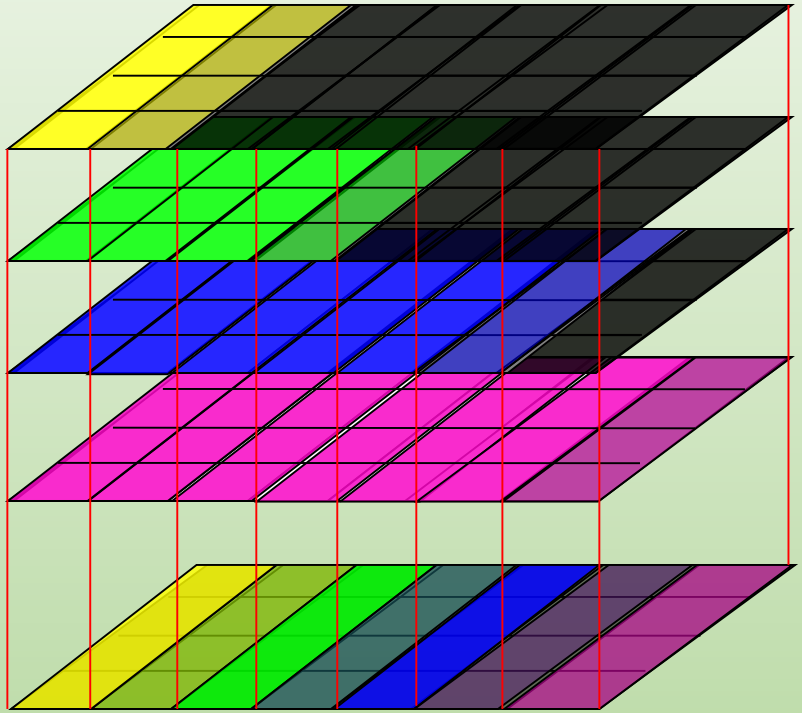
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As many layers as you wish…

Layers of Information



Spatial Opacity Rules



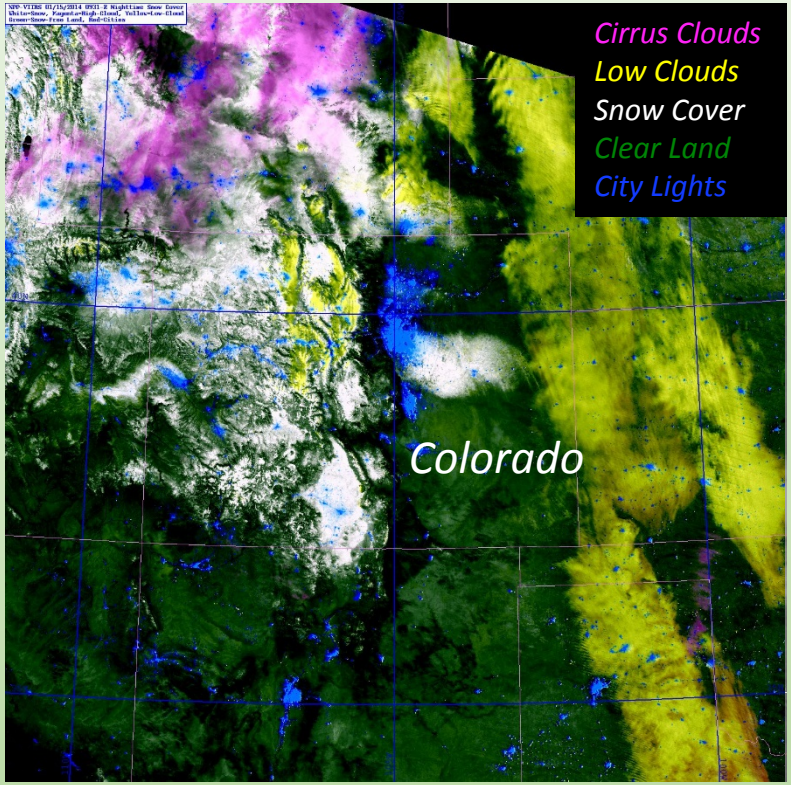
Blending is done in both the vertical and horizontal dimensions of the image

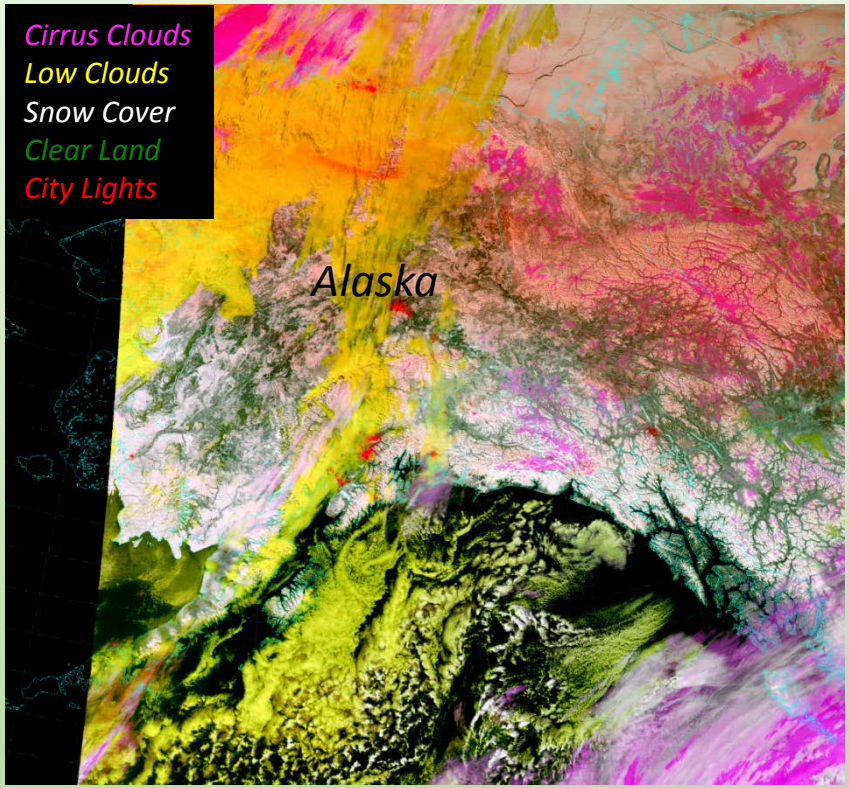
$$C = (N_1 + (1.0 - N_1)(N_2 + (1.0 - N_2)[...(N_{M-1} + (1.0 - N_{M-1})N_M))))]$$

"N-Dimensional Blending" allows for the *dynamic blending of multiple information layers*

CIRA
Connecting Models and Observations

The Snow/Cloud Discriminator



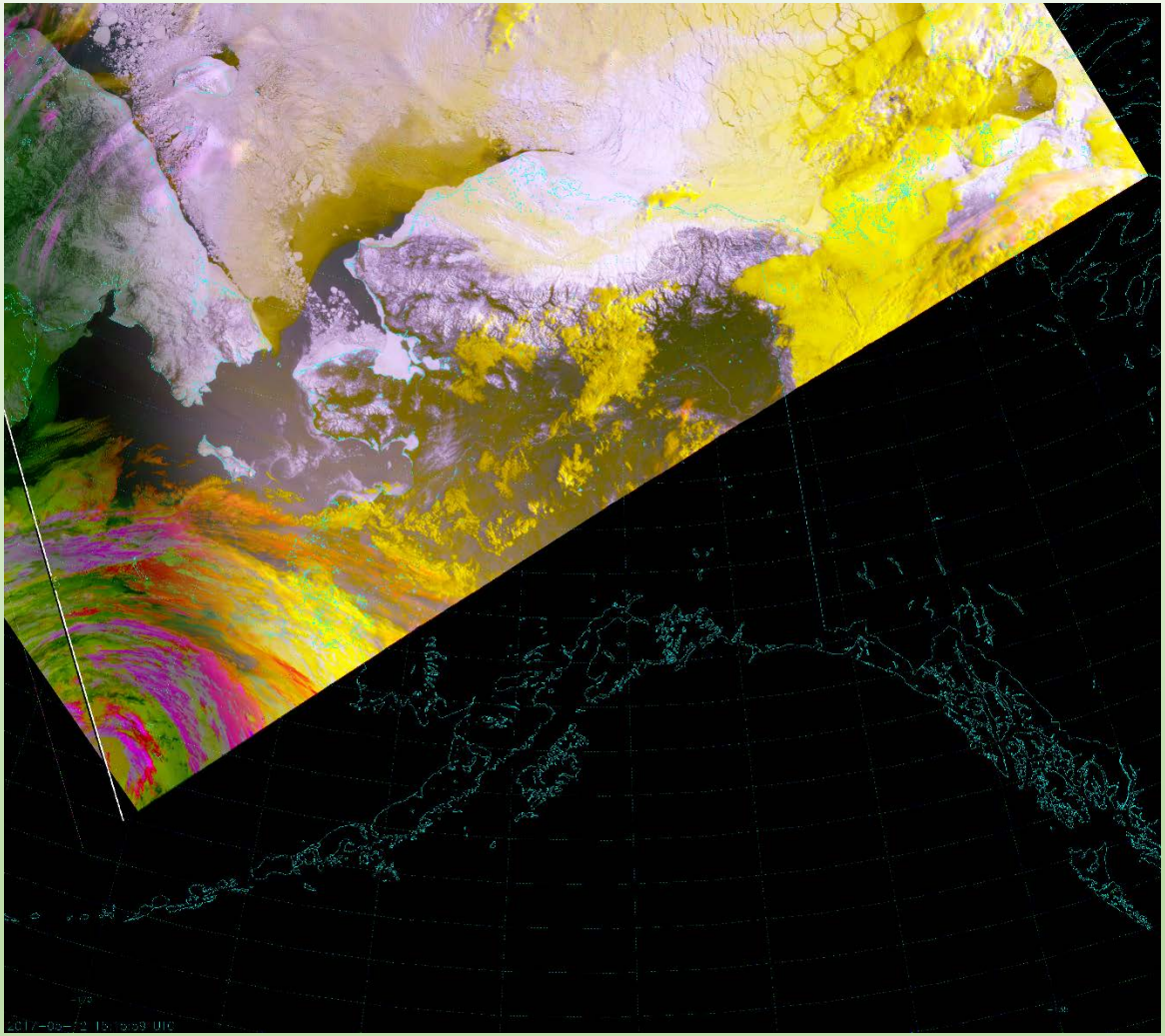


→ Blends information from 11 different VIIRS bands, plus NCEI Nighttime Lights dataset (C. Elvidge) to discriminate snow from clouds

→ First snow detection RGB that works at night!

CIRA
Connecting Models and Observations

On the Path to Operations



- → Now produced in real time at GINA using CIRA code
- → GeoTIFFs available
- → Soon to be added to GINA's Puffin Feeder
- → AWIPS to follow through GINA LDM feed
- → To be completed before Arctic Initiative extensive evaluation period (Spring 2018)

CIRA Connecting Models and Observations

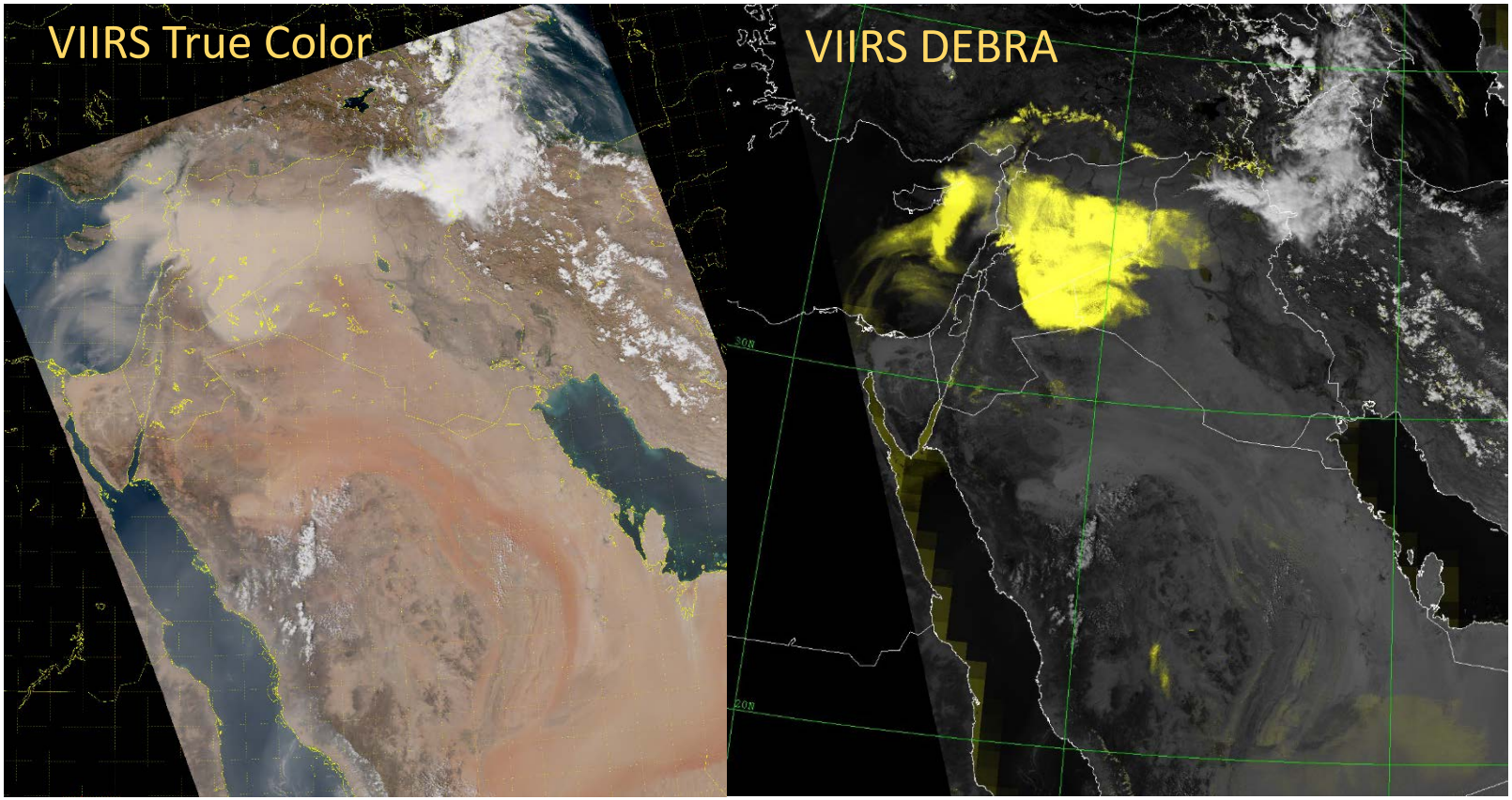
GINA www.gina.alaska.edu

Summary

- → Partnerships between CIRA, GINA, CIMSS, NRL and NASA SPoRT have brought improved VIIRS imagery products to forecasters
- → AWIPS/NAWIPS, GeoTIFF, Puffin Feeder, Nexsat
- → Improved Day/Night Band imagery
- → Fire RGBs
- → Snow/Cloud Discriminator (almost in ops!)
- → We continue to collaborate on training materials with the Satellite Liaisons and SPoRT

Other Products

DEBRA Dust



Syrian Dust Storm (7 September 2015)

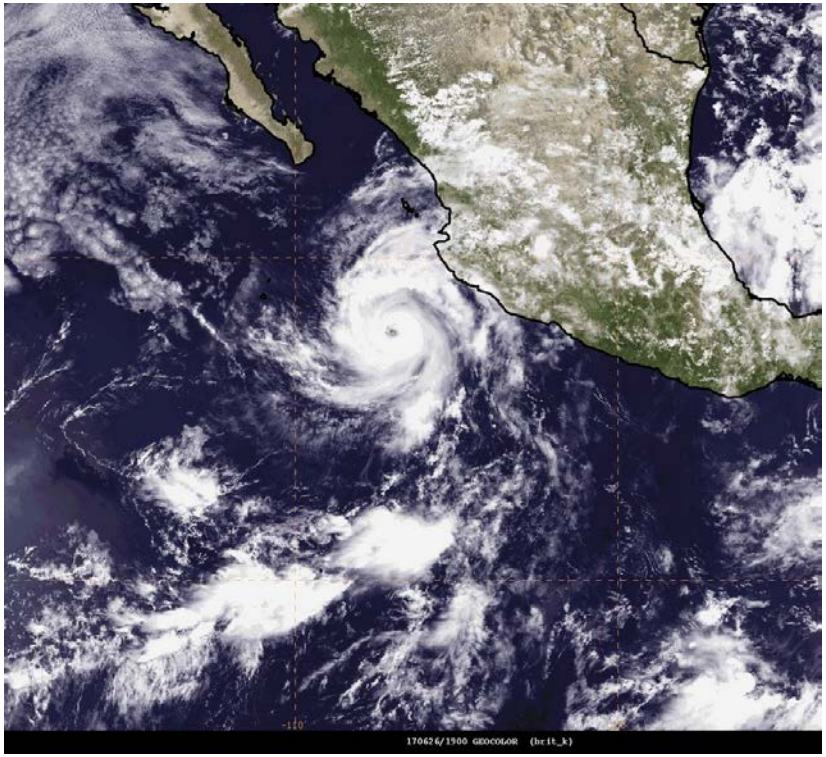
→ Dynamic Enhanced Background Reduction Algorithm (DEBRA) uses the multi-layer blended RGB concept to highlight dust in yellow according to confidence

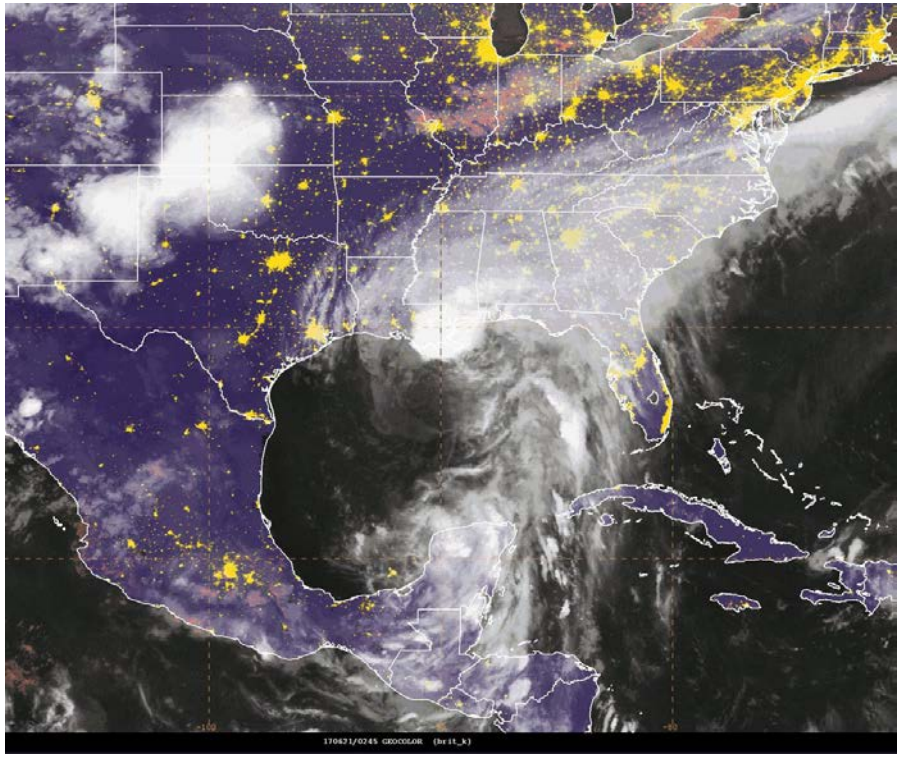
→ Used operationally by the US Navy

CIRA Connecting Models and Observations

U.S. NAVAL RESEARCH LABORATORY

Geocolor





- → Blends True Color imagery during the day with a low cloud detection algorithm at night
- → Applied to GOES, GOES-R, Himawari
- → Used heavily by NWS Aviation Weather Center (AWC), Weather Prediction Center (WPC), Ocean Prediction Center (OPC)

- → VIIRS version in the works (request from GINA for Alaska WFOs)

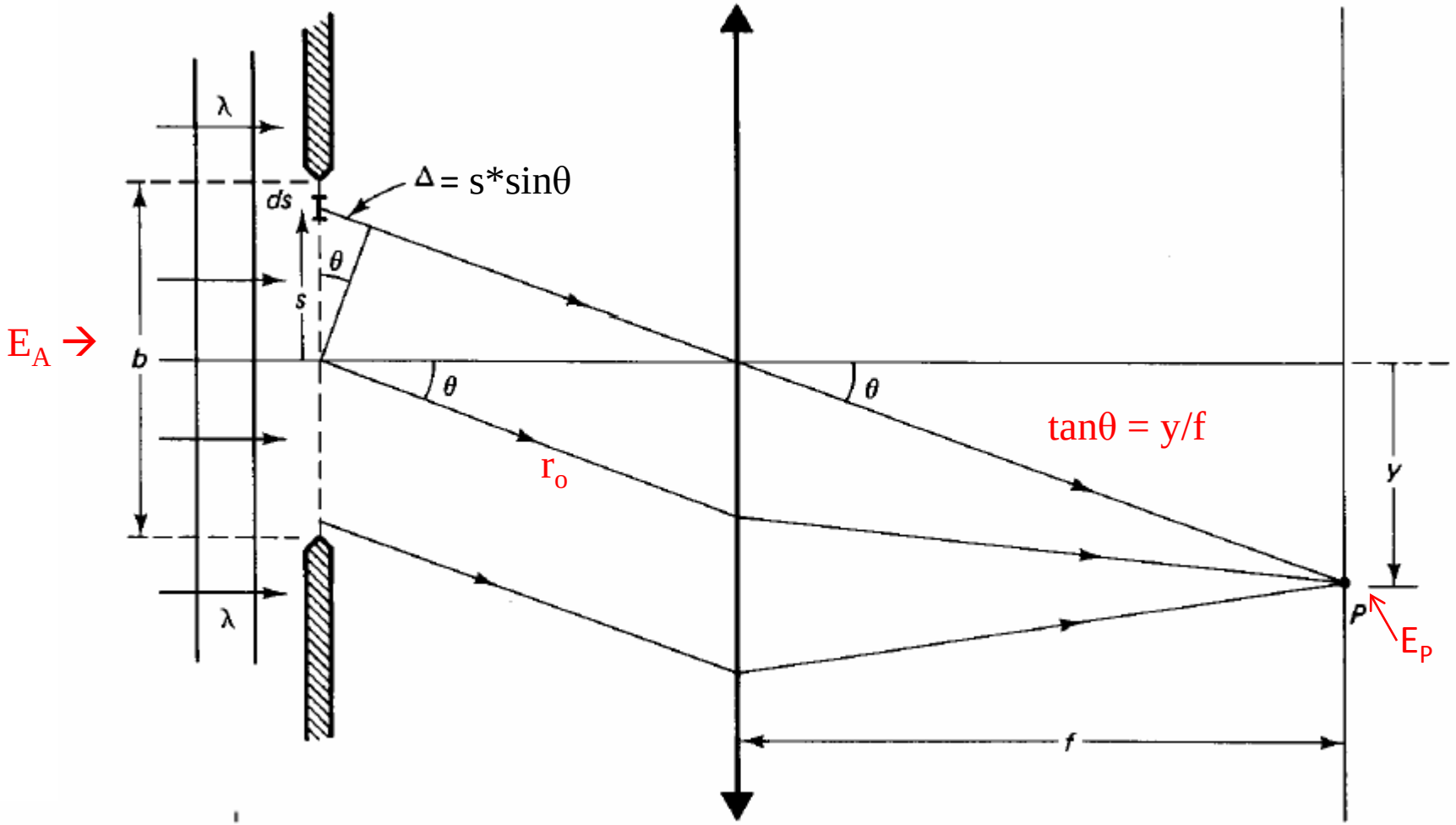
CIRA Connecting Models and Observations

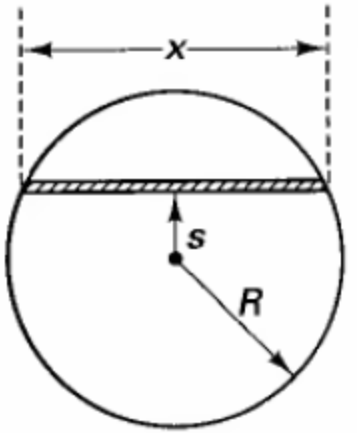
Motion of Diffraction Pattern on VIIRS Detectors

Louie Grasso (CIRA) and Don Hillger (NESDIS)

JPSS Annual Science Meeting

14-18 August 2017





$E_P = (E_A/r_o)*\iint \exp(ik*\Delta)\, dA = (E_A/r_o)*\iint \exp(ik*(s*\sin\theta))\, dA$

$dA = xds = 2*\mathrm{sqrt}(R^2 - s^2)\, ds$

Let $v = s/R$, $\gamma = kR\sin\theta$, then

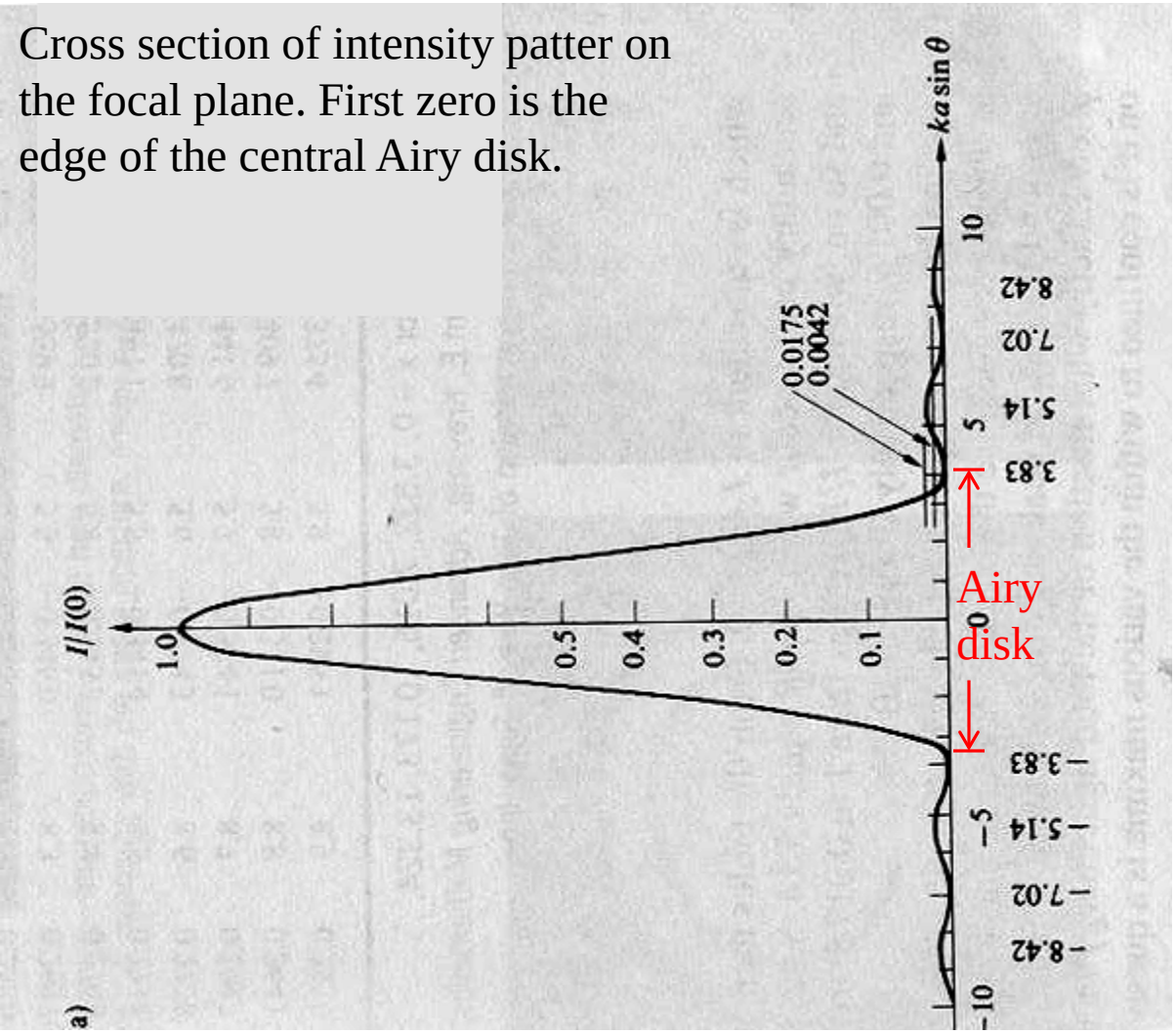
$E_P = 2E_A R^2/r_o \int_{-1}^{1} \exp(i\gamma v)*\mathrm{sqrt}(1-v^2)\, dv$

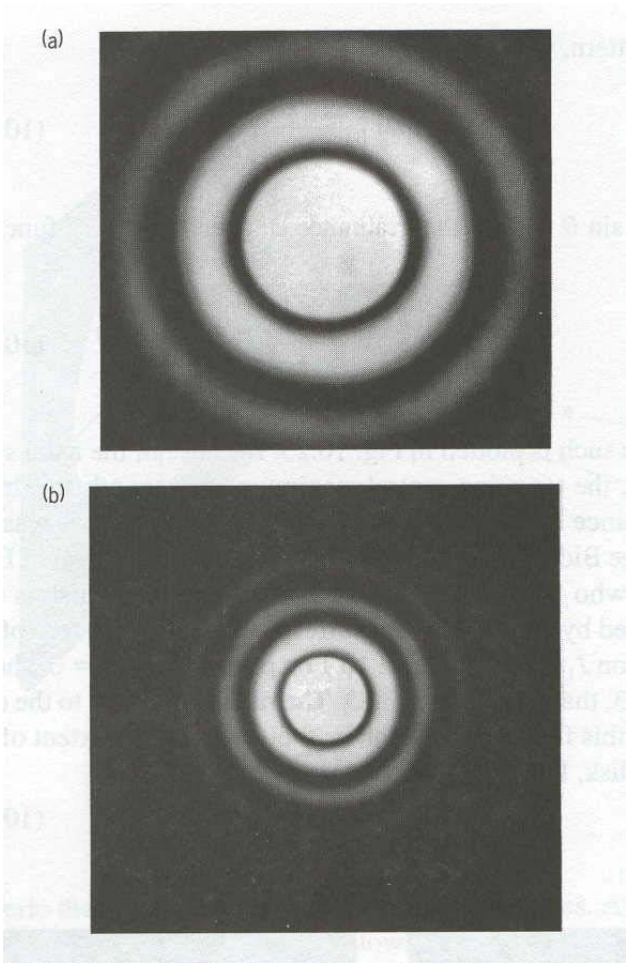
$= 2E_A R^2/r_o\, (\pi J_1(\gamma)/\gamma)$, thus

$I(\theta) = I(0) * (2J_1(\gamma)/\gamma)^{**}2.0$

Plan view of intensity pattern. Inner most dark circle bounds the interior bright Airy disk.

Cross section of intensity patter on the focal plane. First zero is the edge of the central Airy disk.





```
!
dx = 50.0 ! Meters
distance = dx*sqrt(  dfloat((i-1)-(center-1))**2.0  + dfloat((j-1)-(center-1))**2.0 )
!
!*** From slide 2 we have the following:
!
theta = atan(distance/h) (On Earth). theta=atan(y/f) (On focal plane)
sin_theta = sin(theta)
γ=kRsinθ = 2π/λ * Rsinθ = πd/λ * sinθ  Aside: θ_R ~sinθ_R = γ_1 λ/πd ~ 3.83 λ/πd ~ 1.22 λ/d
!                                       Where θ_R is radius of Airy disk; γ_1 first zero of J1
! *** We'll replace γ with "phase" below.
!
phase = ( (pi*d)/(wavelength) ) * abs(sin_theta)
call Int_Bessel(m,phase,Y)
J1(i,j) = Y(1)
Intensity(i,j) = ( 2.0*Y(1)/phase )**2.0
```

For calculations: λ = 3.9e-6 (m) (wavelength of incident radiation—*on detector in satellite*)
h = 35786e3 (m) (distance from satellite to the surface of the Earth)
d = 0.3048 (m) (12 inch aperture of telescope)
dx = 50.0 (m) (length—*on the surface of the Earth*)

Diffraction patterns for GOES-16 ABI

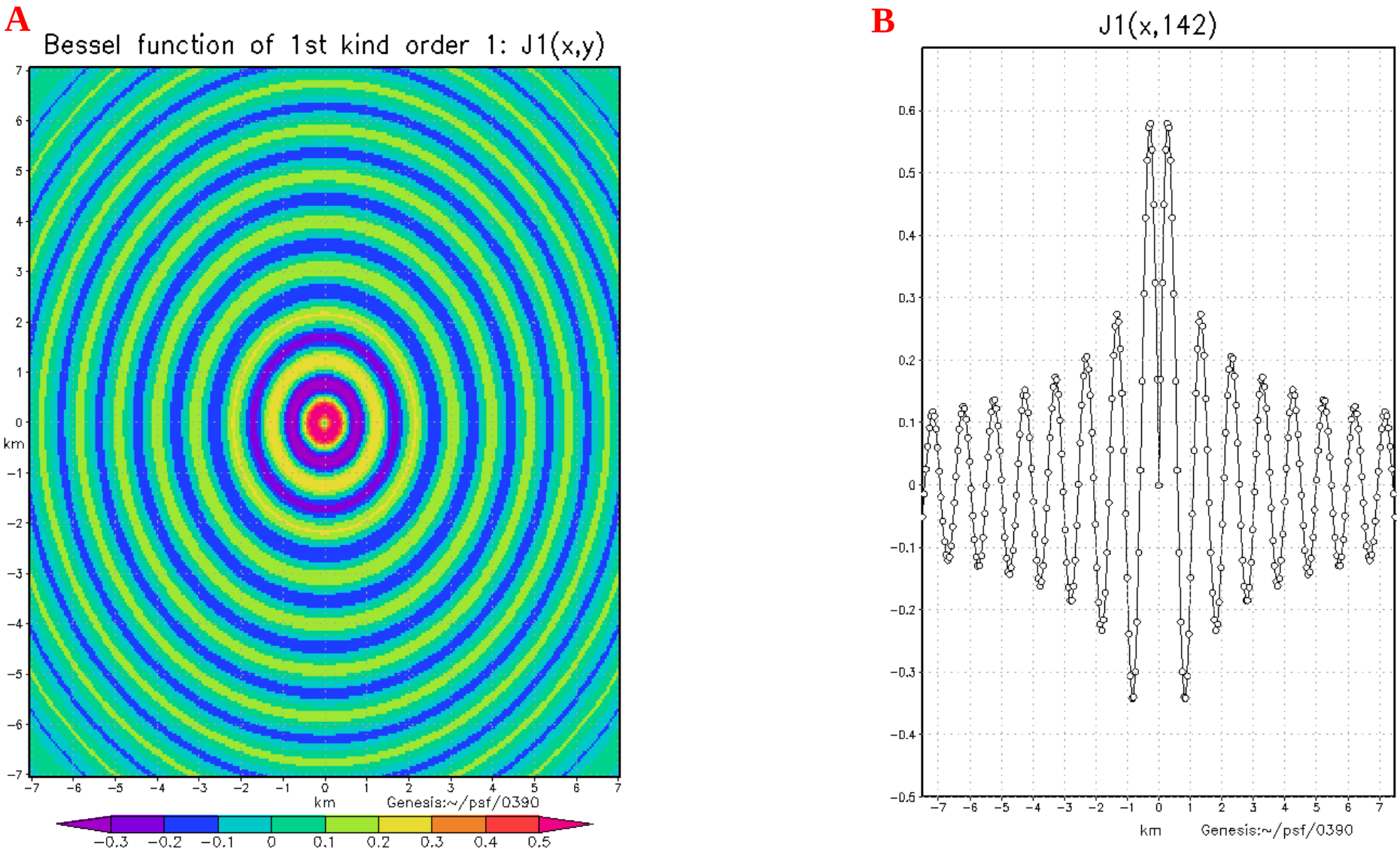
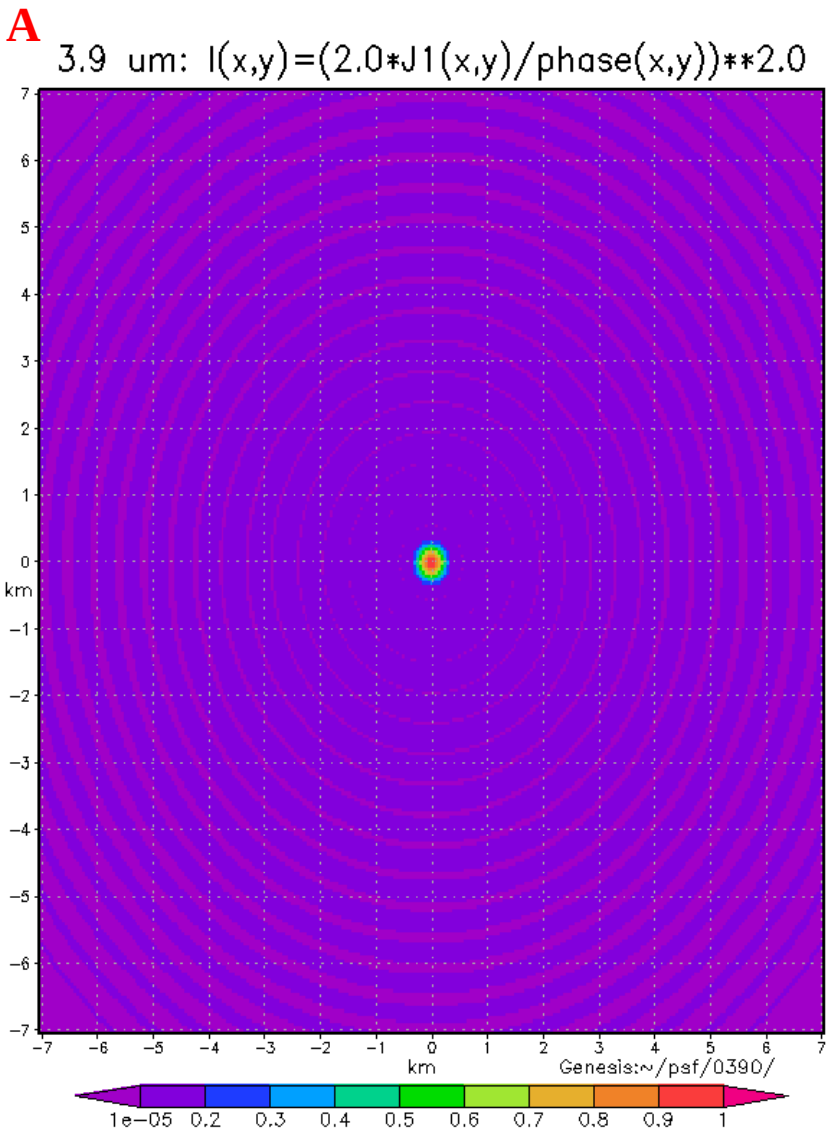


Figure 1: Plots of the Bessel function of the first kind, order 1, J1 in (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in km.



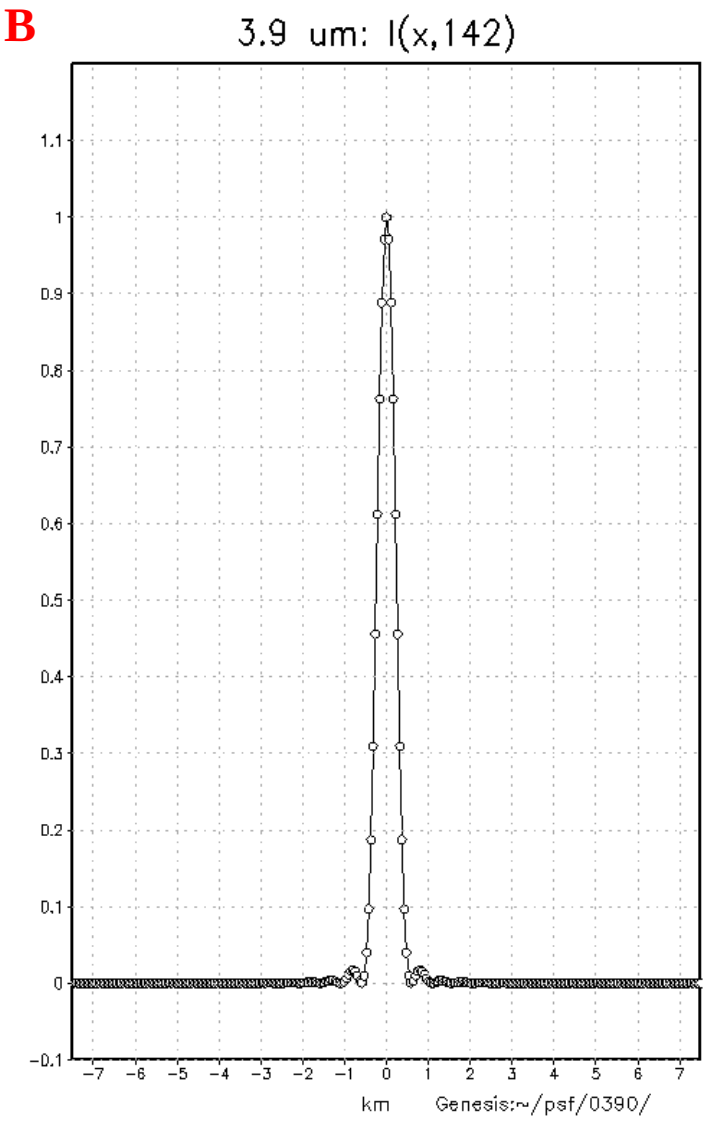


Figure 2: Plots of $I(\theta) = I(0) * (2J_1 (\gamma)/ \gamma)^{**}2.0$, where $\gamma = kR\sin\theta$ and $I(0)=1.0$ projected on the surface of the Earth, in (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in km. These plots would show the diffraction pattern on detectors in a satellite by replacing h with f. I think the x-axis would be on the order of the wavelength of the incident radiation: ~ 1.0e-6 m. See slide 4.

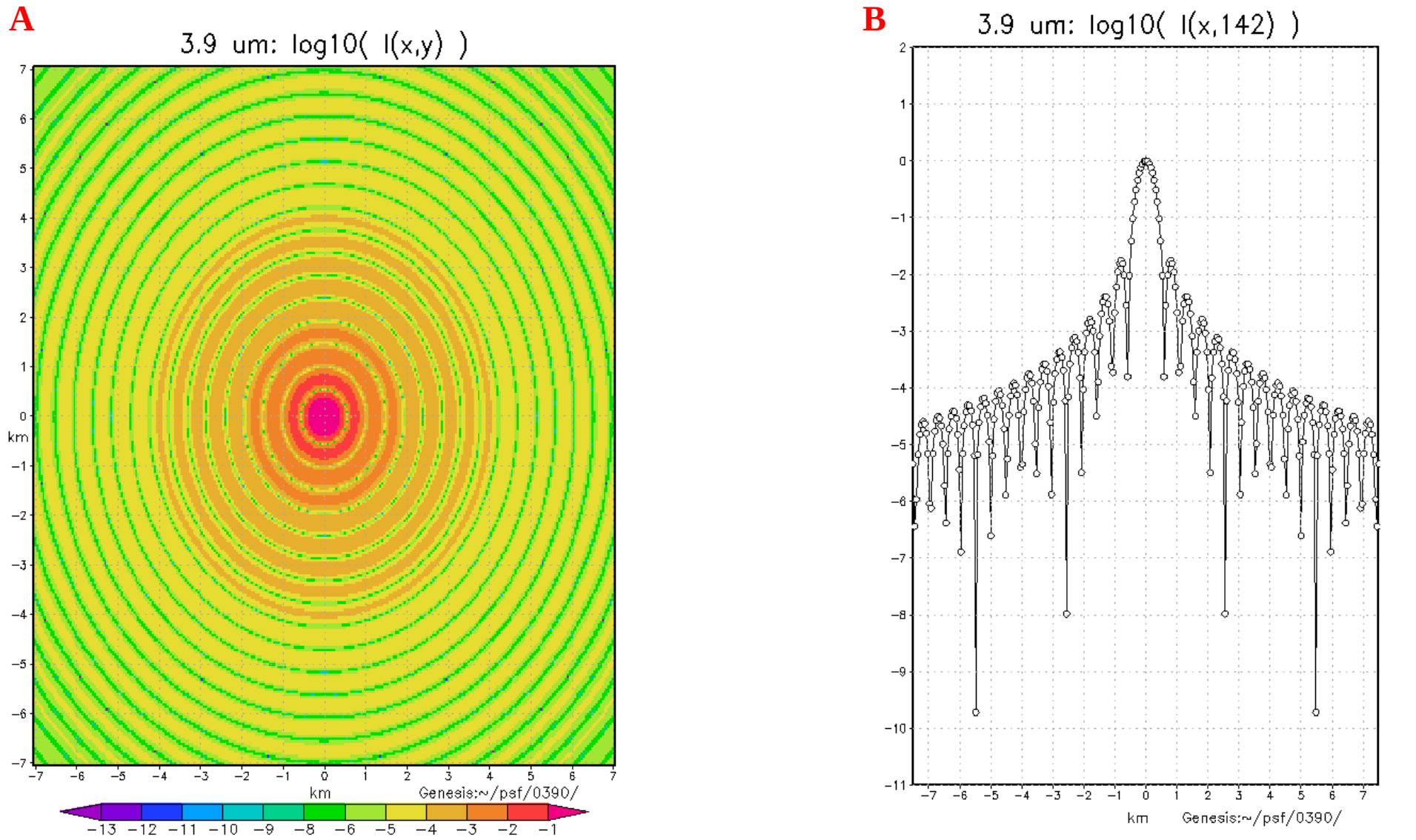
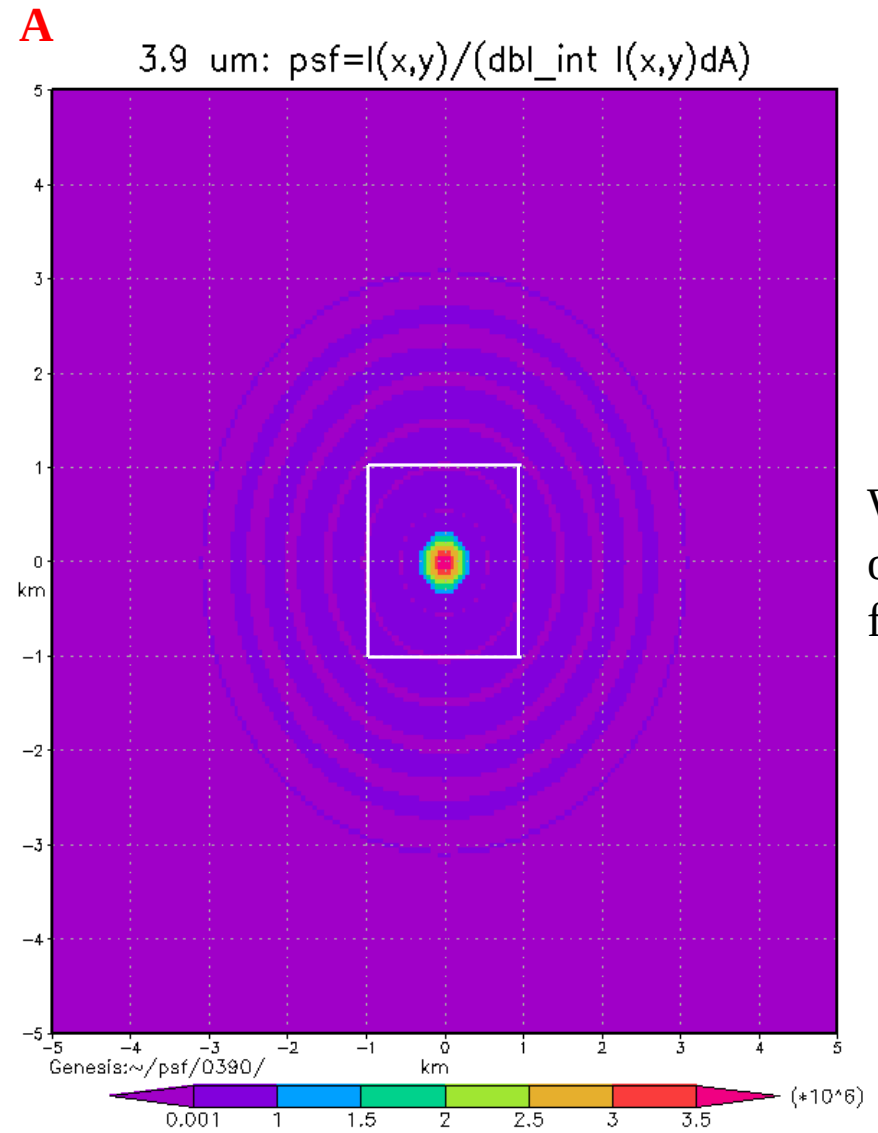


Figure 3: Plots of log_10(I(θ)) (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in km. Downward "spikes" in (B) represent undefined values of log10(I(x,y)=0).



White box is one footprint for GOES-16

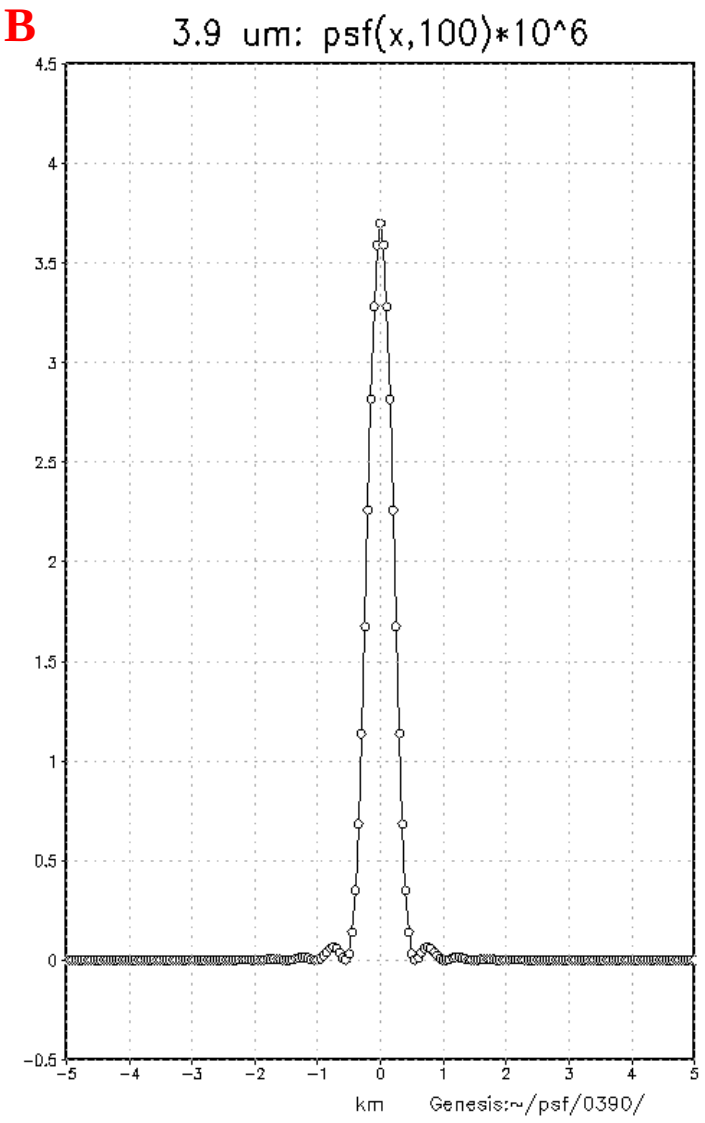
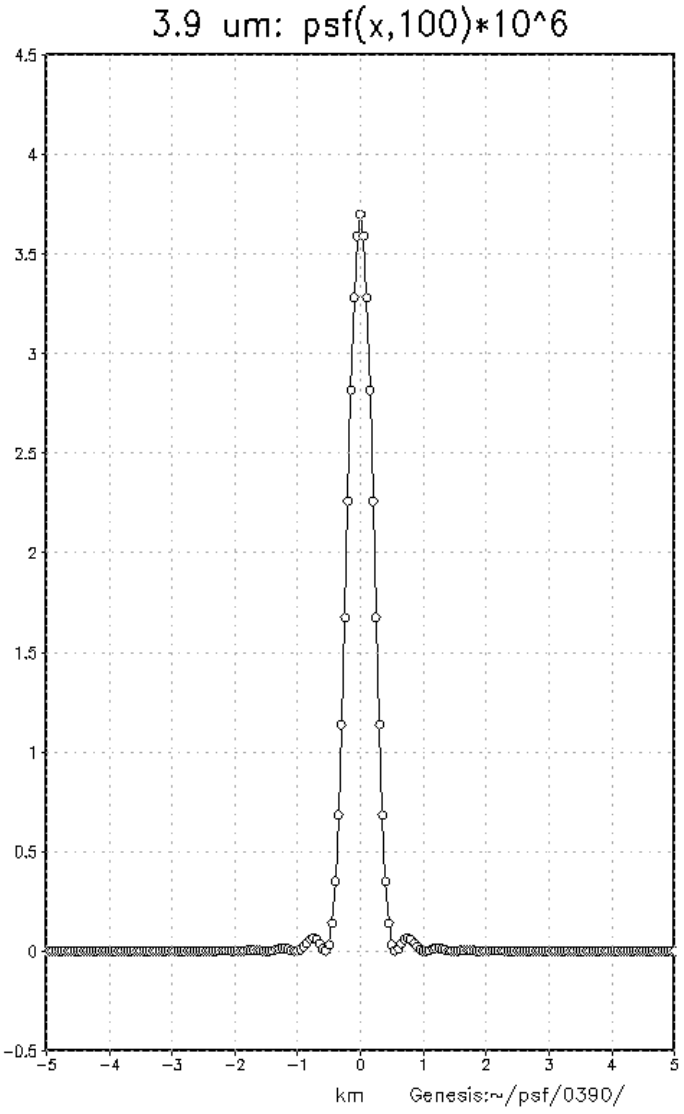


Figure 4: Plots of PSF (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in km. Red box in (A) is one GOES-16 footprint. These plots show PSF(x,y) on the surface of the Earth. Note: PSF(x,y) here (Zhang et al. 2006) excludes the Δt measurement of energy during satellite scanning. Zhang et al. Impact of PSF on Infrared Radiances from Geostationary Satellites, IEEE Trans.Geosci. Remote Sens., vol. 44, no. 8, August 2006

A



B

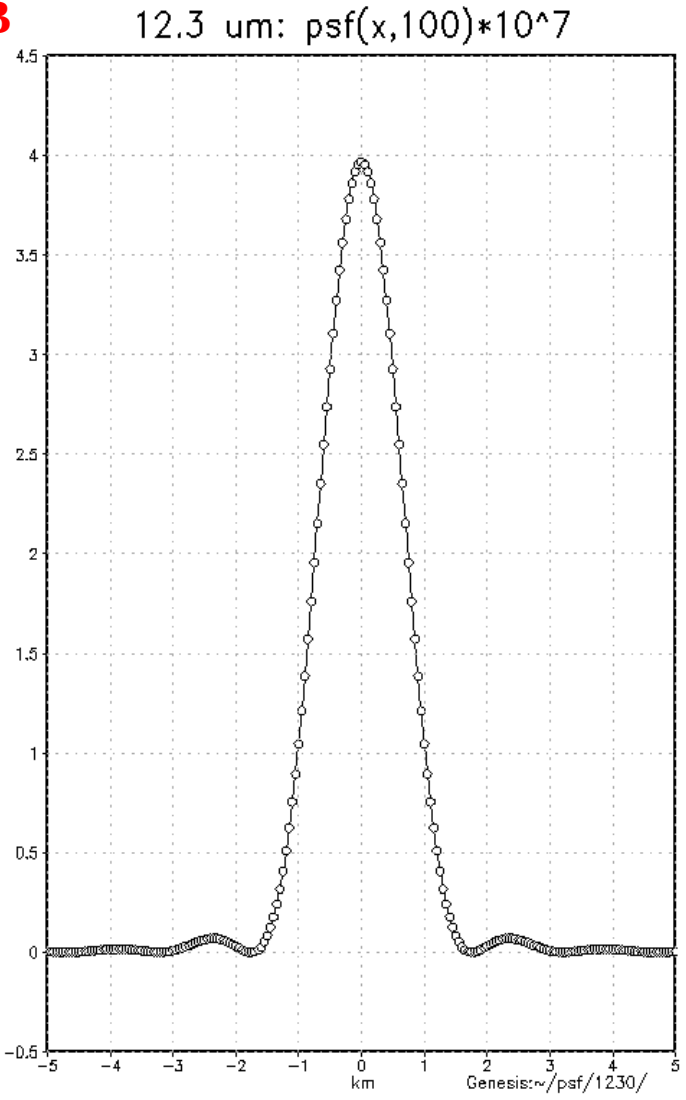


Figure 5: A comparison of PSFs at 3.9 µm and 12.3 µm. From slide 4: $\sin\theta = \lambda\gamma/\pi d$. Thus, the width of the Airy disk is proportional to wavelength. This is why the Airy disk at 12.3 µm is larger than that at 3.9 µm. Note the Airy disk is larger than the ABI 2 km footprint. Alternately, the intensity at 3.9 µm/12.3 µm is concentrated/spread out on a focal plane of a satellite.

Diffraction patterns for VIIRS M12 (3.7µm)

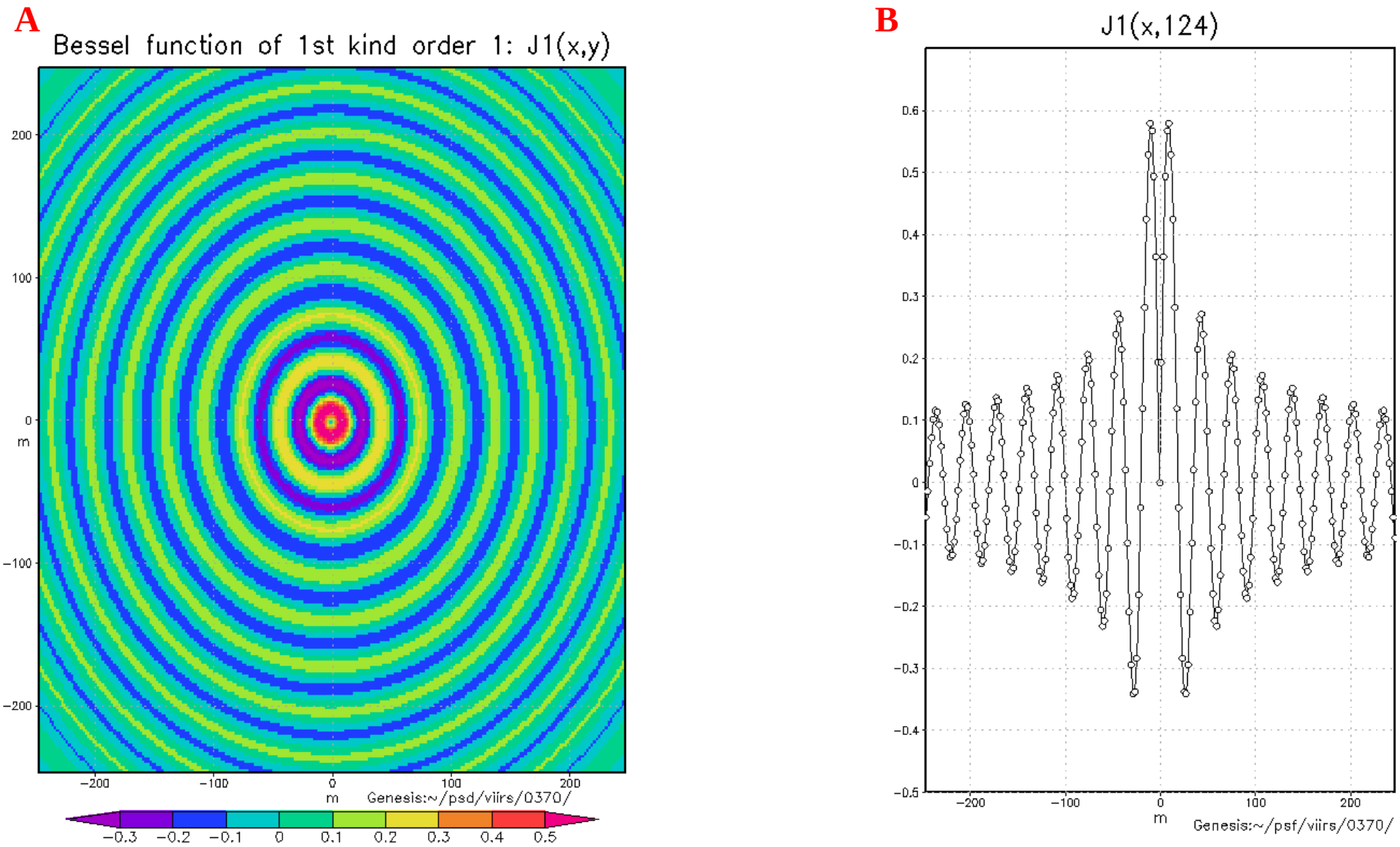


Figure 6: Plots of the Bessel function of the first kind, order 1, J1 in (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in meters for VIIRS M-Bands: *Footprint~750 m*.

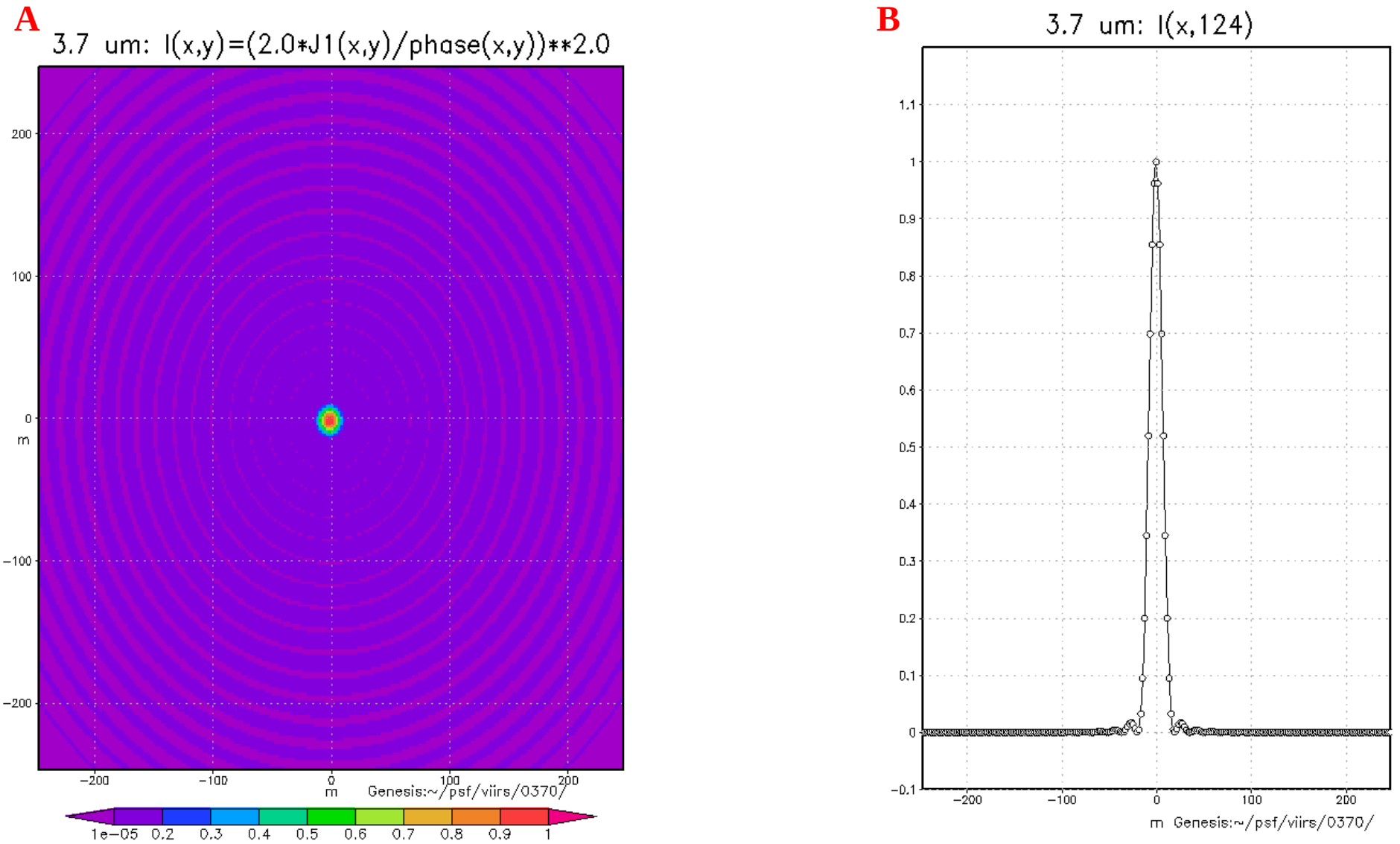
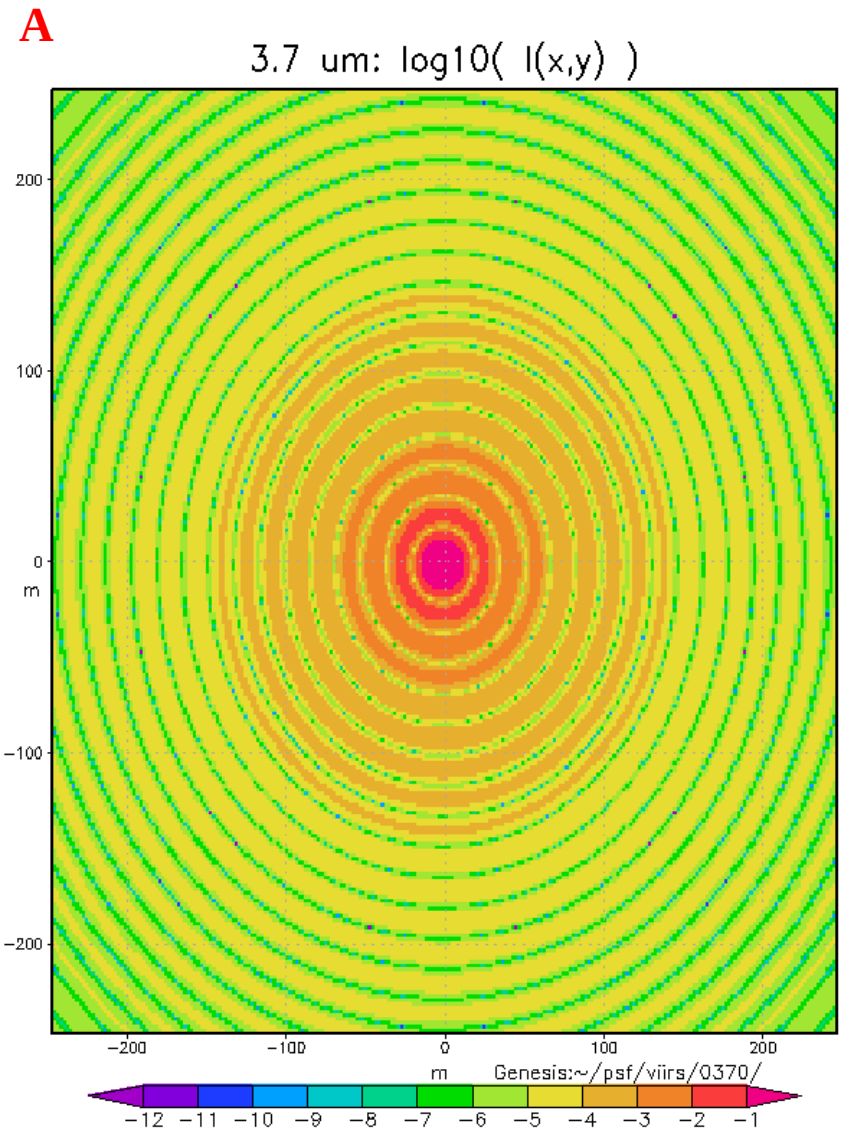


Figure 7: Plots of $I(\theta) = I(0) * (2J_1 (\gamma)/ \gamma)^{**}2.0$, where $\gamma = kR\sin\theta$ and $I(0)=1.0$ projected on the surface of the Earth, in (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in meters for VIIRS M-Bands: *Footprint~750 m*.



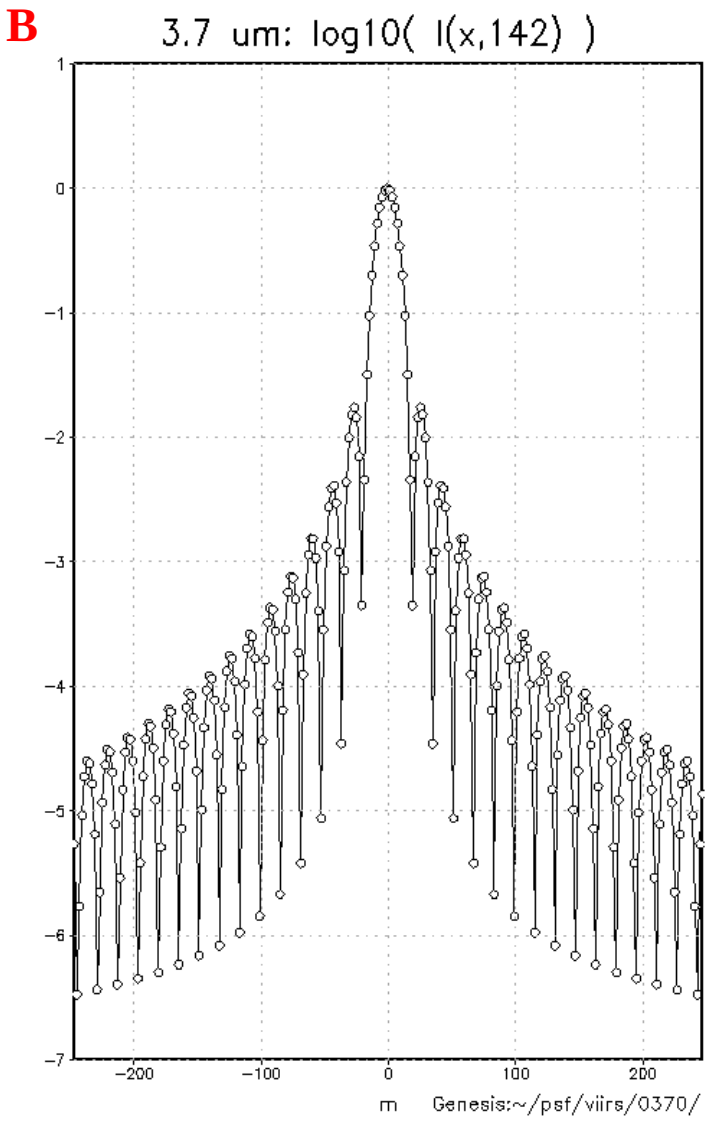
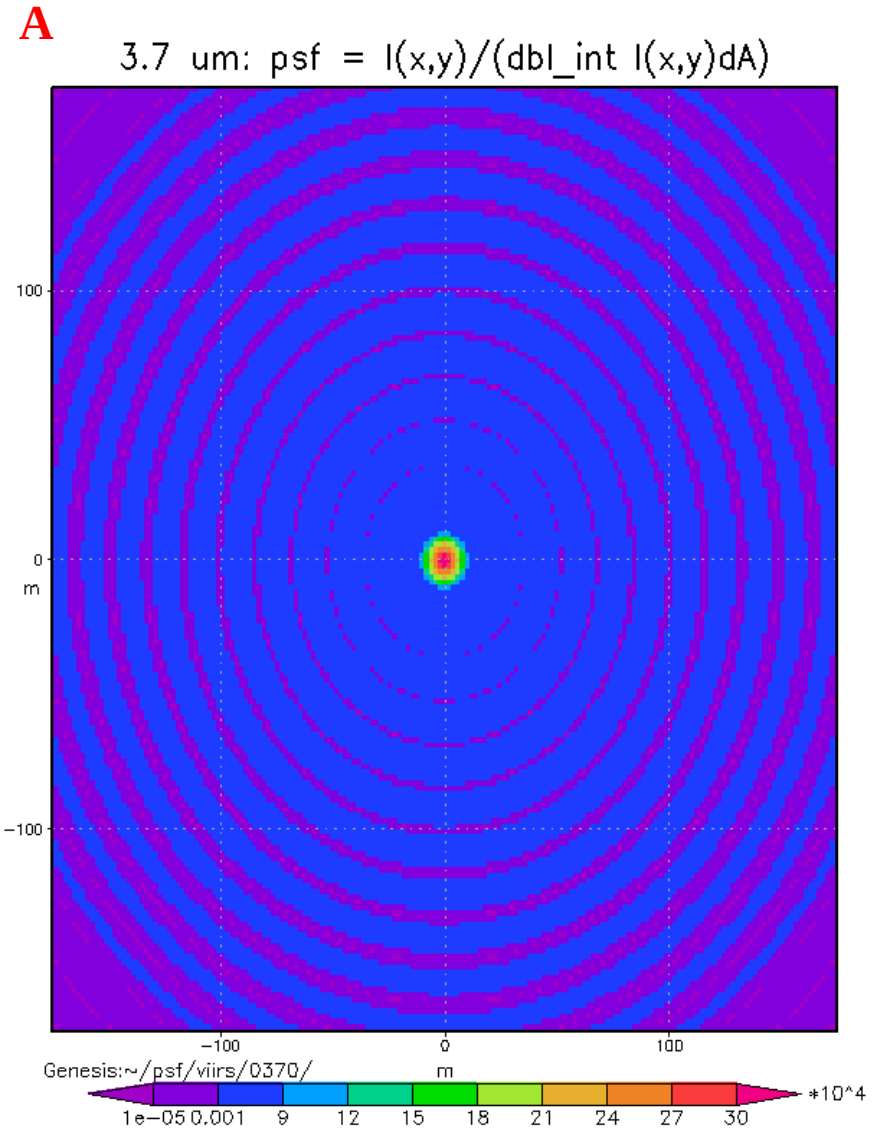


Figure 8: Plots of log_10(I(θ)) (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in meters for VIIRS M-Bands: *Footprint~750 m*. Downward "spikes" in (B) represent undefined values of log10(I(x,y)= 0).



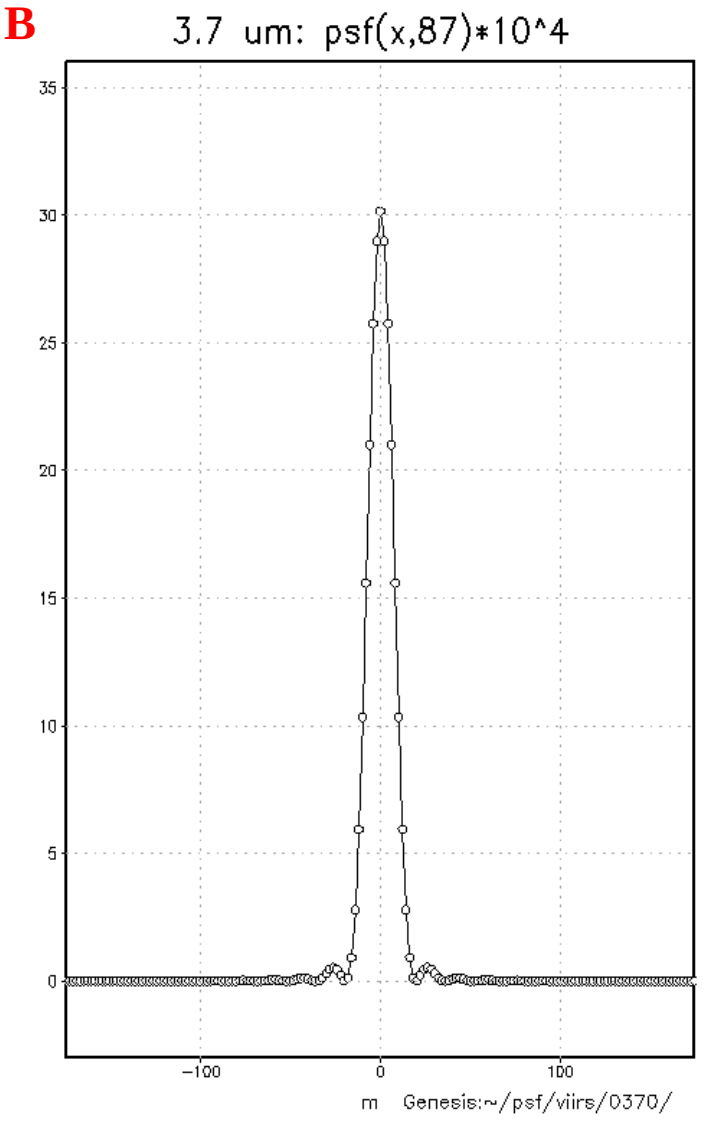


Figure 9: Plots of PSF (A) two dimensions and (B) one dimension. Both the x-axis and y-axis are in meters for VIIRS M-Bands: *Footprint~750 m*. These plots show PSF(x,y) on the surface of the Earth. Note: PSF(x,y) here (Zhang et al. 2006) excludes the Δt measurement of energy during satellite scanning. Zhang et al. Impact of PSF on Infrared Radiances from Geostationary Satellites, IEEE Trans.Geosci. Remote Sens., vol. 44, no. 8, August 2006

From slide 7, Fig.2 caption, we have $\gamma = kR\sin\theta = (\pi D/\lambda)*\sin\theta$. Solve for $\sin\theta$ yields, $\sin\theta = \gamma\lambda/\pi D$. Using the small angle approximation, $\sin\theta \sim \theta$. We now have $\theta = \gamma\lambda/\pi D$. From the figure on slide 2, $\theta = d/h$. Since $\theta = \theta$, we have $d/h = \gamma\lambda/\pi D$. Solving for d we get

$d = \gamma\lambda h/\pi D$.

γ=3.832 gives the first zero of J1(γ).
λ=3.9e-6 m (ABI), =3.7e-6 m (VIIRS M-Band) is the wavelength of incident radiation.
h=3.5786e7 m (ABI), = 8.24e5 m (VIIRS) is the height of sensor above the surface of the Earth.
π is very irrational.
D=3.048e-1 m (ABI), = 1.91e-1 m (VIIRS) is the aperture diameter.
d=558 m (ABI), = 19.47 m (VIIRS M-Band) is the radius of the Airy disk.

*****NOTE*****

The ***diameter*** of an Airy disk to an ABI footprint is (2*558/2000)*100.0 = 55.8 %.
The ***diameter*** of an Airy disk to an M-Band footprint is (2*19.47/750)*100.0 = 5.18 %.

VIIRS has a focal length of f=1.14 m. We can use similar triangles (Slide 2) to get, d(detector)=(1.14*19.47)/824000 = 0.27 µm. Thus the angular measure of the detector would be θ = d(detector)/f = 0.27 µm/1.14m ~ 0.24 µrad. We can also compute θ = d/h =19.47m/82400m ~ 0.24 µrad.

Thus, detector radius=0.27 µm or θ(half width)=0.24 µrad for VIIRS: Can anyone confirm this result?

My Thoughts

- A diffraction pattern of the intensity is what the sensors, in the optics of a satellite, measure. When the measurement occurs for a time Δt, a PSF(x,y,t) results for scanning (pick your broom type) sensors.
- Some refer to the PSF as being "on the surface" of the Earth and neglect Δt sampling. For example,

- Zhang et al. Impact of PSF on Infrared Radiances from Geostationary Satellites, IEEE Trans.Geosci. Remote Sens., vol. 44, no. 8, August 2006
- Grandell, J. and R. Stuhlmann, 2007: Limitations to a Geostationary Infrared Sounder due to Diffraction: The Meteosat Third Generation Infrarred Sounder (MTG IRS). J. Atmos. Ocean Tech., vol 24, pp 1740-1749.
- Huang, C, J. R.G. Townshend, S. Liang, S. N.V. Kalluir, and R. S. DeFries, 2002: Impact of sensor's point spread function on land cover characterization: Assessment and deconvolution. Remote Sensing of Environment, vol 80, pp 203-212.

- Fires outside an ABI central footprint may influence the radiance of the central footprint via the PSF(x,y,t). Since the ***diameter*** of the Airy for a VIIRS M-band is so small (5.18%) relative to an M-band footprint, can fires outside a central VIIRS footprint influence the radiance of a central footprint?

Applications

1) Build PSF(x,y,t) for any satellite and any wavelength. Need height of satellite from the surface of the Earth, wavelength of incident light, telescope aperture, satellite image footprint size and dx of PSF. You pick dx.

2) Apply PSF(x,y,t) at ~3.9 μm to fires of, which have a size that is a multiple of dx meters. This application will be used to examine the sensitivity of fire hotspots, "under" the PSF(x,y,t), to build one JPSS footprint. Since the size of the Airy disk is so small relative to one VIIRS M-band footprint (5.18 %, slide 16), can we actually use the "surface of the Earth" PSF(x,y,t) concept? Do we need to know more about how the sensor (detector) works?

3) Ed Hyer (NRL, Monterey) just visited and delivered a presentation in which the above application has already been done by

Schroeder, W., I. Csiszar, L. Giglio, and C. C. Schmidt (2010), On the use of fire radiative power, area, and temperature estimates to characterize biomass burning via moderate to coarse spatial resolution remote sensing data in the Brazilian Amazon, *J. Geophys. Res.*, 115, D21121, doi:10.1029/2009JD013769.

Thank You


That's all Folks!



JPSS Training and Products in AWIPS-II for NWS forecasters

Jorel Torres, Bernie Connell & Steve Miller

CIRA/CSU

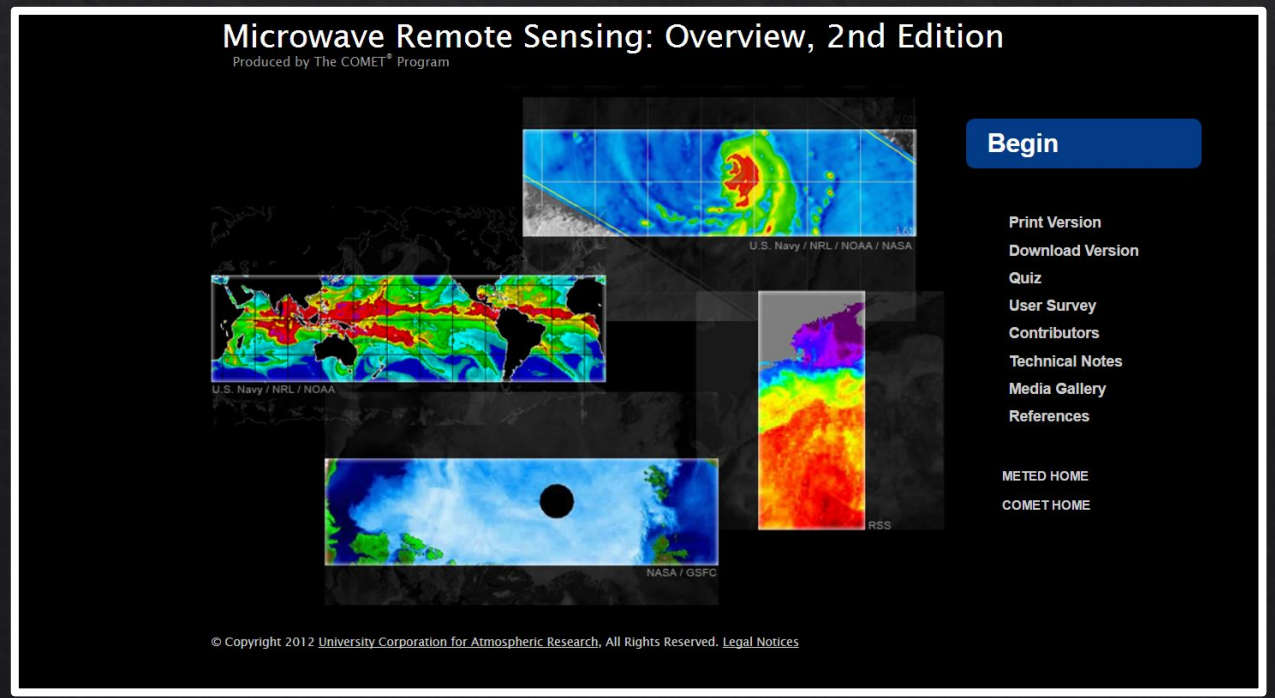
16 August 2017

STAR JPSS 2017 Annual Science Team Meeting



The Need for JPSS Training

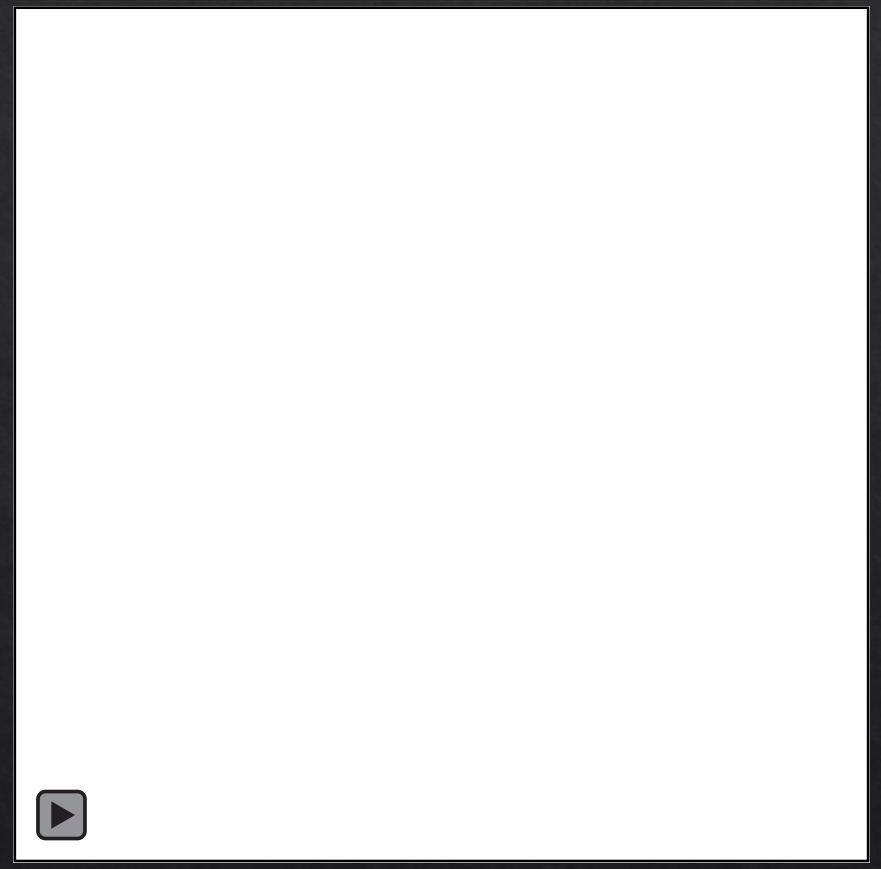
- Suomi-NPP (VIIRS) was launched in October 2011 and JPSS-1 that will be launched in Fall 2017.
- Beneficial for NWS forecasters to utilize satellite data in their forecasts and daily operations. Key for forecasters to understand how JPSS satellite products add observational value to the forecast process.
- Awareness of Existing Training





Key aspects of Polar-orbiting Satellites

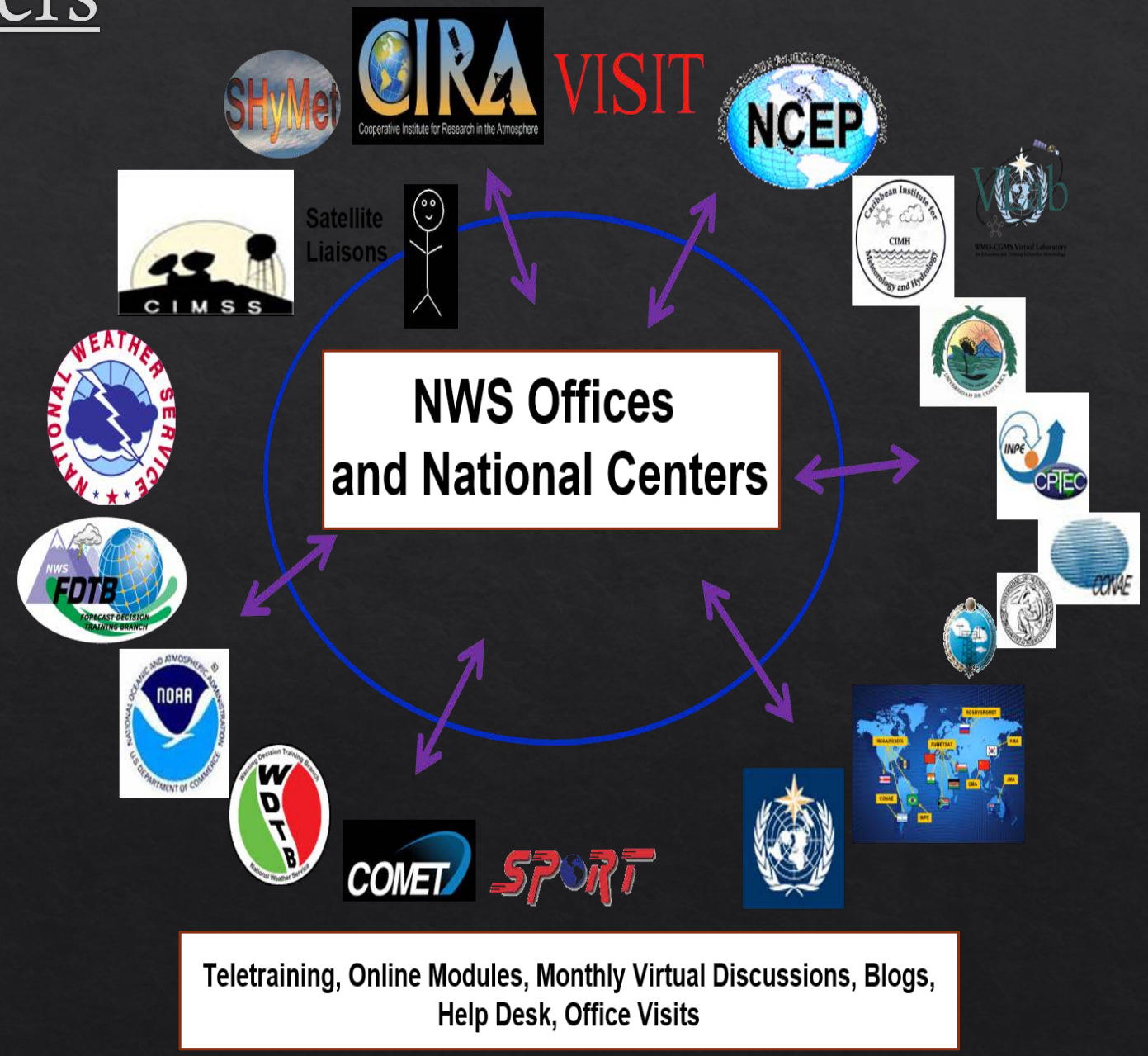
- Also known as Low Earth Orbiting (LEO) satellites
- Sun-synchronous
- Improved weather forecasting via assimilation of observations twice a day into Numerical Weather Prediction (NWP) models
- Provide global coverage over the oceans/remote areas where radar coverage and ground observations are poor and or limited
- Higher spatial and spectral resolution
- Provides observational value in complement to GOES-R



Source: Introduction to VIIRS Imaging and Applications Module (COMET)

Users

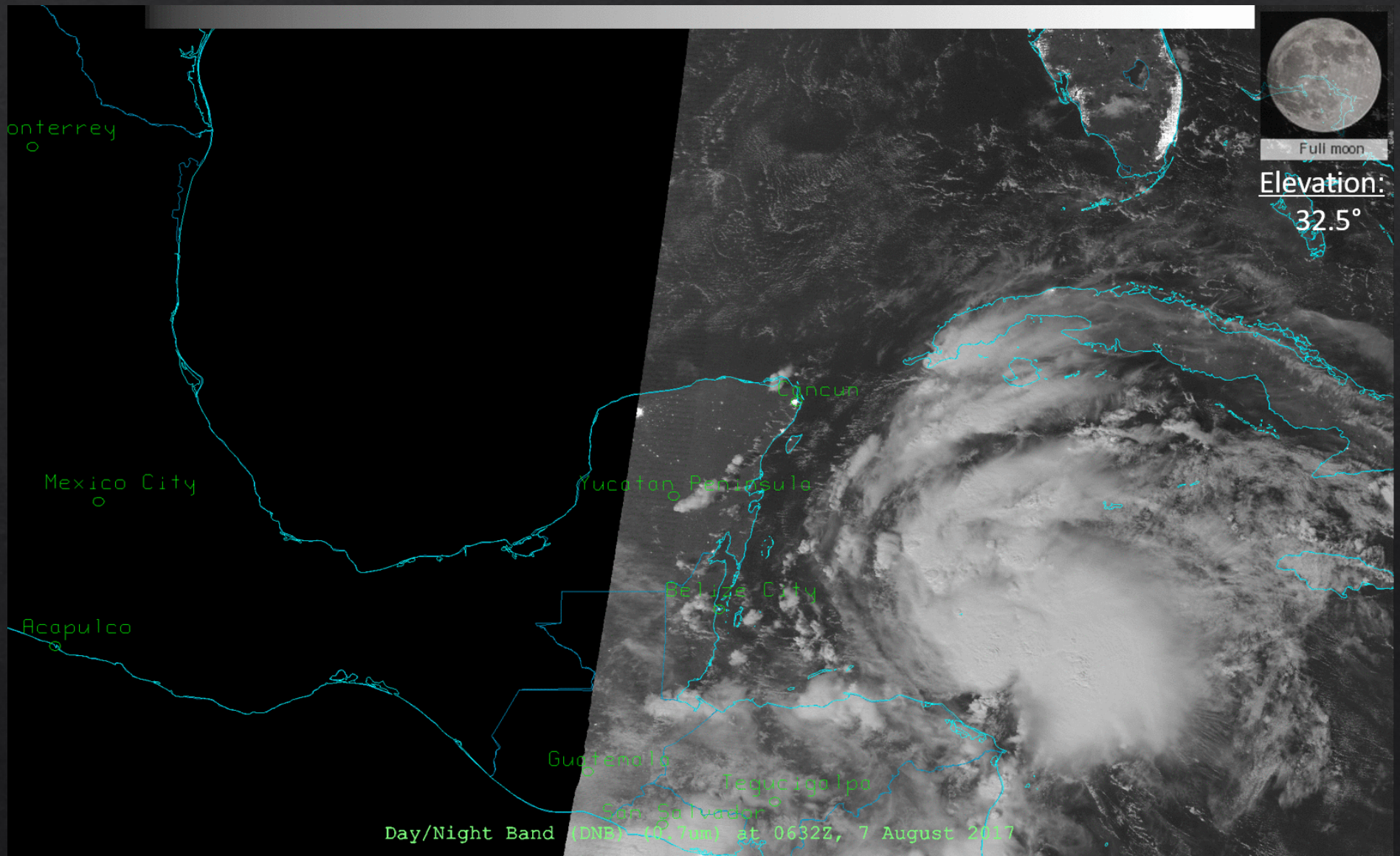
- Who are the primary/targeted users?
  - NOAA and non-NOAA users
- How mature are the user relationships?
  - More established for OCONUS
  - CONUS less established



Training Examples

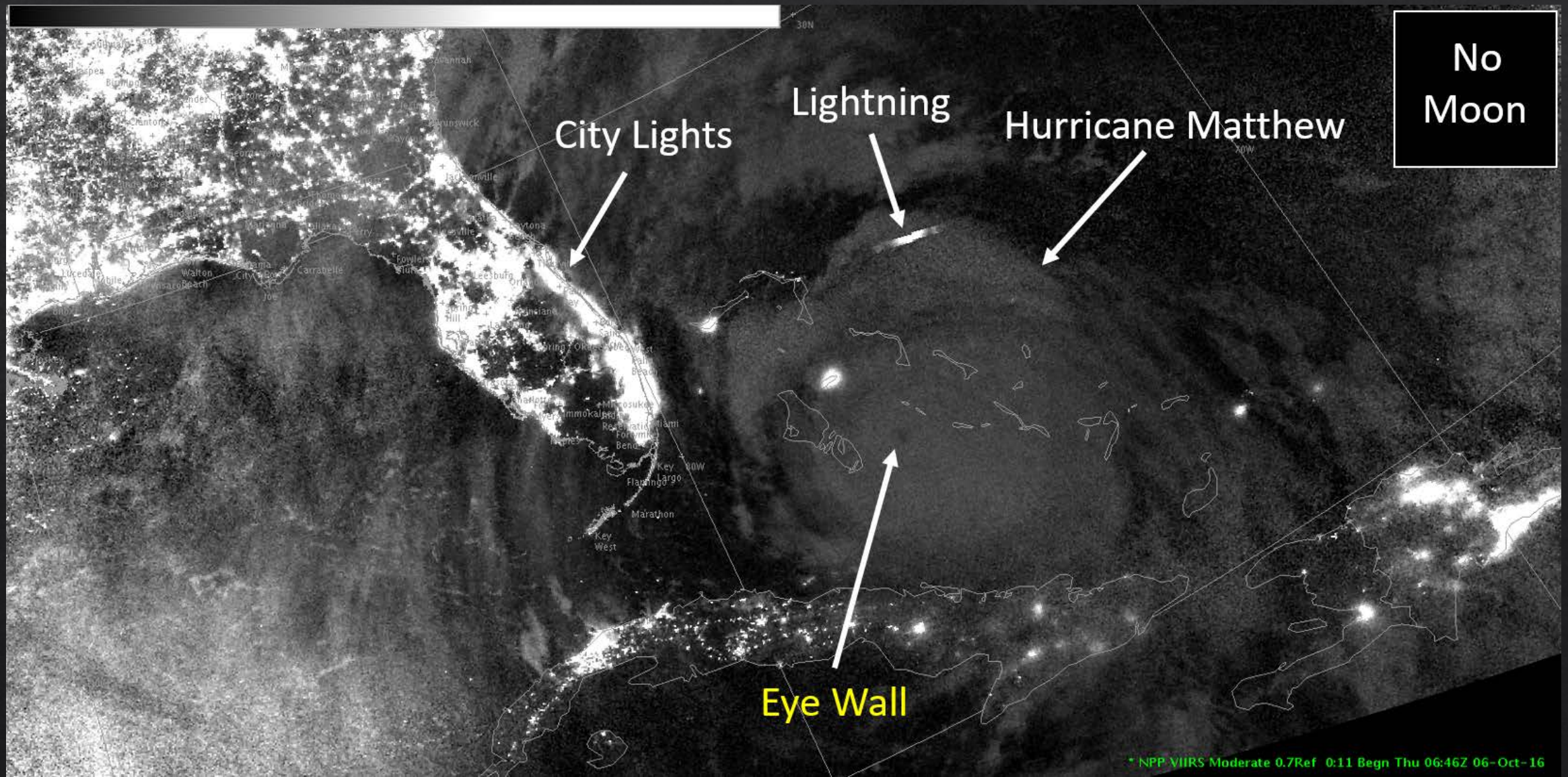
Day/Night Band (DNB)

'Hurricane Franklin, 7-10 August 2017. See reflected and emitted light sources, and their appearance in satellite imagery. Night-time images in animation are ~ 6-8Z local time.'



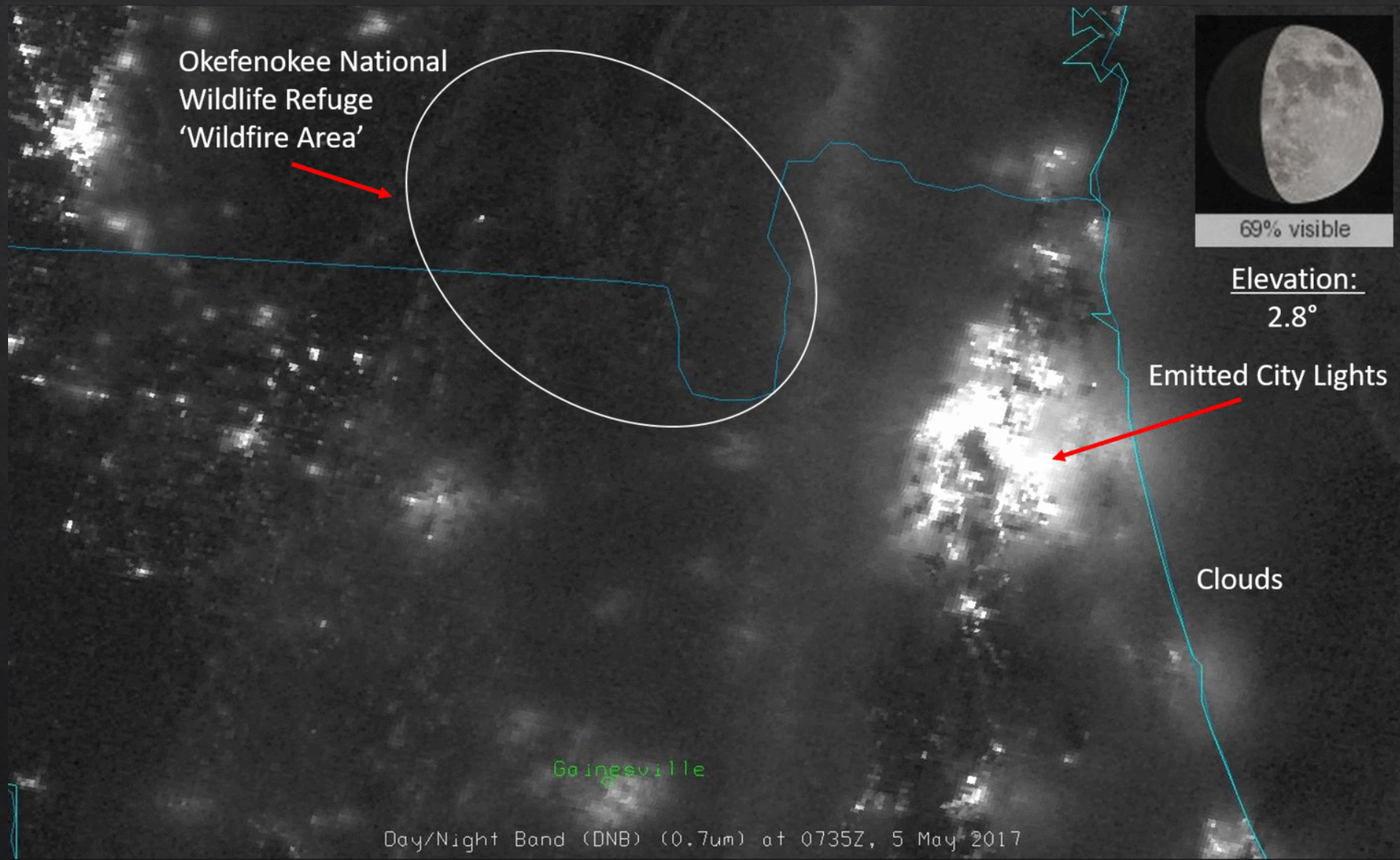
Hurricane Matthew

'Near-Constant Contrast (NCC): Faint Eye Wall detected with No Moon Present.'



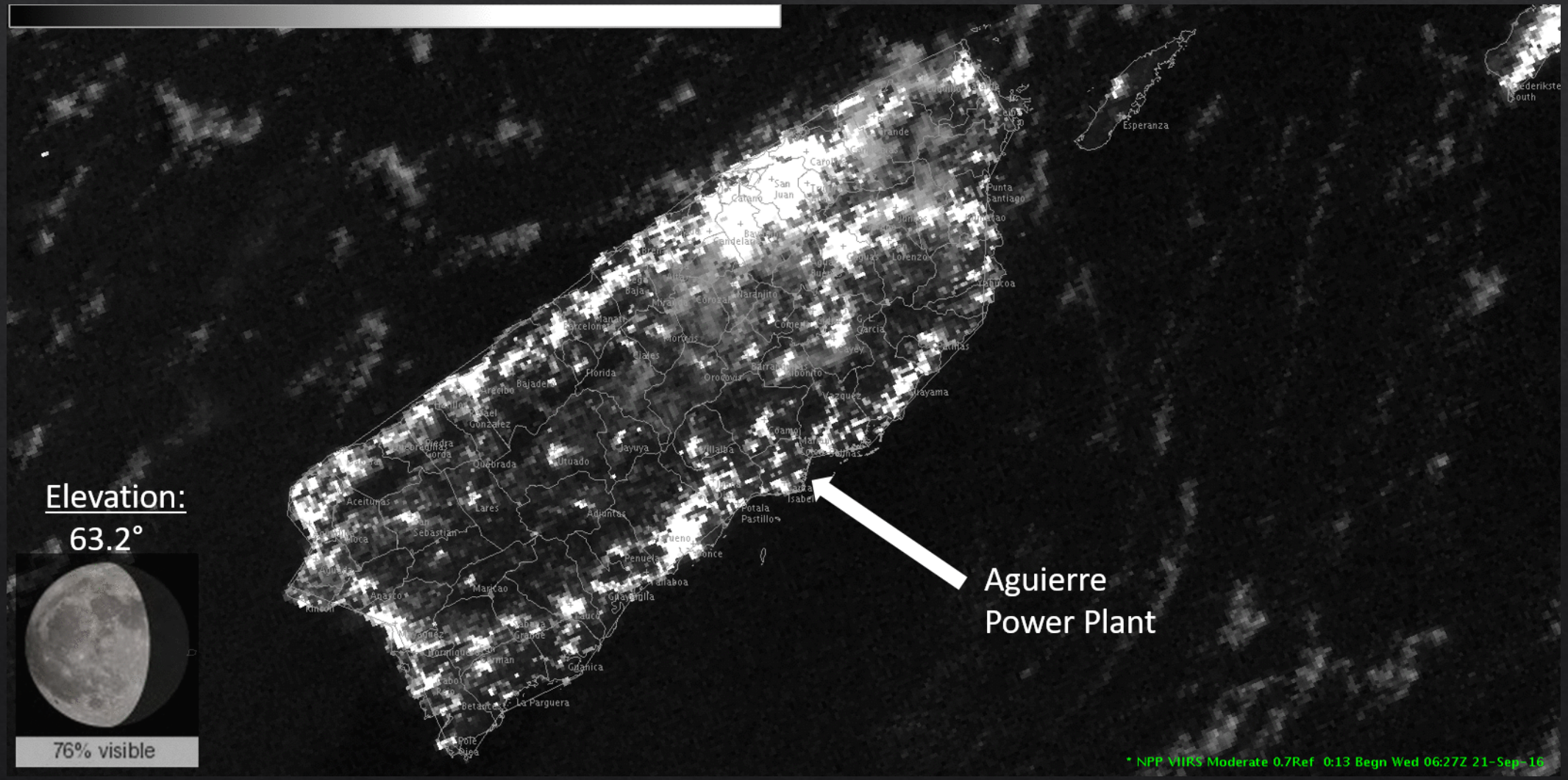
West Mims Fires, Georgia

'Fires detected by DNB in southeastern Georgia, 5-12 May 2017'.

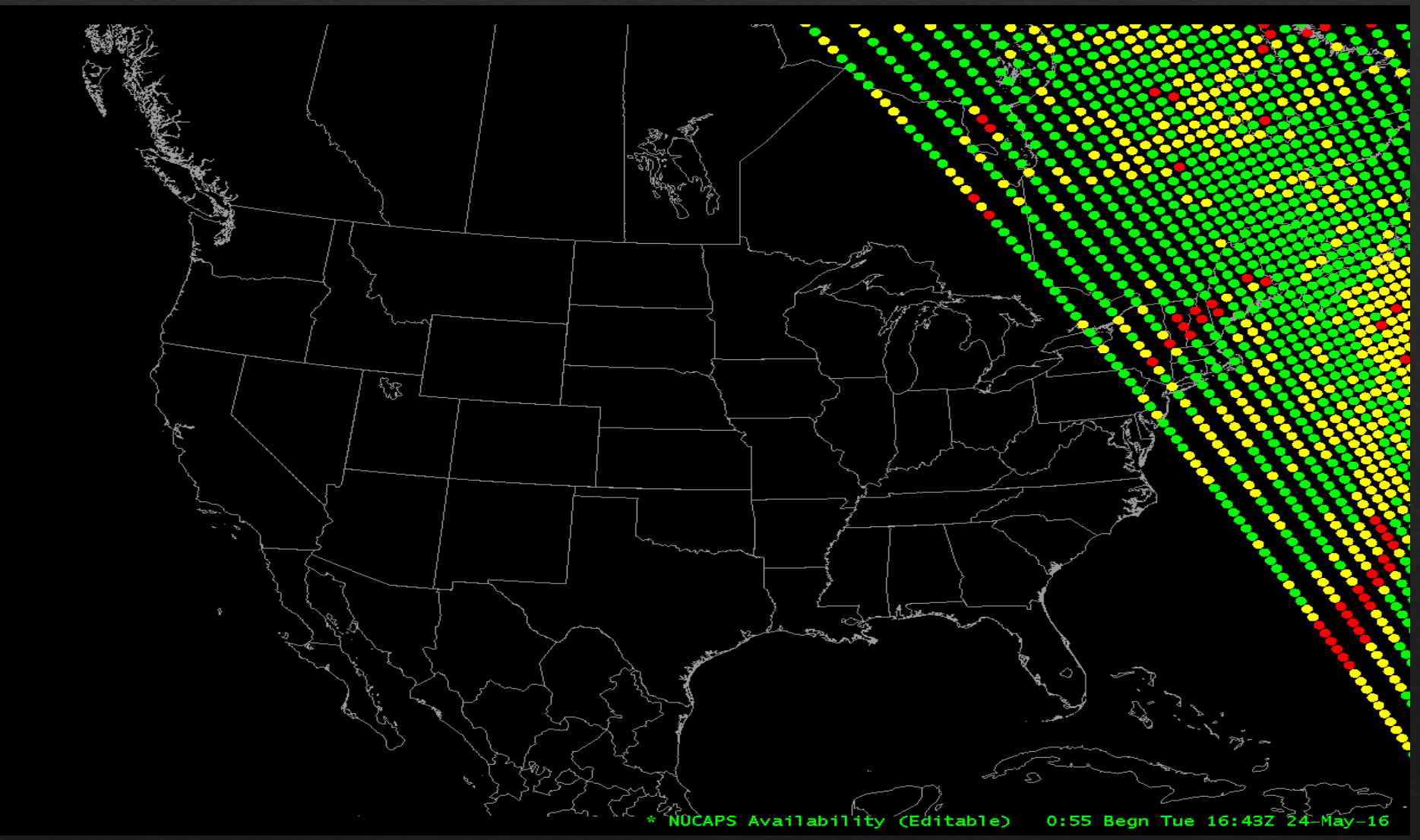


Puerto Rico Power Outage

'Emitted city lights reduced in Puerto Rico, 21-22 September 2017'



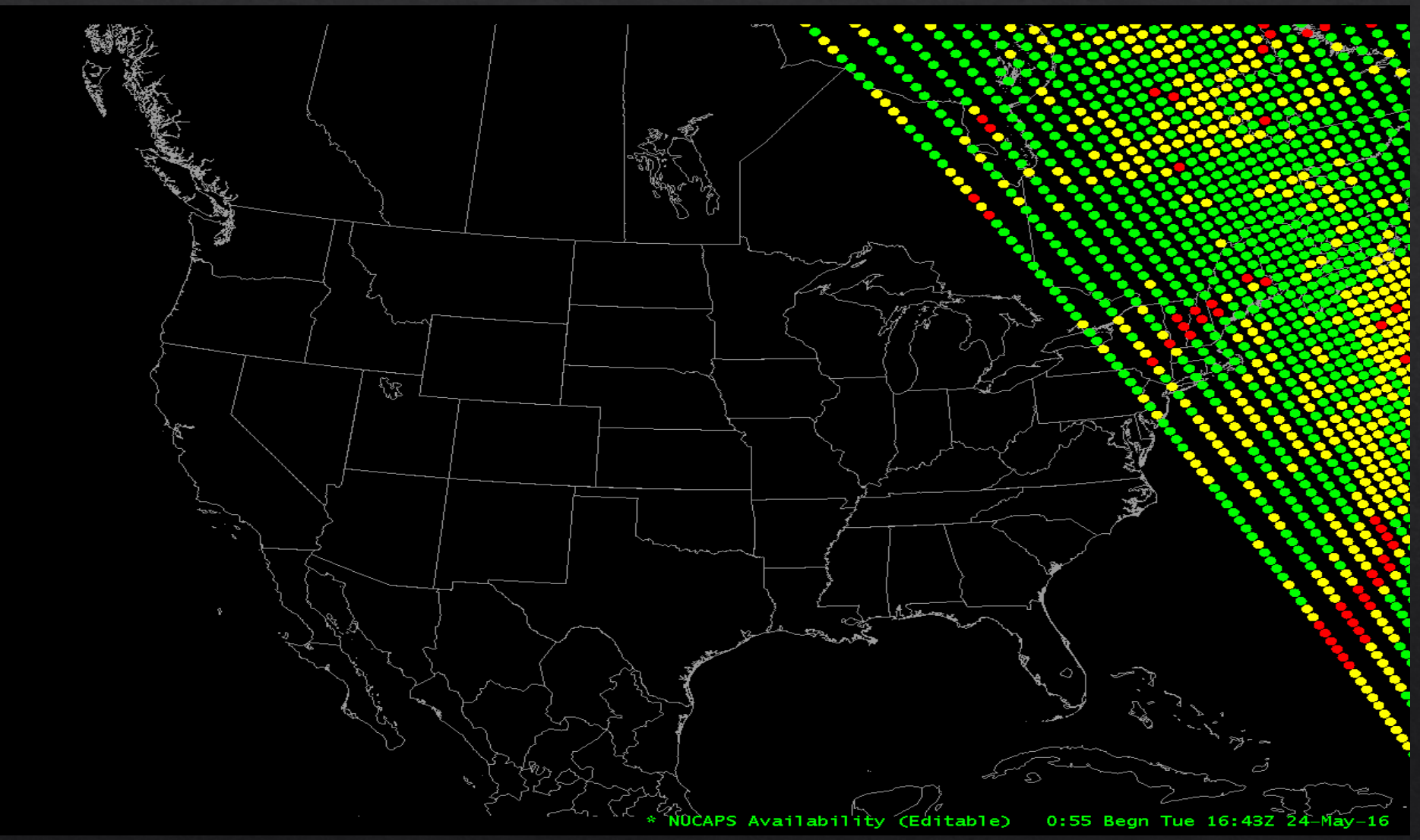
NUCAPS: MICROWAVE/IR Soundings



- NOAA – Unique Combined Processing System (NUCAPS)
- Operational CrIS and ATMS Physical Retrieval Algorithm
- Vertical temperature and moisture soundings ~50 km (30 miles) apart

Source: Bill Line, Hazardous Weather Testbed Presentation (2016)

NUCAPS: MICROWAVE/IR Soundings

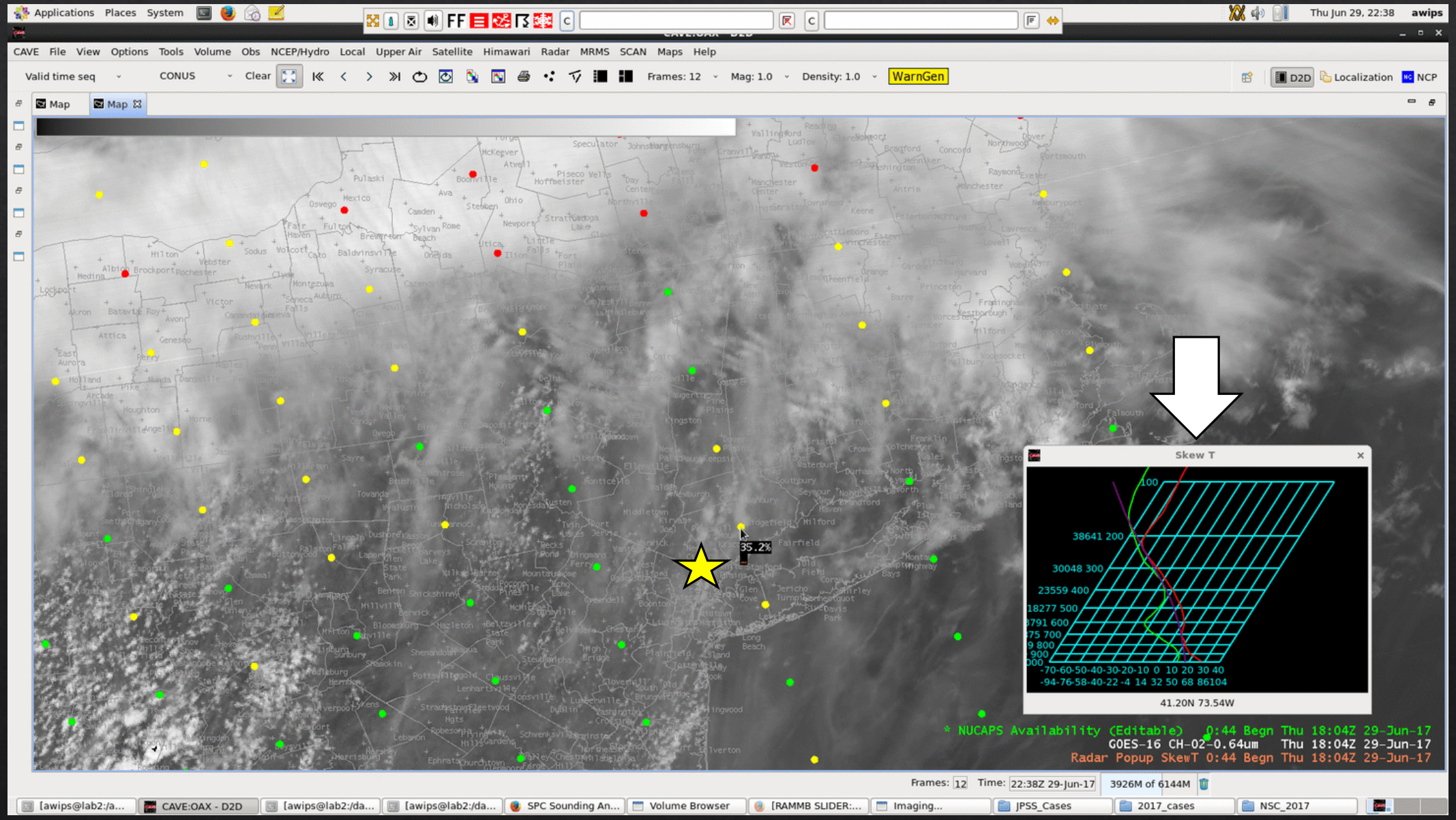


- Quality Control Flags
- Green = Good (microwave, IR regression, retrieval)
- Yellow = Caution (microwave OK, IR regression or retrieval failed)
- Red = Data likely unusable (microwave and other sensors failed)

Source: Bill Line, Hazardous Weather Testbed Presentation (2016)

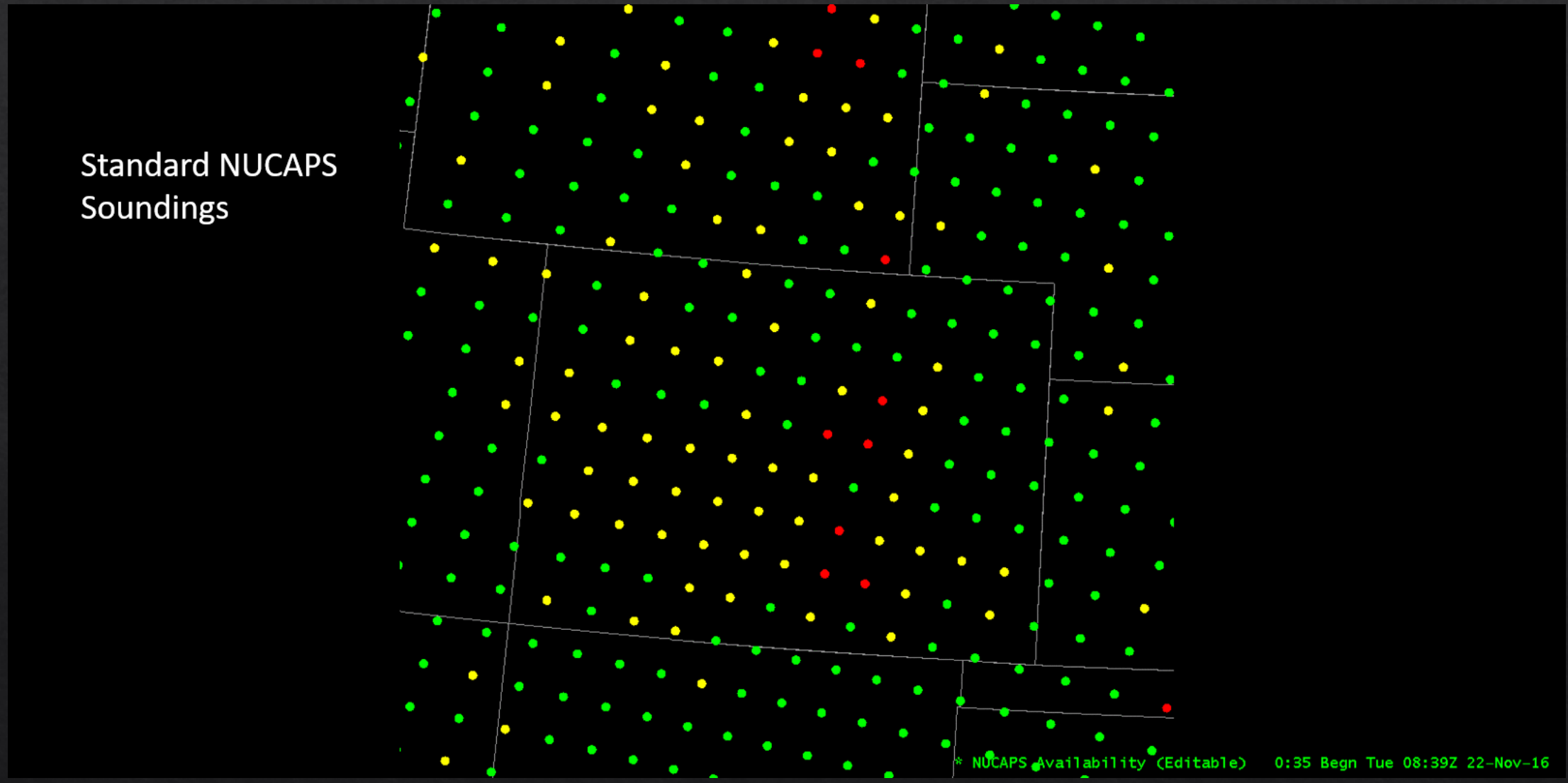
NUCAPS

'Pop-up Skew-T Soundings over New York City.' (29 June 2017)



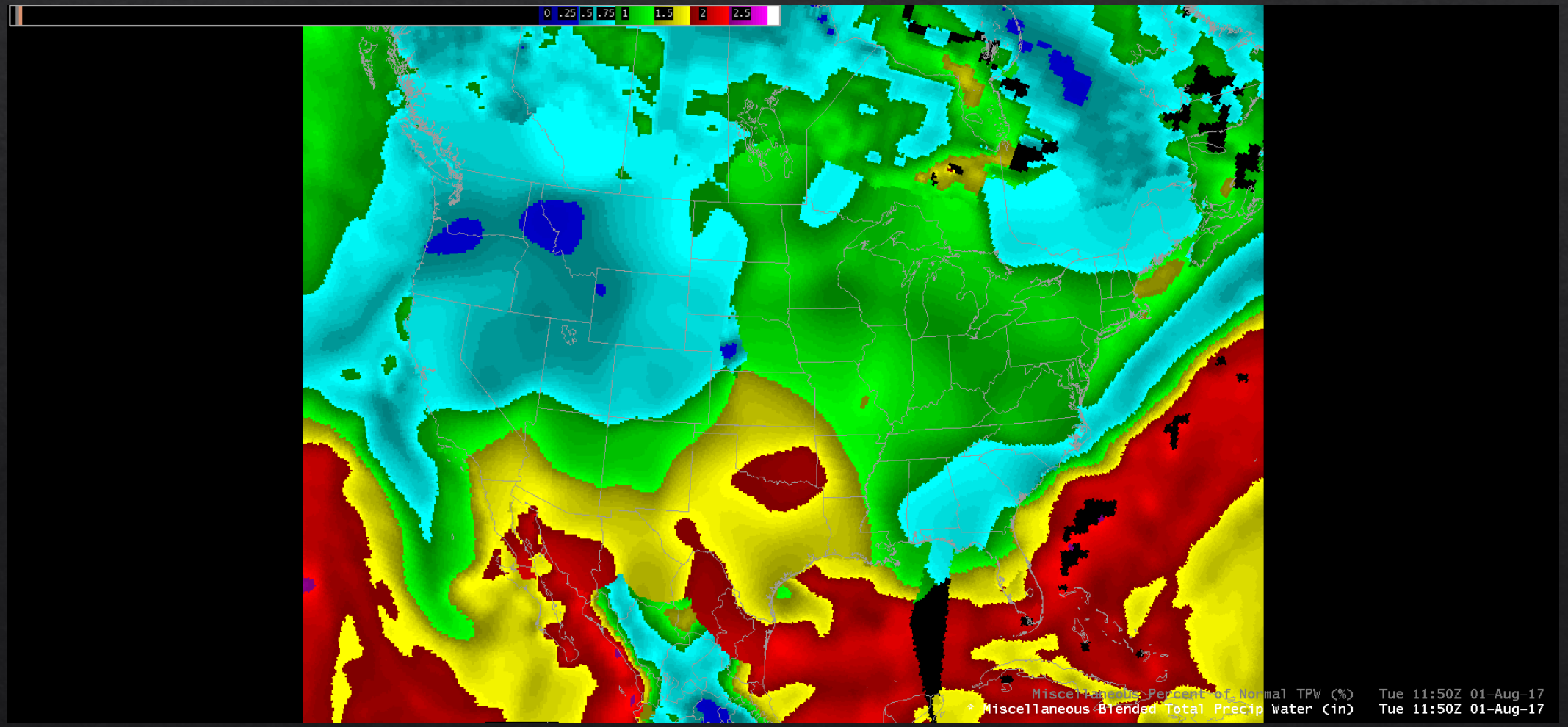
NUCAPS: COLOR VISION DEFICIENCY

Configuration of the NUCAPS soundings (colors) will be implemented in AWIPS 18.1.1 to adapt for users that have color-vision deficiencies.



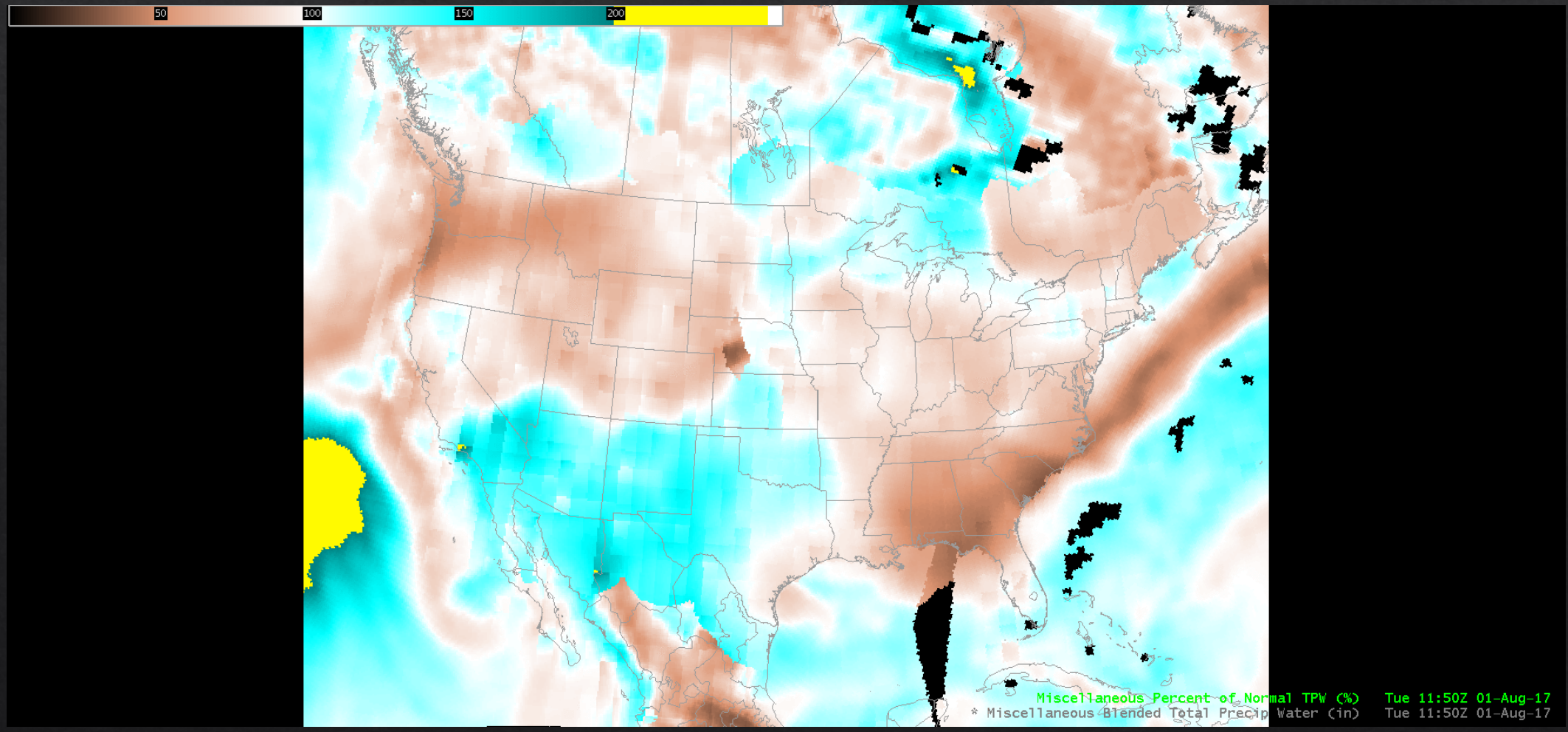
Blended Total Precipitable Water (bTPW)

Derived from several data sources: SSM/I (DMSP), AMSU (POES), GPS, GOES-East and GOES-West sounders. Currently operational and can be accessed in AWIPS-II for NWS forecasters. Animation of bTPW shown throughout the morning hours on 1 August 2017.



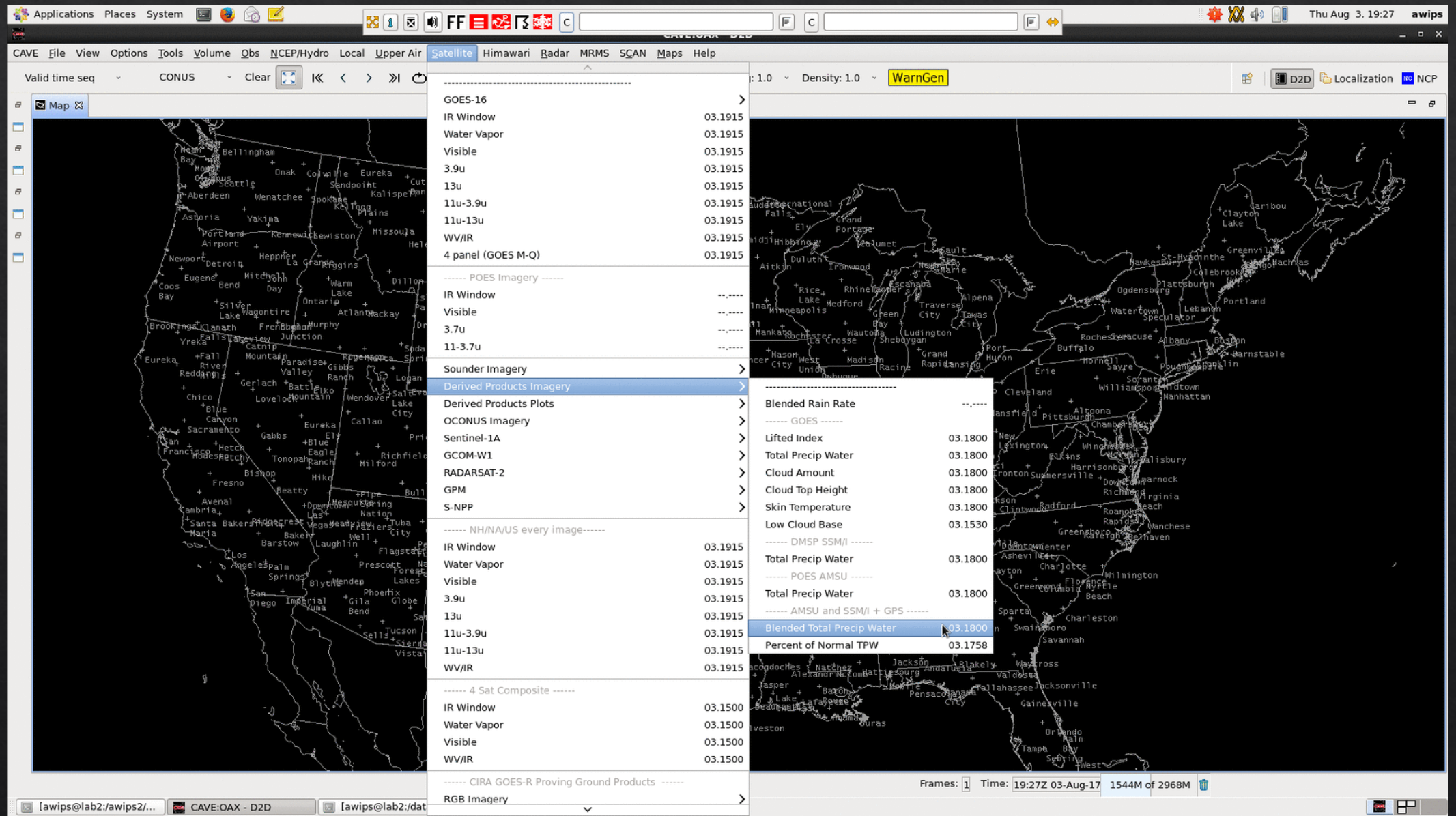
Percent of Normal TPW

A TPW anomaly that displays the percentage departure from climatology. High percentages indicate strong flooding potential, conversely, low percentages indicate potential fire hazards. Animation shown throughout the morning hours on 1 August 2017.



How to Access Polar Data

Animation shows how to access polar data (i.e. bTPW, NCC and NUCAPS) in AWIPS-II interface.



Satellite Foundational Course – JPSS (SatFC-J)

- Current Status: underway
- Collaborative development effort between: OCLO/STAT, CIRA, CIMSS, NASA-SPoRT, and COMET
- Length: 3-4 hours of content
- Available: Fall/Winter 2017

SatFC-J Training Plan Overview
Objective 1: Introduction to Microwave Remote Sensing
Objective 2: Introducing Suomi-NPP, JPSS, GCOM, GPM
Objective 3: Basic Forecast Applications
Follow on Section: Additional SNPP/JPSS Applications

Past JPSS Training Workshops



CIRA / VISIT Webpage

NUCAPS Horizontal Profiles

- Temperature Profiles (800-1000mb levels) on 26 January 2017 (morning overpass).
- Water Vapor Profiles (800-1000mb levels) on 26 January 2017 (morning overpass).
- Temperature Profiles (800-1000mb levels) on 26 January 2017 (evening overpass).
- Water Vapor Profiles (800-1000mb levels) on 26 January 2017 (evening overpass).

VIIRS Active Fire (VIIRS-AF) Data

- VIIRS-AF Download
- VIIRS-AF Text File (26 January 2017 @ 0531Z)
- VIIRS-AF PNG File (26 January 2017 @ 0531Z)
- VIIRS-AF Netcdf File (26 January 2017 @ 0531Z)

VIIRS Active Fire Global Map

- Global Map

Chilean Wildfires Handout

- Handout

Photos of the Event via various Media Outlets

- Photos from CNN.
- Photos from The Guardian.
- Photos from National Geographic.

JPSS Training

0430-0455PM: JPSS Online Training Resources (Jorel Torres)

- JPSS Online Training Resources Presentaion

0455-0500PM: Wrap-Up, Questions from audience

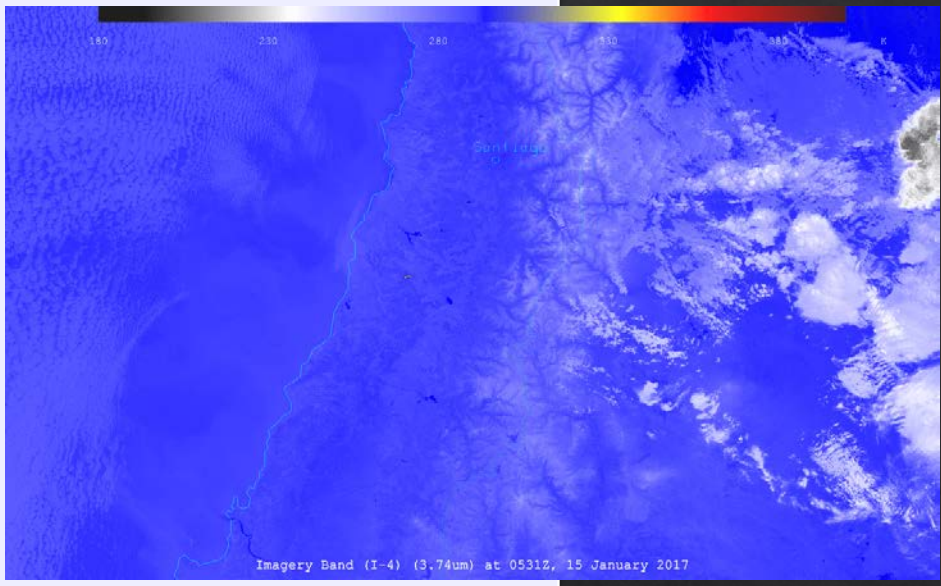
- JPSS Training Evaluation Form

0500PM: End of Workshop

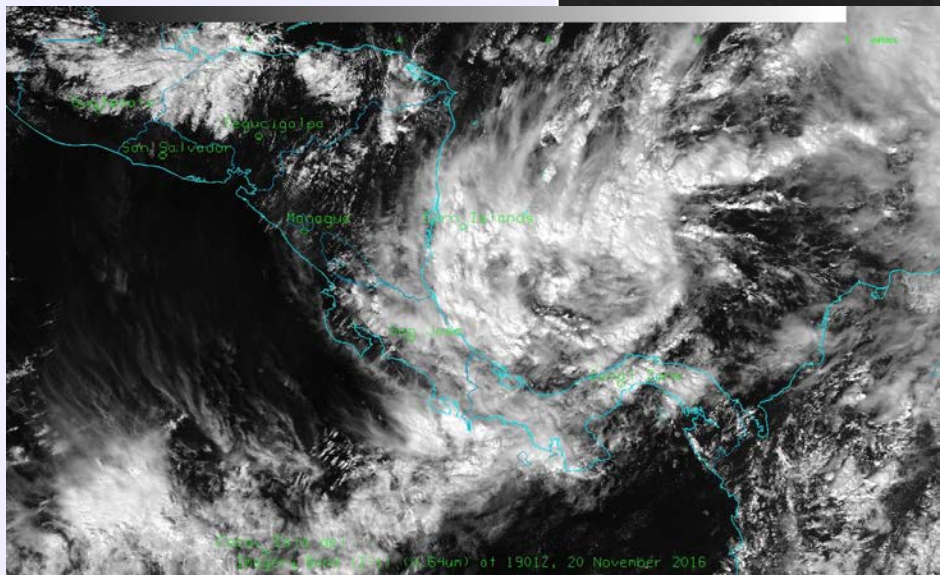
Training Resources

- JPSS Satellites (COMET)
- VIIRS Products (NASA SPoRT)
- The Wide World of SPoRT Blog (NASA SPoRT)
- VISIT Satellite Chat (CIRA)
- VISIT: Meteorological Interpretation Blog (CIRA)
- CIMSS Satellite Blog (CIMSS)
- Direct Broadcast Applications Workshop (CIMSS)
- JPSS Training Questionnaire

Chilean Wildfires: Imagery Band (I-4) (3.74um), January 2017

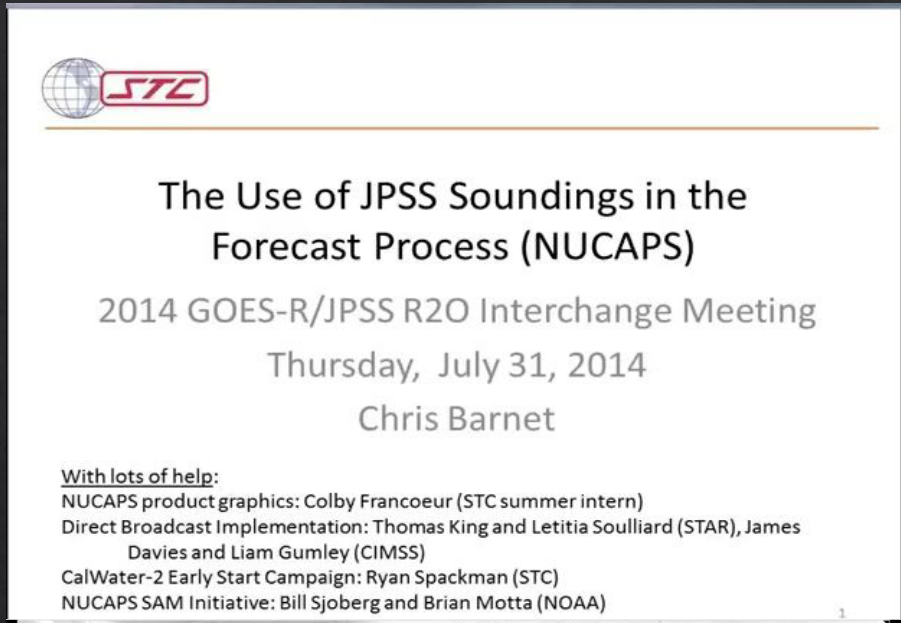


Hurricane Otto: Imagery Band (I-1)(0.64um), 20-26 November 2016



More Existing JPSS Training Links….

- Suomi NPP: A New Generation of Environmental Satellites (COMET, 2012)
  https://www.meted.ucar.edu/training_module.php?id=948
- Introduction to VIIRS Imaging and Applications (COMET, 2013)
  https://www.meted.ucar.edu/training_module.php?id=1075
- Advances in Space-Based Nighttime Visible Observation, 2nd Edition (COMET, 2017)
  https://www.meted.ucar.edu/training_module.php?id=1327
- NUCAPS Soundings in AWIPS (VISIT/CIMSS, 2015)
  http://rammb.cira.colostate.edu/training/visit/training_sessions/nucaps_soundings_in_awips/
- The use of JPSS Soundings in the Forecast Process (VISIT, 2014)
  https://www.youtube.com/watch?v=JpQ0KUJXOhQ
- Microwave Remote Sensing: Overview, 2nd Edition (COMET, 2012)
  https://www.meted.ucar.edu/training_module.php?id=979
- Microwave Remote Sensing: Clouds, Precipitation, and Water Vapor (COMET, 2006)
  https://www.meted.ucar.edu/training_module.php?id=226
- Microwave Remote Sensing: Land and Ocean Surface Applications, 2nd Edition (COMET, 2015)
  https://www.meted.ucar.edu/training_module.php?id=1100





List of Available Satellite Blogs and Additional Training Resources

- JPSS Satellites (COMET)
- VIIRS Products (NASA-SPoRT)
- The World Wide of SPoRT Blog (NASA-SPoRT)
- VISIT Satellite Chat (CIRA)
- VISIT Meteorological Interpretation Blog (CIRA)
- CIMSS Satellite Blog (CIMSS)
- Direct Broadcast Applications Workshop (CIMSS)
- GEONETCast Blog
- More Links to Blogs

NOAA Satellites
@NOAASatellites

Follow

It's #WorldOceansDay! Join us in celebrating the beauty, wonder, and ecological importance of the Earth's oceans! goo.gl/QYXnC1

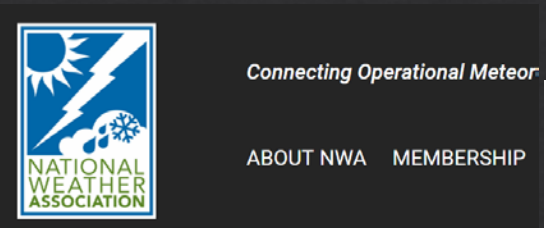


Suomi NPP captured this true-color image of ice melting into the Atlantic Ocean off the coast of Newfoundland on June 7, 2017.

8:30 AM - 8 Jun 2017

33 Retweets 58 Likes

1 33 58





Look forward to future JPSS Workshops

Questions ????

Contact Information

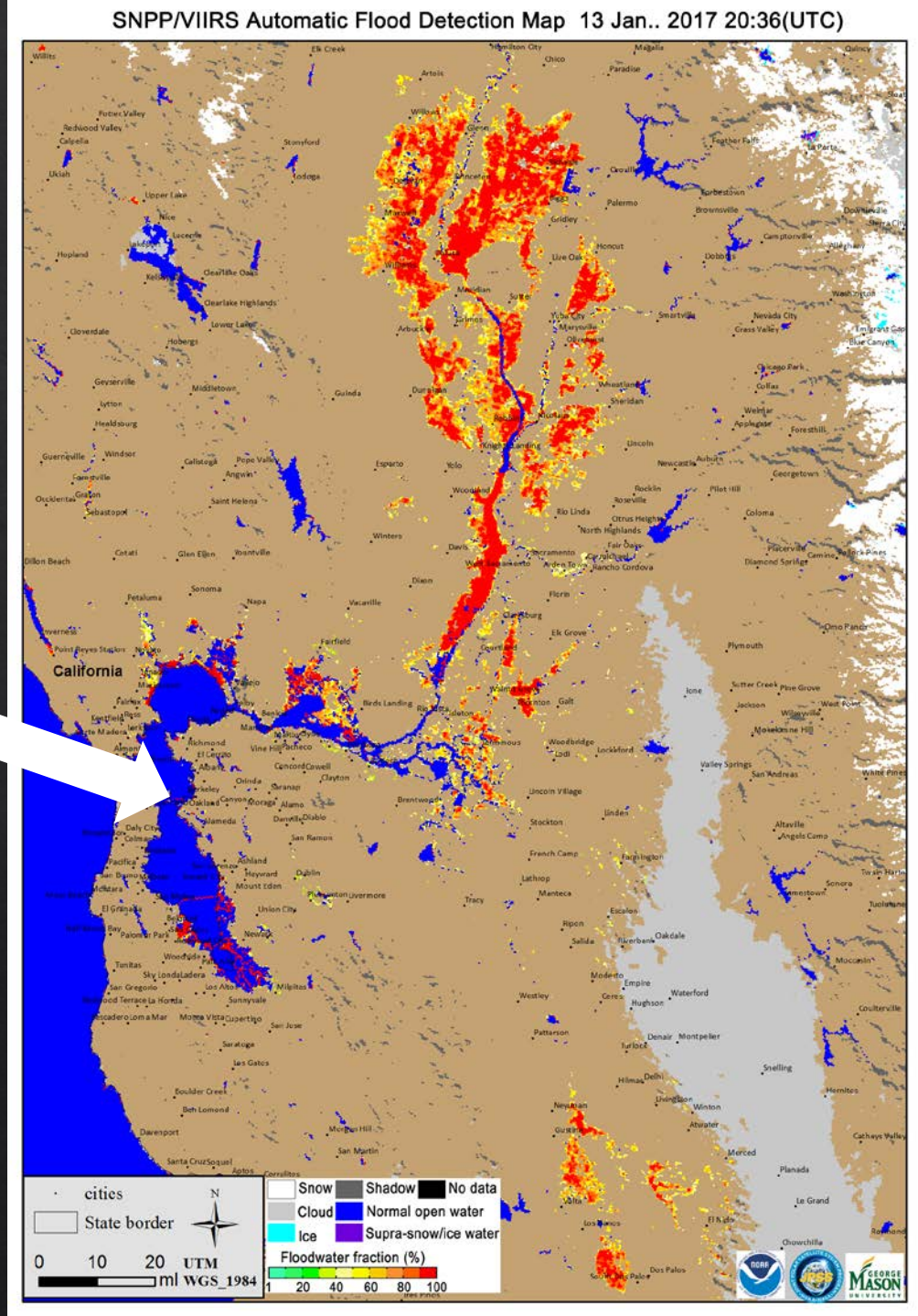
Jorel.Torres@colostate.edu

Jorel.Torres@noaa.gov

Supplemental slides

VIIRS FLOOD Detection MAP

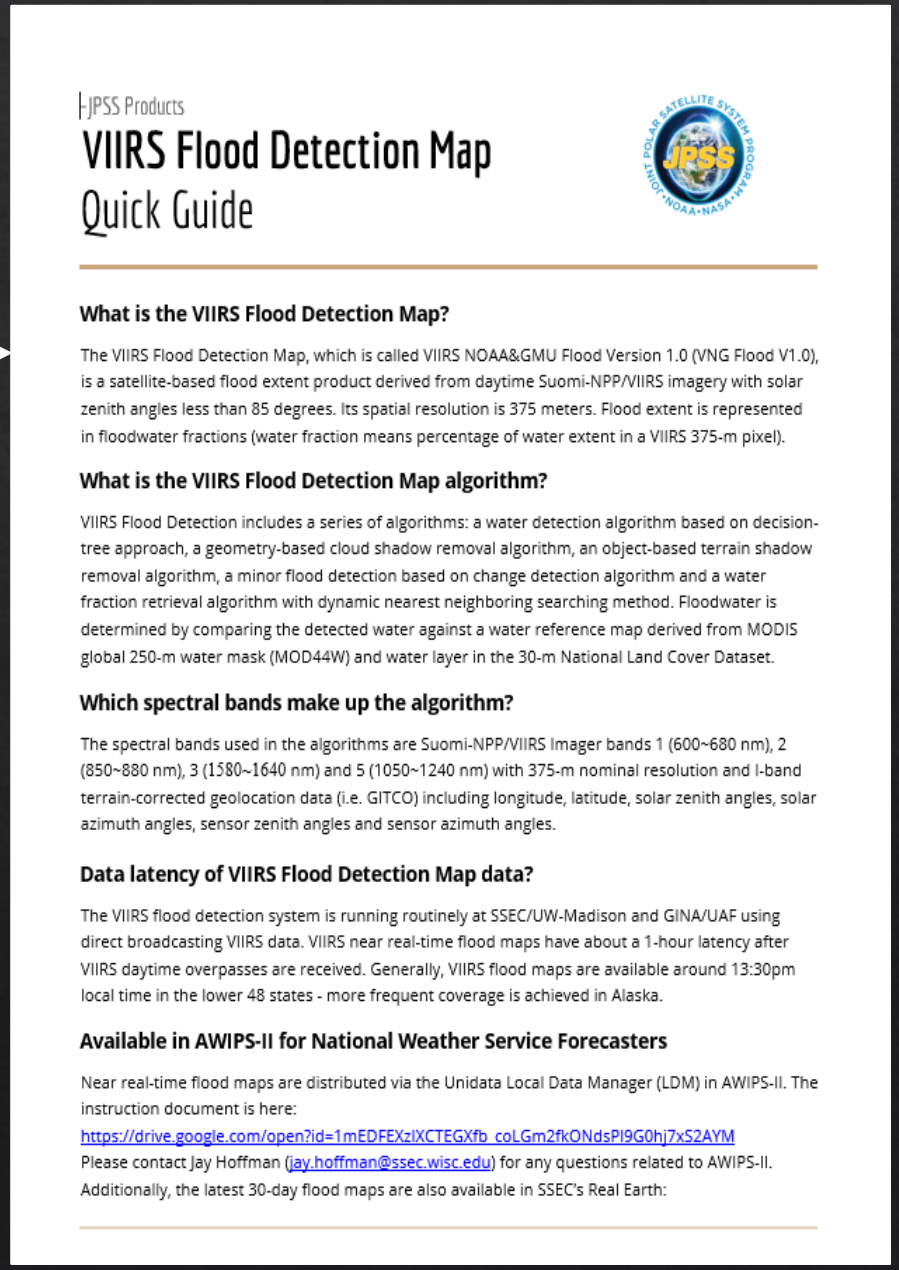
- 375 m spatial resolution
- Map of Northern California
  - Flooding evident north-east of San Francisco Bay Area
  - After atmospheric river event last weekend, 13 January 2017 at 2036 UTC



Provided by Sanmei Li, GMU

User Engagement - Interactions/Feedback

- How do we engage users?
  - Blogs, input to satellite chats, quick guides.
    - http://rammb.cira.colostate.edu/training/visit/blog/
  - JPSS Workshops: Case Scenarios
- Welcome feedback to address product issues and improve training.



JPSS Products

VIIRS Flood Detection Map
Quick Guide

What is the VIIRS Flood Detection Map?

The VIIRS Flood Detection Map, which is called VIIRS NOAA&GMU Flood Version 1.0 (VNG Flood V1.0), is a satellite-based flood extent product derived from daytime Suomi-NPP/VIIRS imagery with solar zenith angles less than 85 degrees. Its spatial resolution is 375 meters. Flood extent is represented in floodwater fractions (water fraction means percentage of water extent in a VIIRS 375-m pixel).

What is the VIIRS Flood Detection Map algorithm?

VIIRS Flood Detection includes a series of algorithms: a water detection algorithm based on decision-tree approach, a geometry-based cloud shadow removal algorithm, an object-based terrain shadow removal algorithm, a minor flood detection based on change detection algorithm and a water fraction retrieval algorithm with dynamic nearest neighboring searching method. Floodwater is determined by comparing the detected water against a water reference map derived from MODIS global 250-m water mask (MOD44W) and water layer in the 30-m National Land Cover Dataset.

Which spectral bands make up the algorithm?

The spectral bands used in the algorithms are Suomi-NPP/VIIRS Imager bands 1 (600~680 nm), 2 (850~880 nm), 3 (1580~1640 nm) and 5 (1050~1240 nm) with 375-m nominal resolution and I-band terrain-corrected geolocation data (i.e. GITCO) including longitude, latitude, solar zenith angles, solar azimuth angles, sensor zenith angles and sensor azimuth angles.

Data latency of VIIRS Flood Detection Map data?

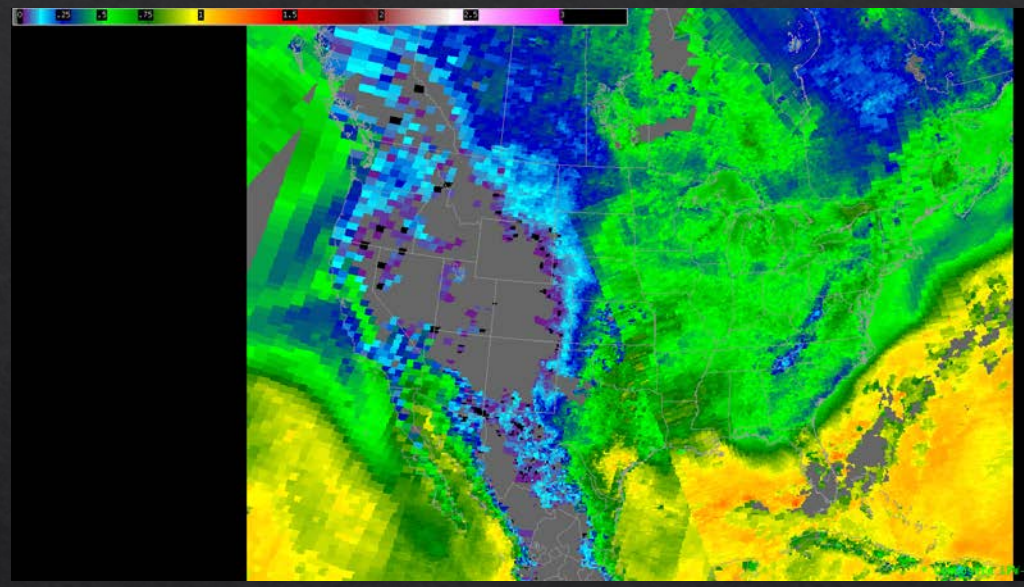
The VIIRS flood detection system is running routinely at SSEC/UW-Madison and GINA/UAF using direct broadcasting VIIRS data. VIIRS near real-time flood maps have about a 1-hour latency after VIIRS daytime overpasses are received. Generally, VIIRS flood maps are available around 13:30pm local time in the lower 48 states - more frequent coverage is achieved in Alaska.

Available in AWIPS-II for National Weather Service Forecasters

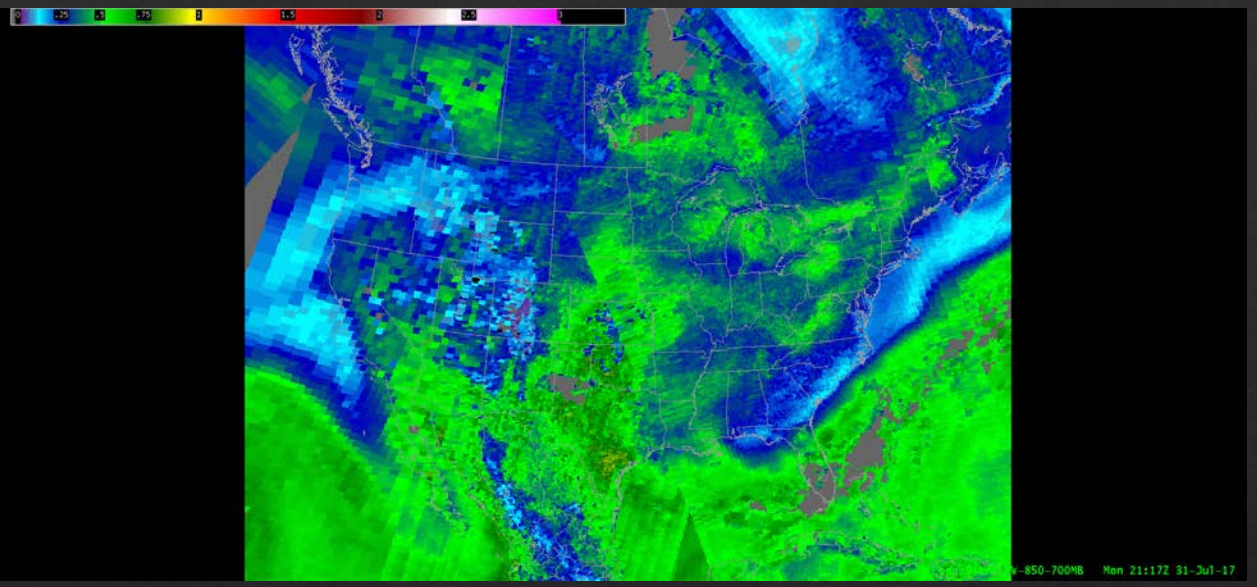
Near real-time flood maps are distributed via the Unidata Local Data Manager (LDM) in AWIPS-II. The instruction document is here:
https://drive.google.com/open?id=1mEDFEXzIXCTEGXfb_coLGm2fkONdsPI9G0hj7xS2AYM
Please contact Jay Hoffman (jay.hoffman@ssec.wisc.edu) for any questions related to AWIPS-II. Additionally, the latest 30-day flood maps are also available in SSEC's Real Earth:

LPW

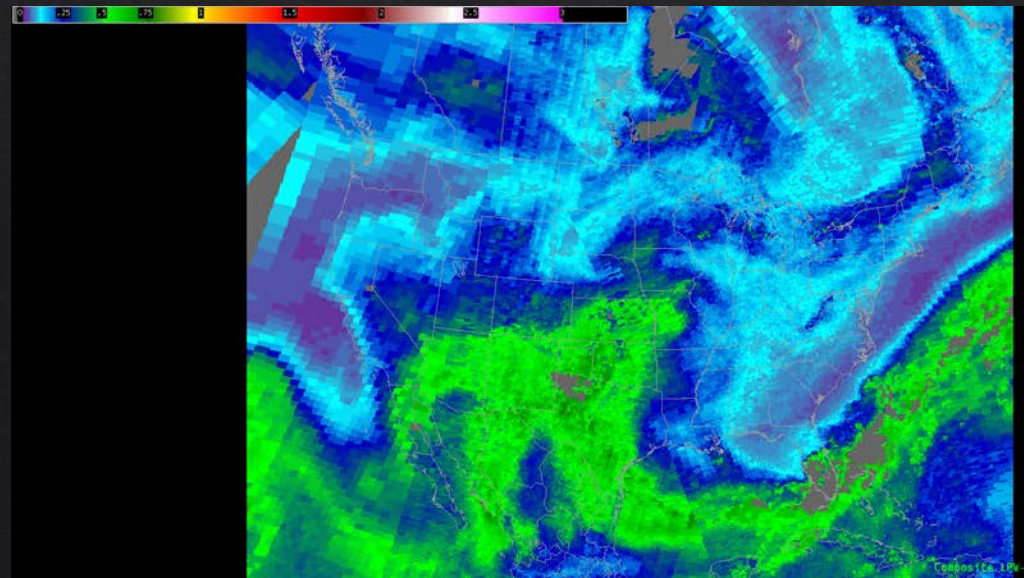
- Surface-850mb



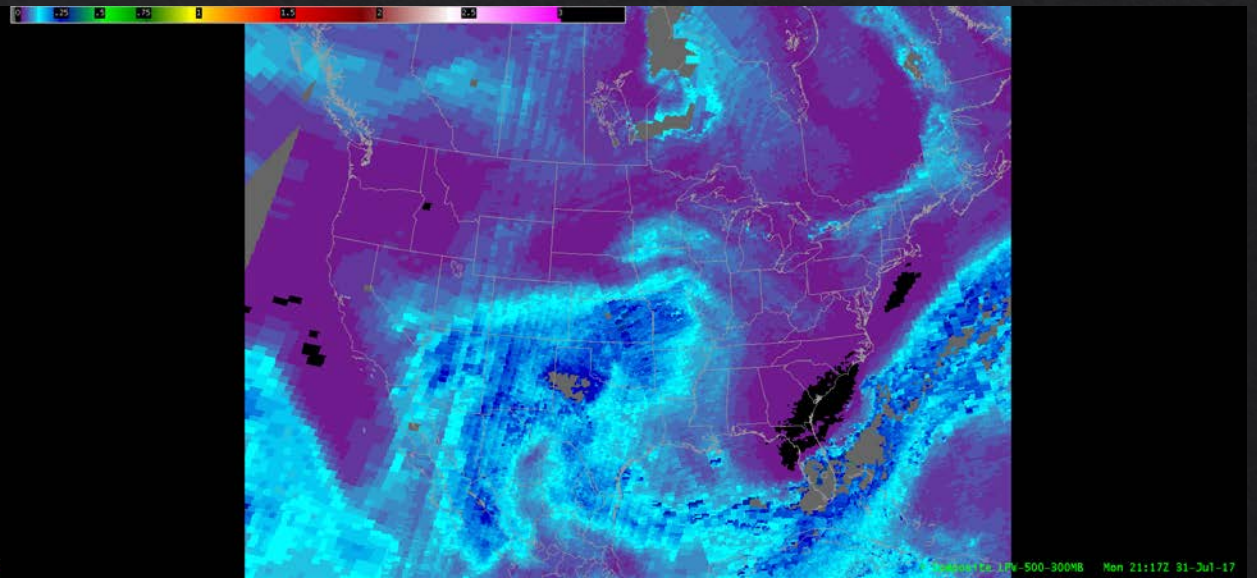
- 850-700mb



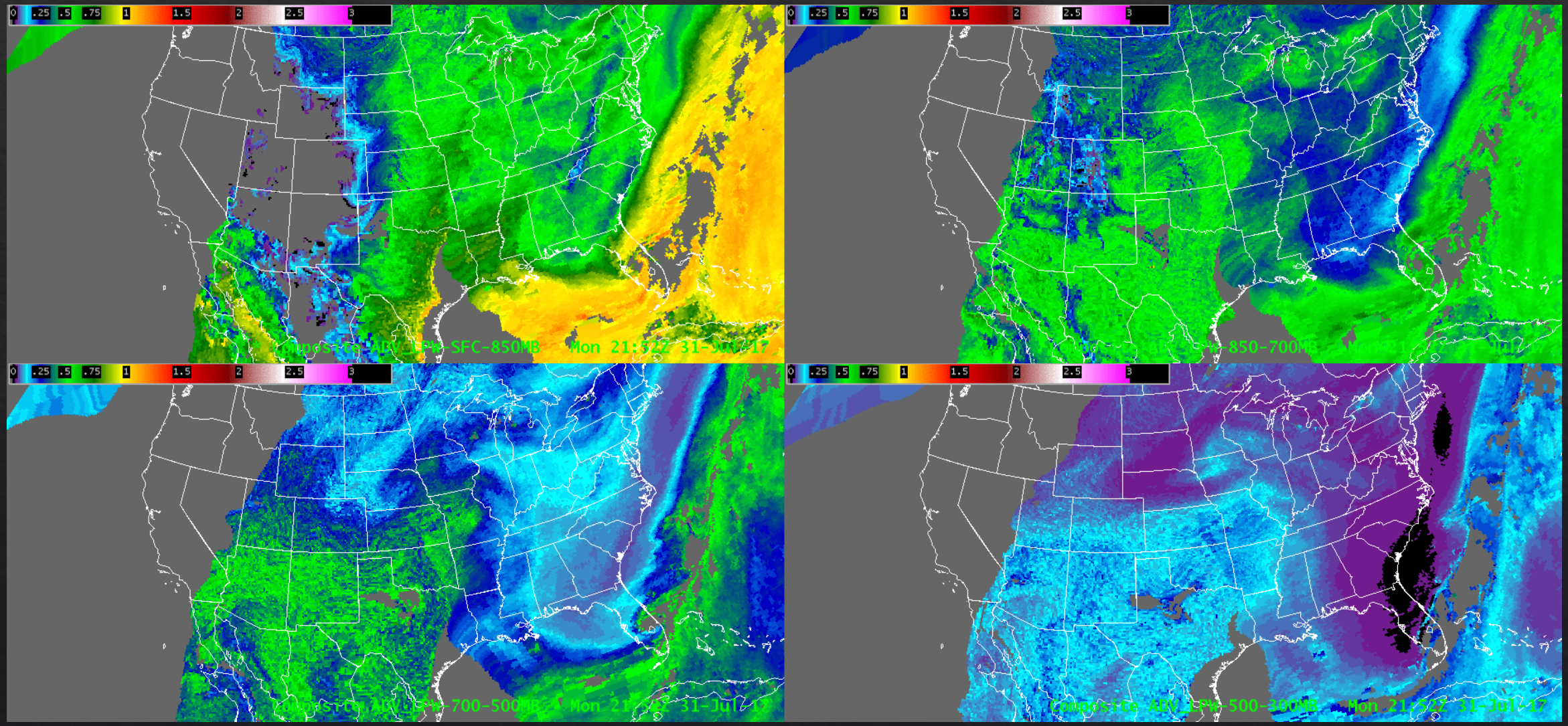
- 700-500mb



- 500-300mb



Advected LPW



CIMSS support of Imagery EDR team

William Straka III[1]

Tommy Jasmin[1], Bob Carp[1], Dan Lindsey[2], Steve Miller[3], Don Hillger[2]

[1]Cooperative Institute for Meteorological Satellite Studies, Space Science and Engineering Center, University of Wisconsin-Madison
[2]NOAA, RAMMB
[3]Cooperative Institute for Research in the Atmosphere, Colorado State University

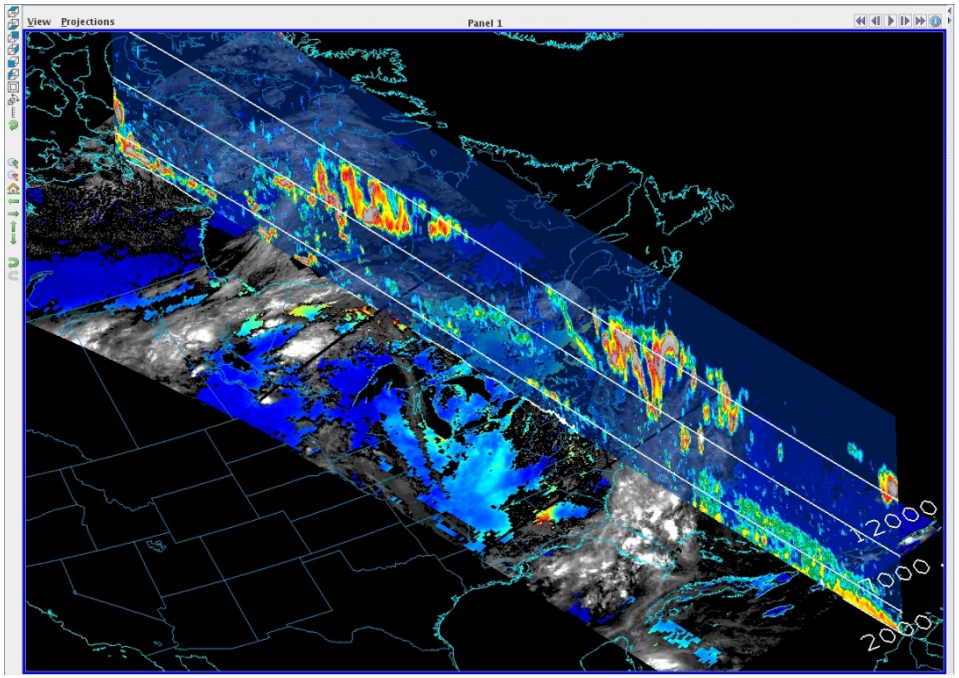
Outline

- Overview of McIDAS-V
- Examples
- McIDAS-V summary
- Other work

What is McIDAS-V

McIDAS-X → VisAD + IDV + HYDRA =

- **Integration of Geophysical Data**
- **Remote and Local Data Access**
- **Powerful Analysis Tools**
- **3D Visualization**
- **Ease of Re-projection**



Key Aspects of McIDAS-V

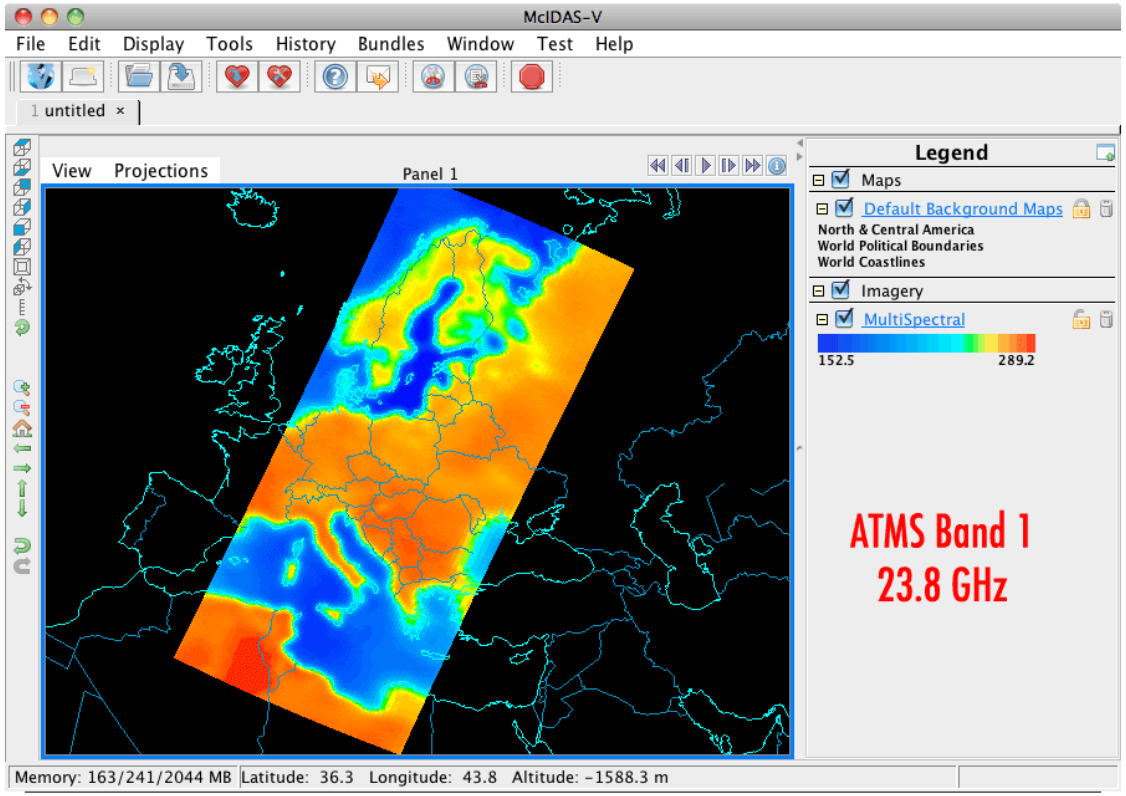
- **Built on top an extensible framework for adapting new sources of data (format and type, local or remote), user interface components and for creating novel displays and analysis techniques**
- **Developed in the Java programming language – object oriented, write once run anywhere, very portable**
- **Persistence mechanism (bundles) for saving and sharing interesting displays/analysis with other McIDAS-V users**
- **Python based user defined computation**
- **Open source, freely available, community driven software**
- **Is able to easily load and manipulate Suomi NPP (Block 1 and 2) and JPSS-1 simulated Block 2 data without any special readers**

Suomi NPP

- It has 5 instruments which retrieve data regarding the atmosphere, land and ocean. 3 of these instruments can be displaye in McIDAS-V
  - VIIRS
  - CERES
  - CrIS
  - ATMS
  - OMPS

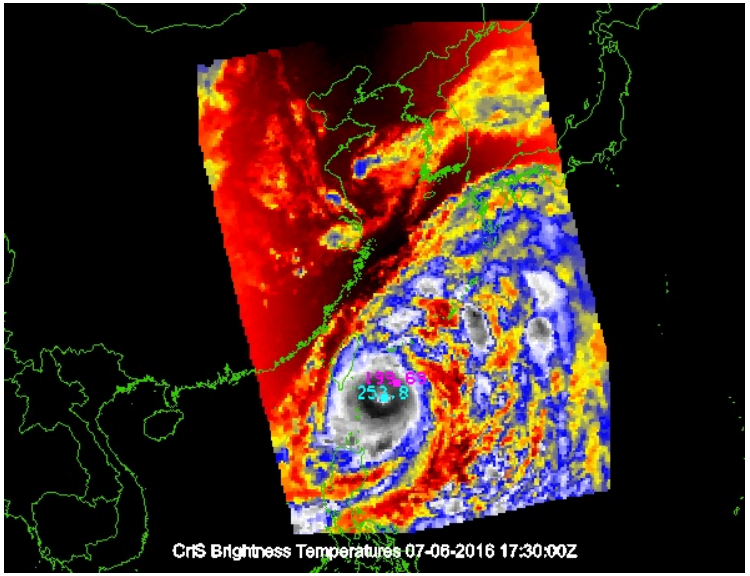
Advanced Technology Microwave Sounder (ATMS)

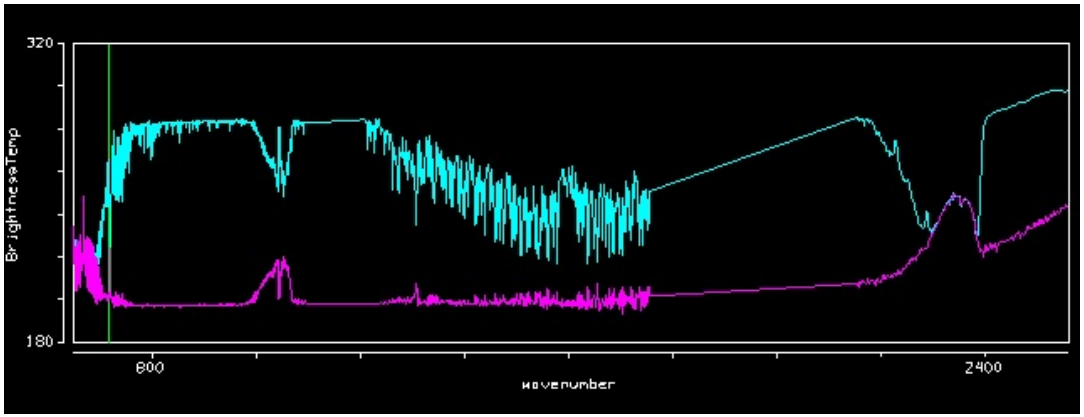
- 22 microwave channels, combining all the channels of the preceding AMSU-A1, AMSU-A2, and AMSU-B sensors into a single package
- Provides sounding observations needed to retrieve profiles of atmospheric temperature and moisture for forecasting models and continuity for climate monitoring purposes.



Cross-track Infrared Sounder (CrIS)

- 1,305 infrared spectral channels
- Designed to provide high vertical resolution information on the atmosphere's structure of temperature and water vapor.

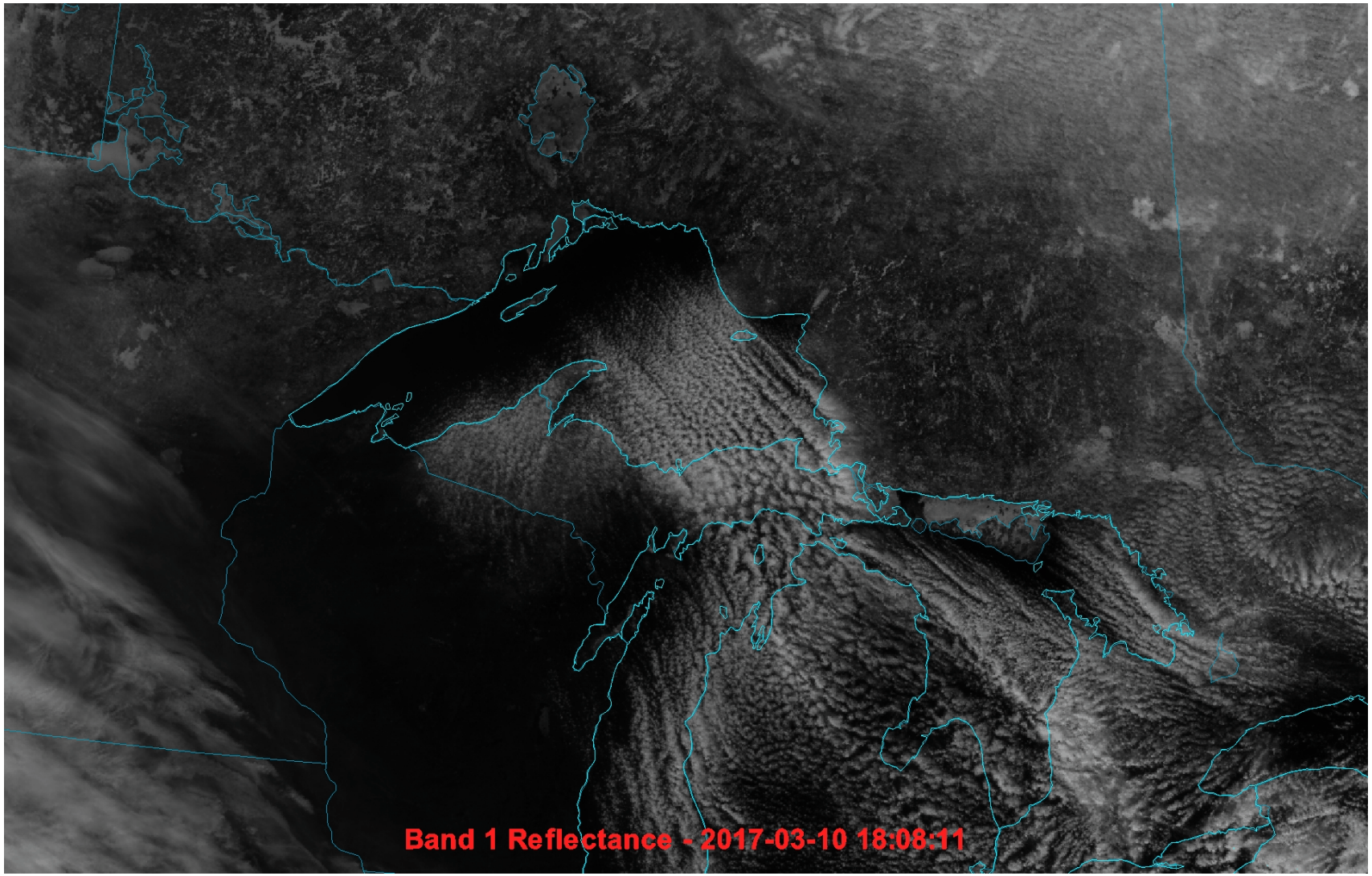




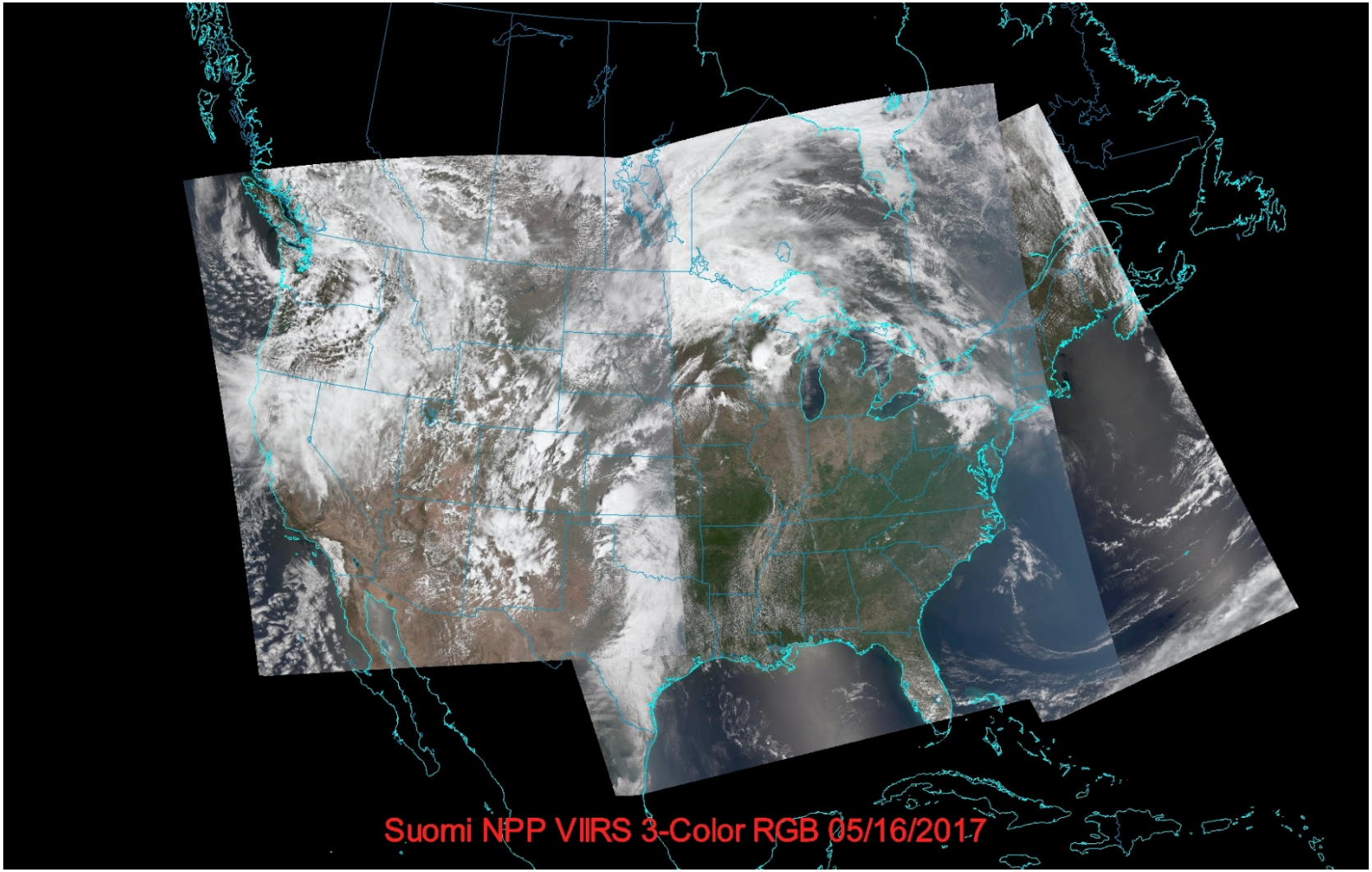
Visible Infrared Imaging Radiometer Suite (VIIRS)

- Has 22 channels at three different resolutions
  - 16 Moderate Band (M-Band) channels (~750 m at nadir)
  - 5 high resolution (I-Band) channels (~375 m at nadir)
  - Day Night Band (~750 m at nadir)
- M and I band data encompass data from 412 nm to 12 µm
- Used to produce Level 2 products

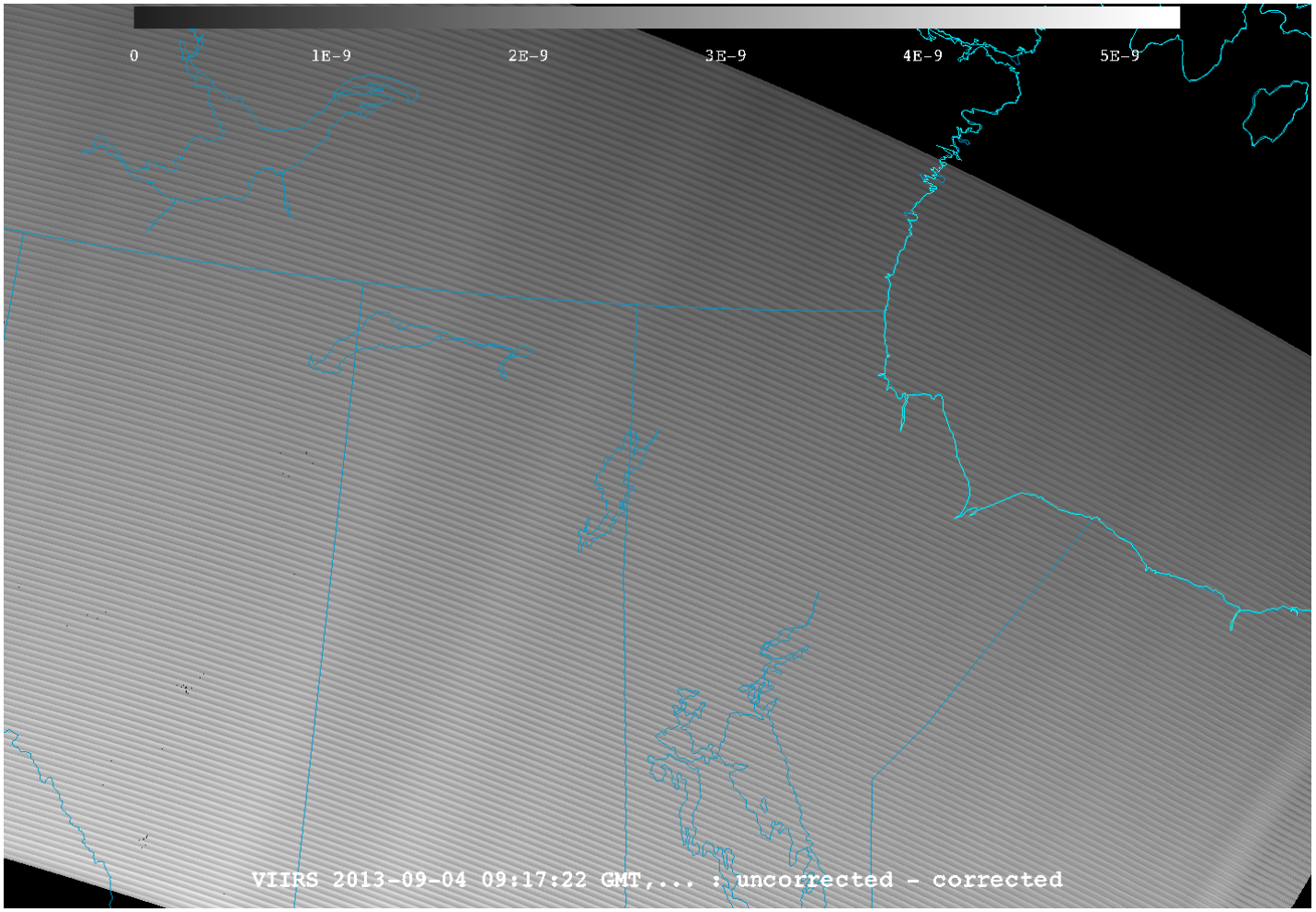
Multi-channel animation



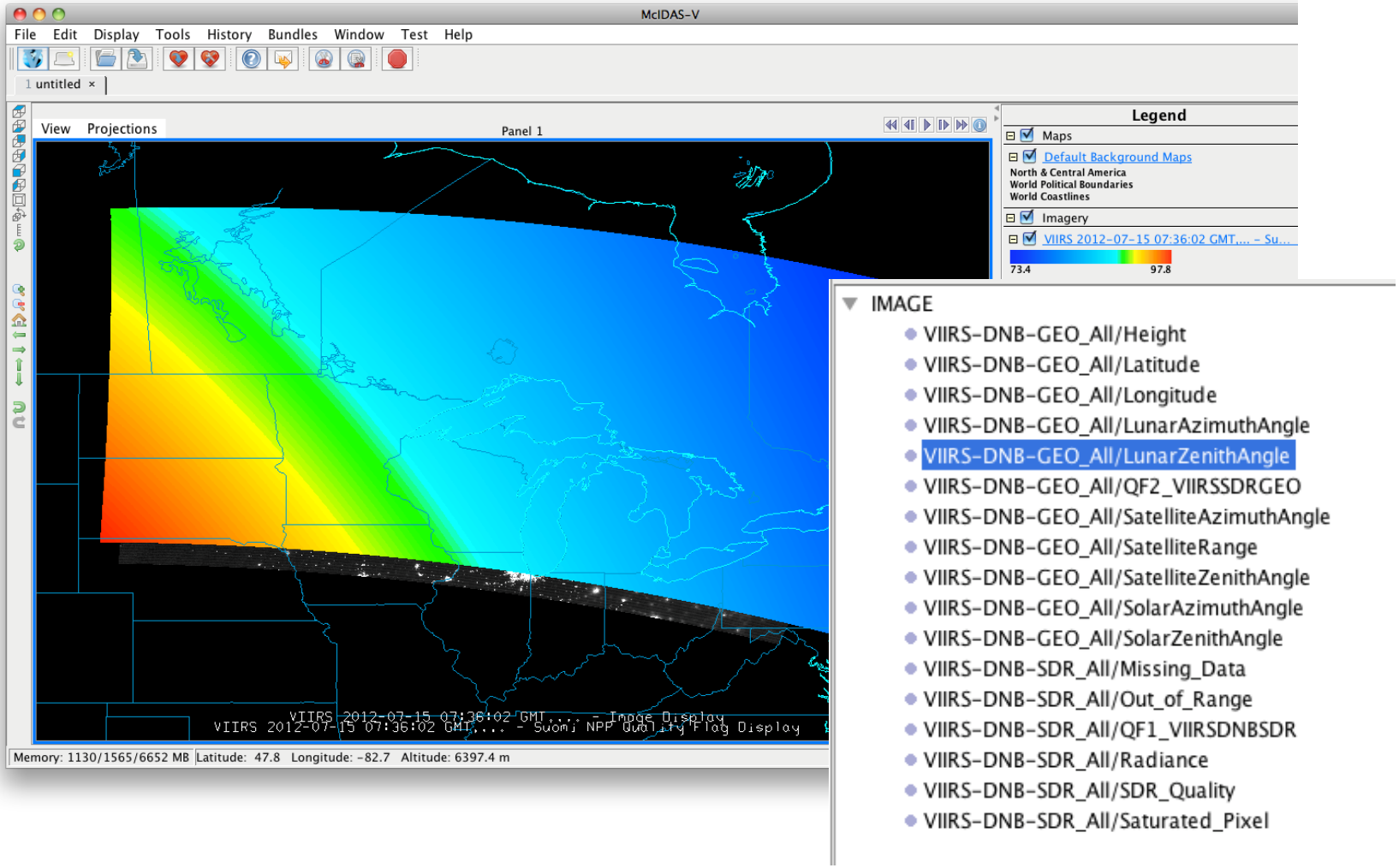
RGB composite



VIIRS Channel Differencing
DNB Stray light example



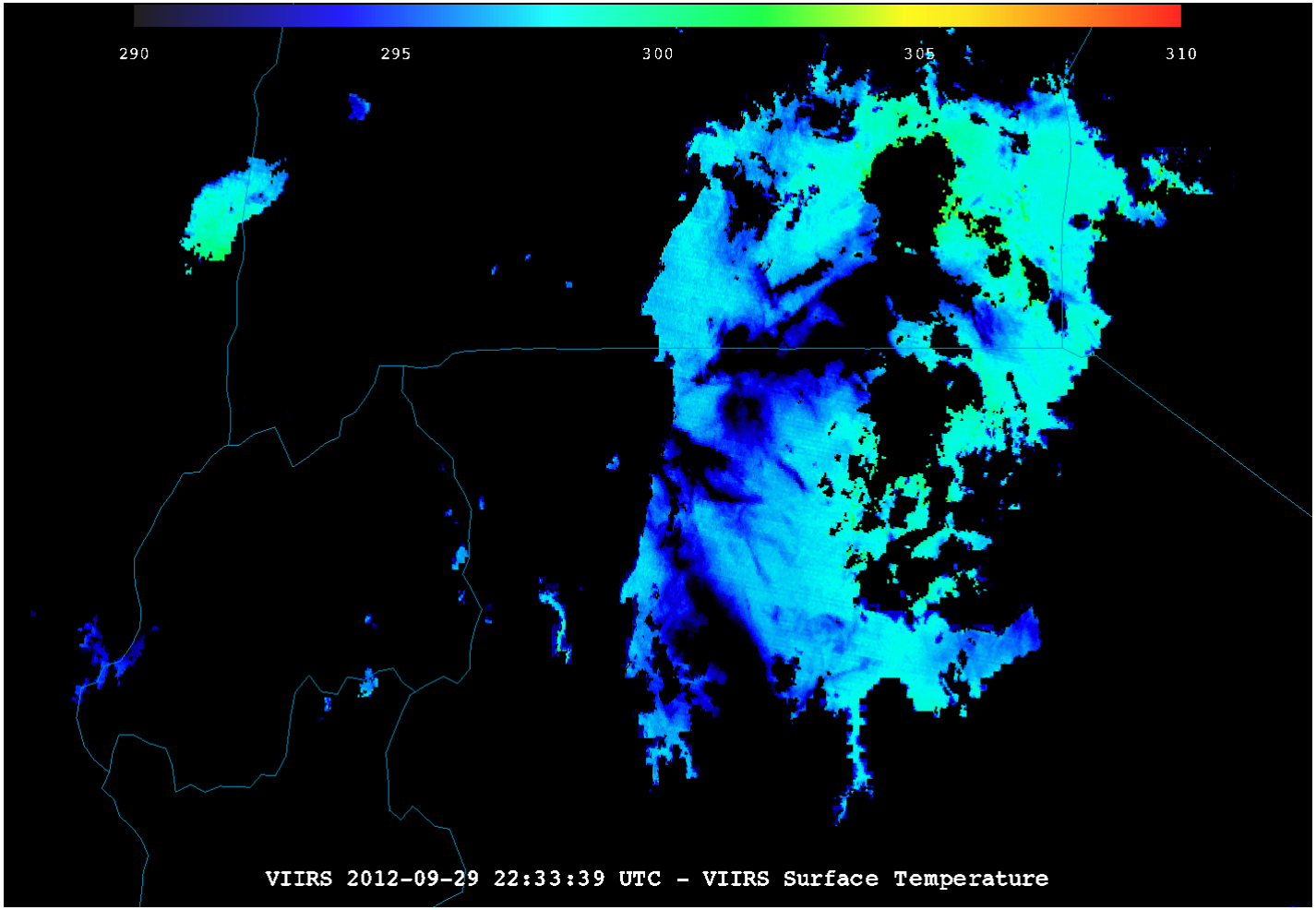
VIIRS SDR
Ancillary data



Visible Infrared Imaging Radiometer Suite (VIIRS) EDR

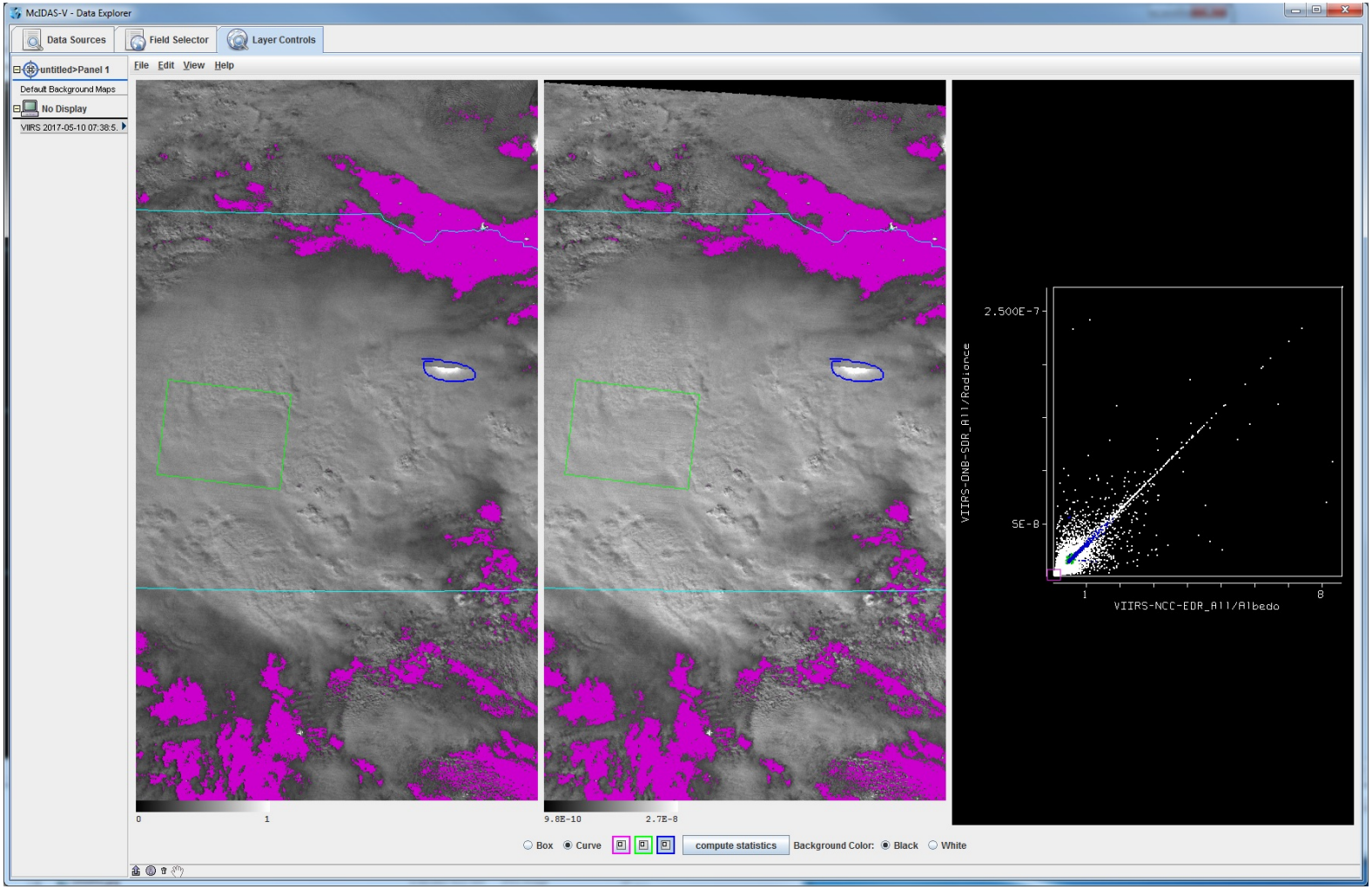
- There are a series of 20 Environmental Data Records (EDRs) produced from VIIRS
- McIDAS-V has been able to successfully ingest all EDRs including NDE Enterprise output
- McIDAS-V can unpack and display bit level data.
  - Ex. Displaying VCM test results

VIIRS DNB and Surface temperature EDR 2236Z, 09/29/2012

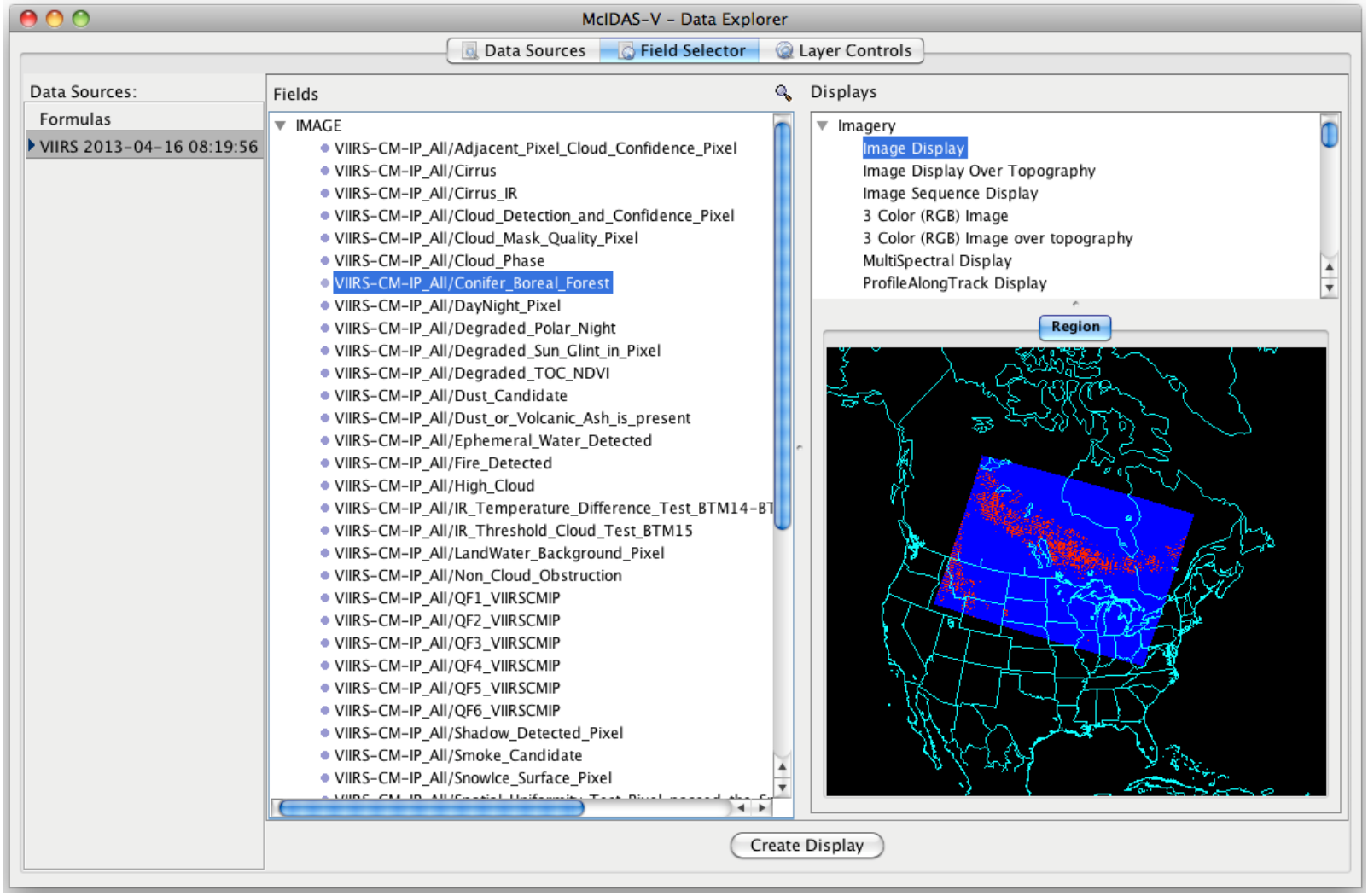


★ Lake Victoria

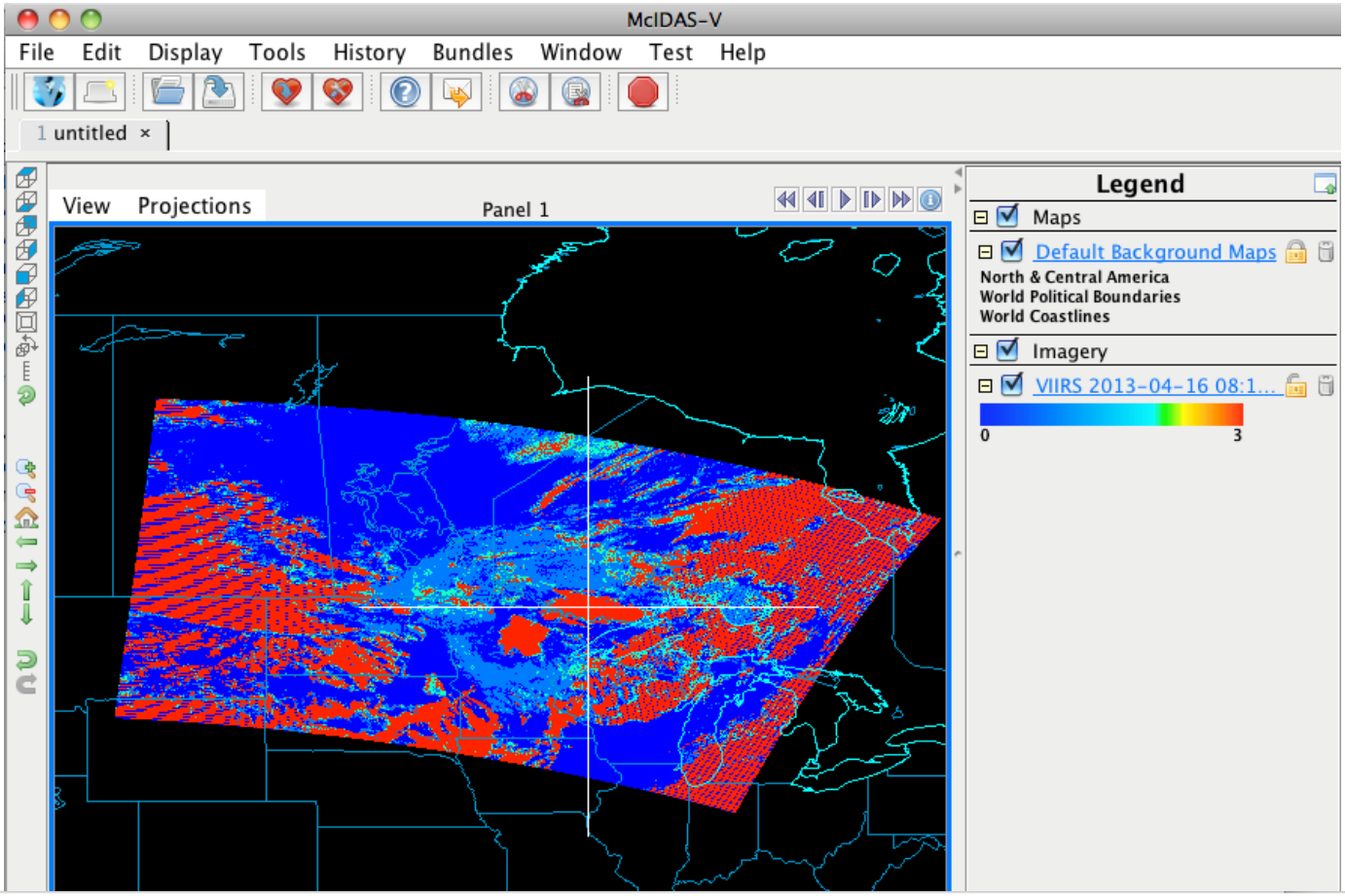
Imagery EDR example
Scatter analysis



Product EDR Variable selection



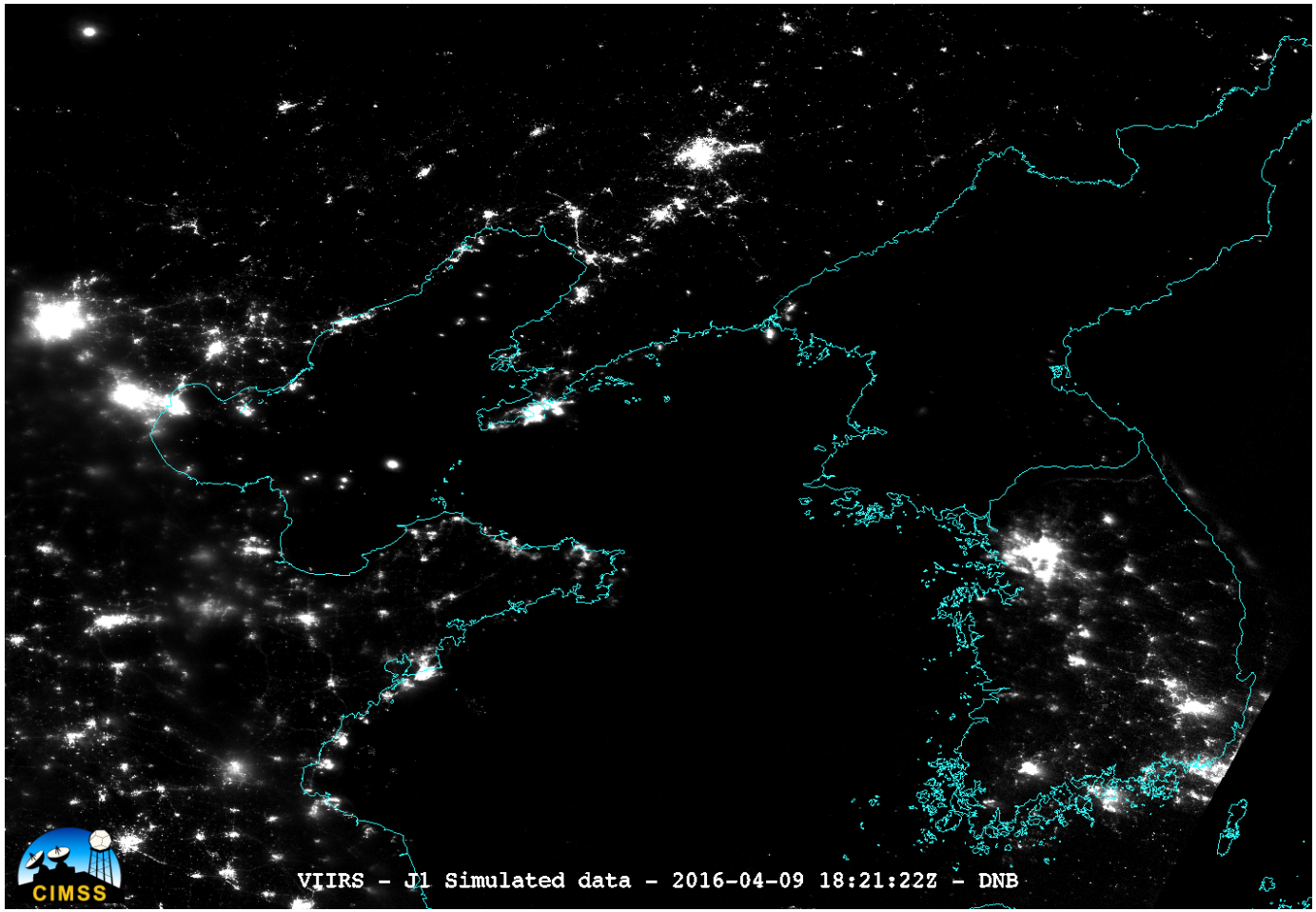
Product EDR Data Probe



S-NPP specific McIDAS-V 1.7 Updates

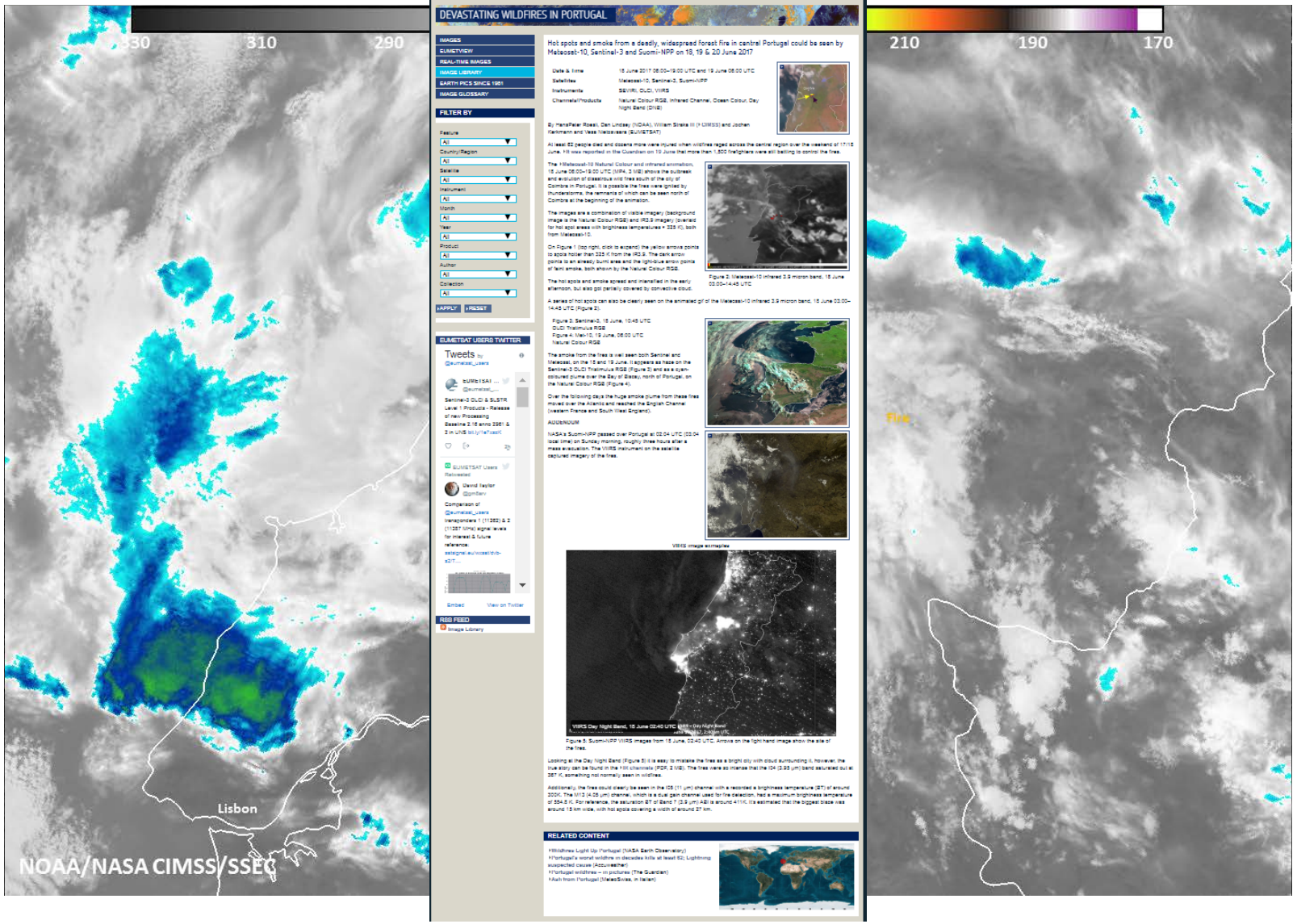
- Support for the VICMO cloud mask EDR (released March 2017) as well as backwards compatibility with IICMO data.
- Added a new "show variables" button to the Field Selector tab of the Data Explorer which can show the variable shortname or (if present) long name.
- VIIRS Formulas plugin that gives formulas to remove the bowtie deletion and create RGB displays without the bowtie
- Added several VIIRS specific Scripting functions to load and grab information from SNPP/J1 files.

S-NPP specific McIDAS-V 1.7 Updates



OTHER CIMSS SDR/EDR SUPPORT

Disaster monitoring
Fires and Smoke support

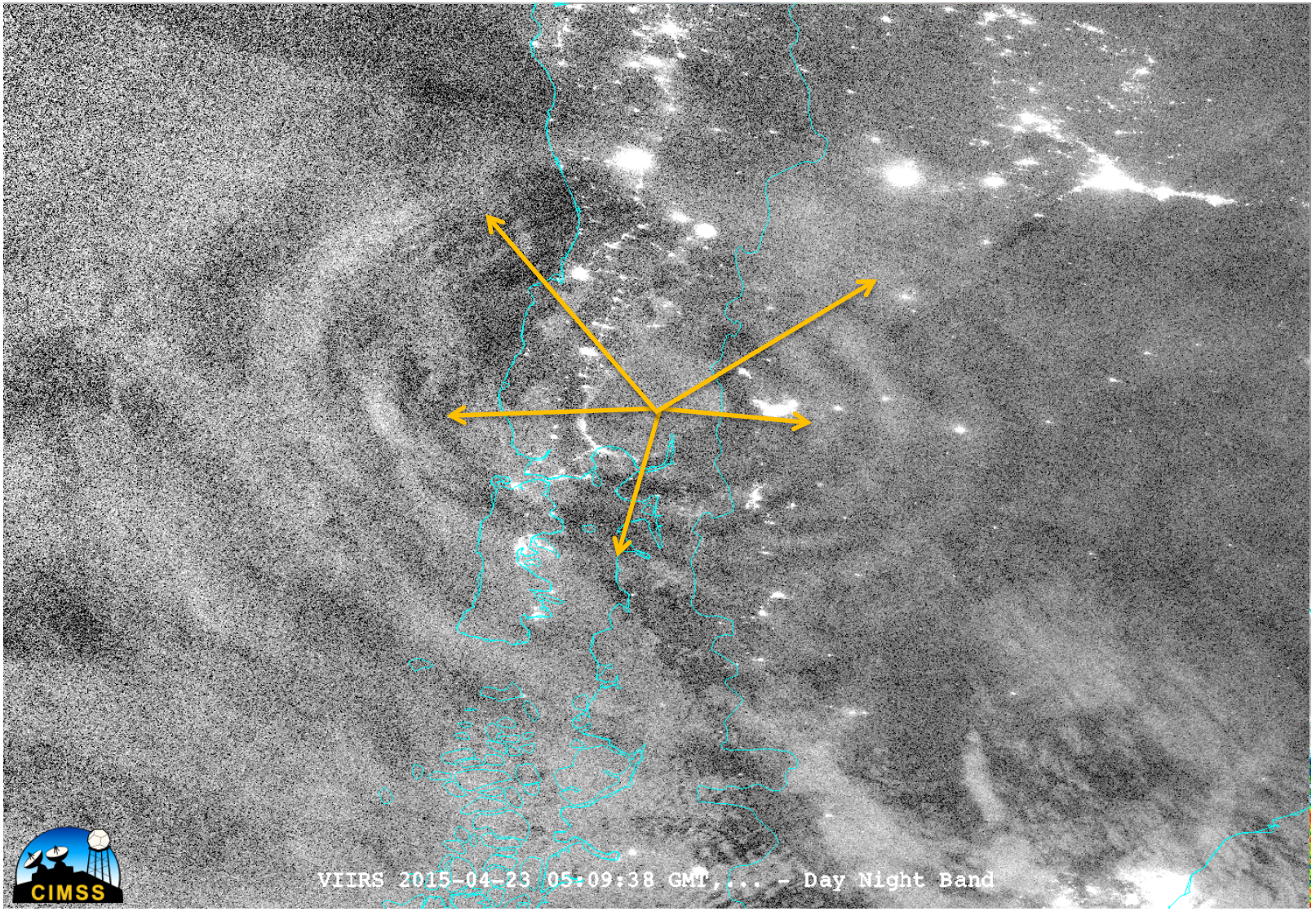


https://www.eumetsat.int/website/home/Images/ImageLibrary/DAT_3524803.html

Polar Monitoring Public Outreach



Mesospheric Gravity Wave monitoring



Mesospheric Gravity Wave monitoring

- Comparisons of DNB observations with ground based observations
  - Palomar Observatory
  - Amateur airglow photography (US and China)
  - Ground based low-light cameras (US and China)

Texas Thunderstorm



Other activities

- Observations of other interesting phenomena
  - Unexplained streaking in DNB
  - Aurora
  - search for marine bioluminescent sources in Southwest Asia and Indonesia
- Participation in ongoing Cal/Val Team discussions, TIMs, and support studies concerning DNB data quality on J1 and beyond.

Fires, flares, boats and lights: product lines from nighttime VIIRS data

Christopher D. Elvidge, Ph.D.
NOAA-NESDIS-NCEI Earth Observation Group
Boulder, Colorado USA
chris.elvidge@noaa.gov
Kimberly Baugh, Mikhail Zhizhin, Feng-Chi Hsu, Tilottama Ghosh
University of Colorado
August 16, 2017

Lights At Night!



Cities and human settlements



Boats



Industrial Sites



Gas Flares



Fires

VIIRS Collects Two Styles of Low Light Imaging Data

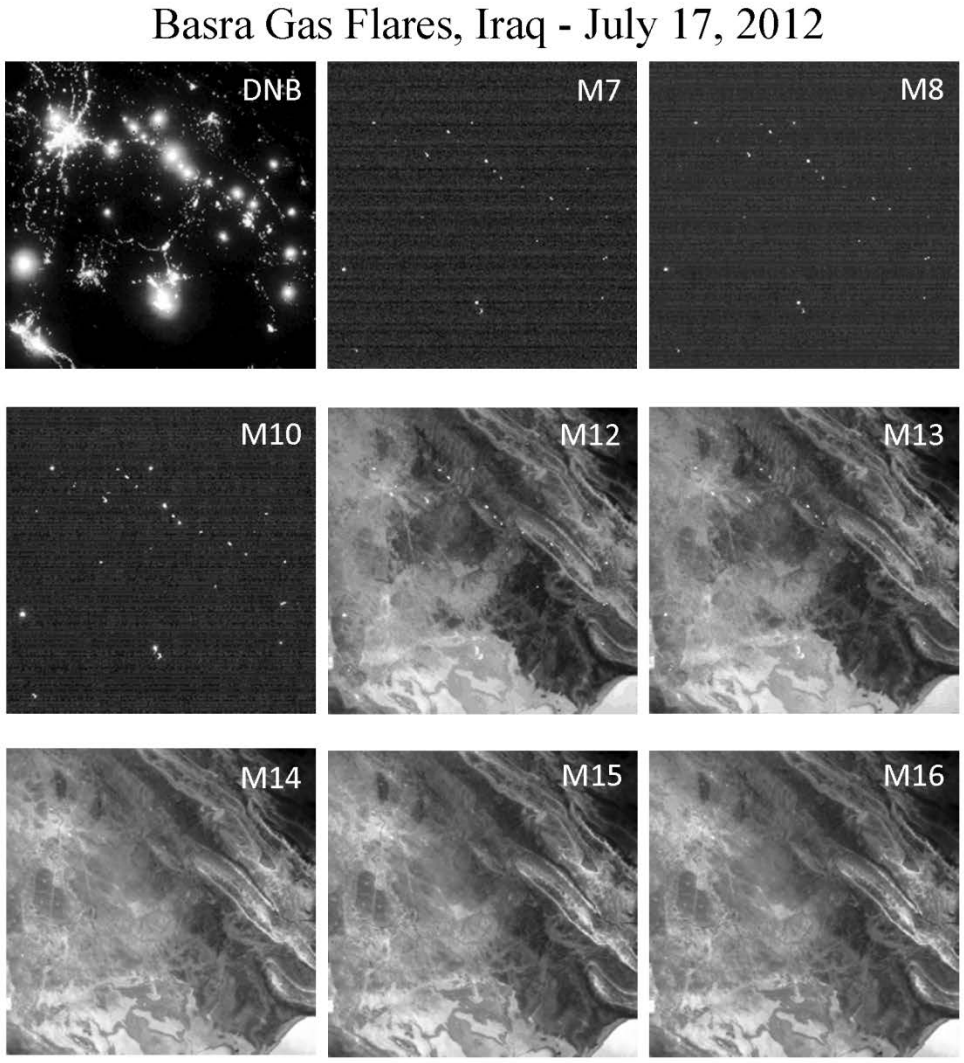
1. Signal intensification to detect faint radiant emissions in the visible and near infrared – the Day Night Band (DNB).
2. Daytime channels at night – enabling the detection of radiant emissions that are obscured by reflected sunlight. VIIRS collects the following at night:

   M7 at 0.865 um

   M8 at 1.24 um

   M10 at 1.61 um

   M11 at 2.25 to be added soon!

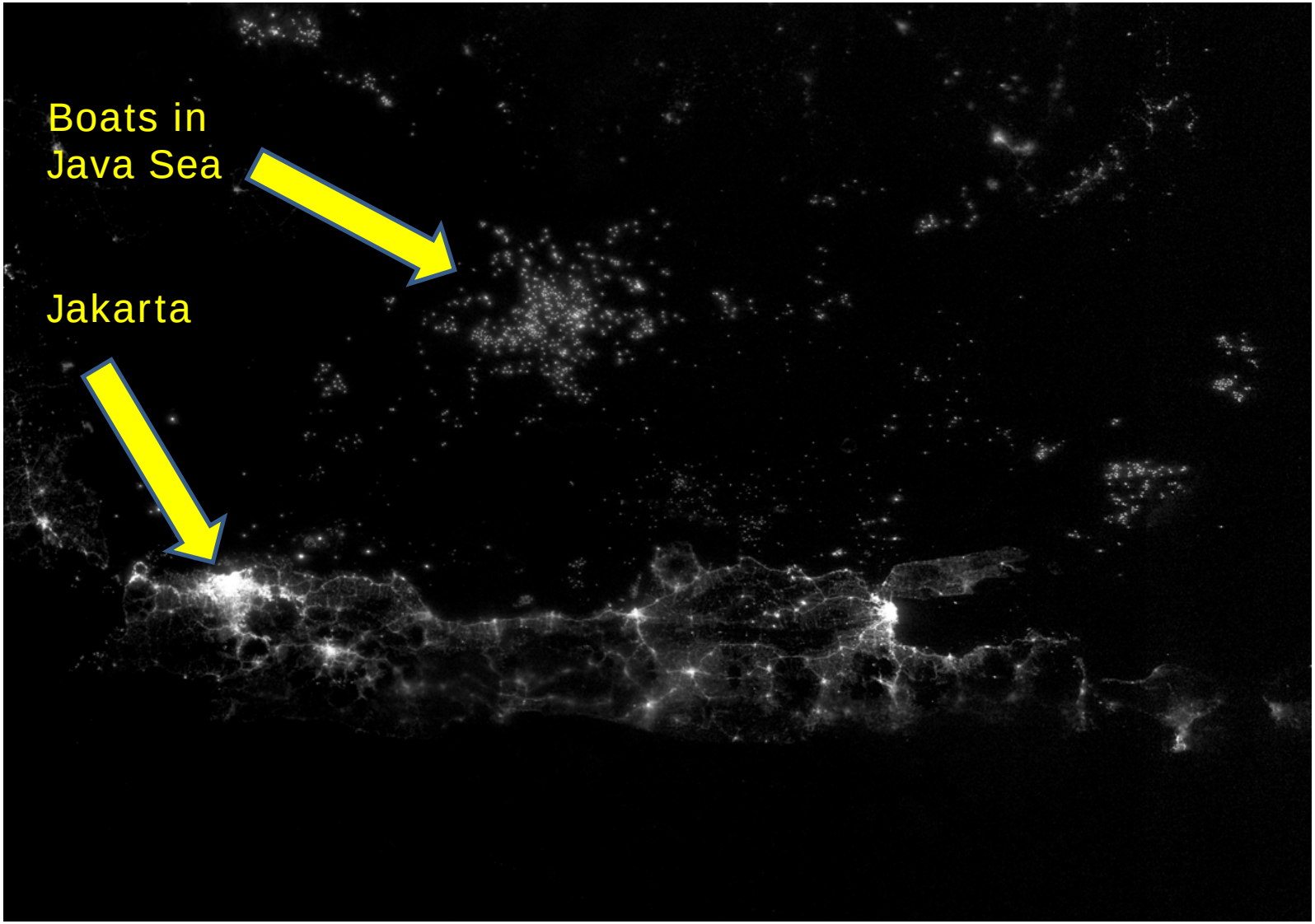


VIIRS low light imaging at night: DNB detects electric lighting, fires and flares. M7,8 & 10 detect combustion sources.

Three global product lines
https://ngdc.noaa.gov/eog/viirs/index.html

- **VIIRS boat detections (VBD):** Offshore detections of lights used by fishery agencies. Expanded to global in May, 2017. JPSS proving ground project (FY15-17). Four hour temporal latency. https://ngdc.noaa.gov/eog/viirs/download_boat.html
- **VIIRS nightfire (VNF):** Multispectral detections of fires, flares and other IR emitters. Used for annual surveys of gas flare locations and flared gas volumes. JPSS proving ground project (FY12-14). NASA carbon monitoring system (FY16-18). Four hour temporal latency. https://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html
- **VIIRS nighttime lights (VNL):** Global annual average radiances filtered to remove sunlit, moonlit, and cloudy observations. Additional filtering to remove lightning, fires, aurora, and background noise. NASA VIIRS Science Team (FY15-17). Widely used in the sciences, social sciences, and development tracking communities. https://ngdc.noaa.gov/eog/viirs/download_dnb_composites.html

VIIRS boat detection (VBD)

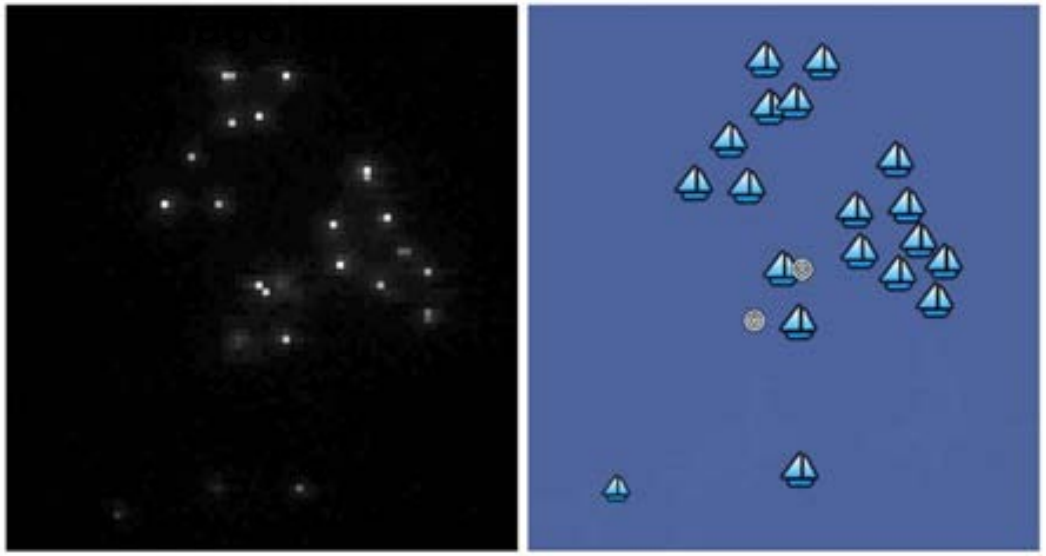


Algorithms run on images, output points, vast data volume reduction



VIIRS day/night band (DNB) nighttime

Boat detection data (points)



Single Night of Detections (June 9, 2017)

Standard is four hour temporal latency,
with files available at 06:00 local time



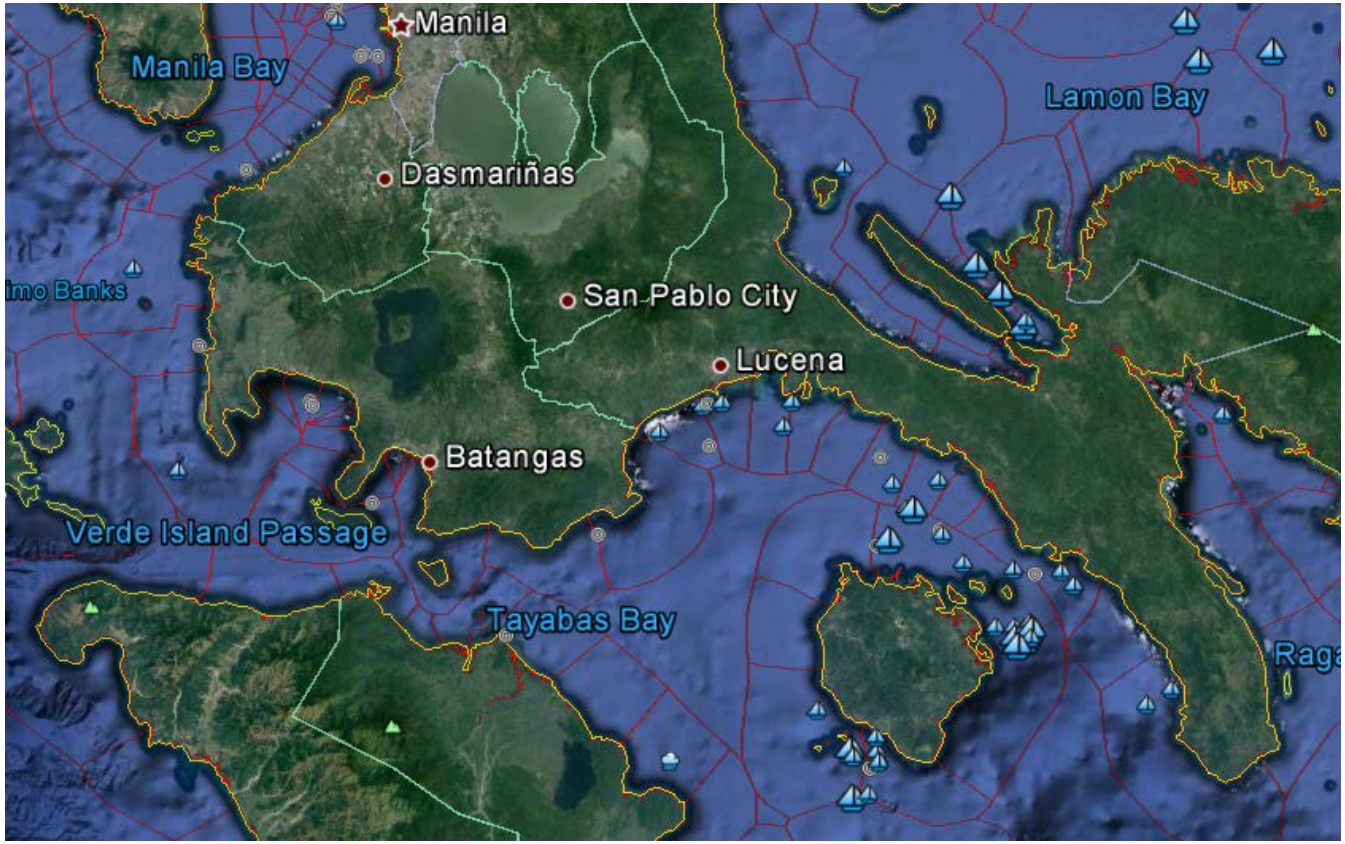
Placemarks sized based on radiance and have information panels



VIIRS Boat Detection (VBD)

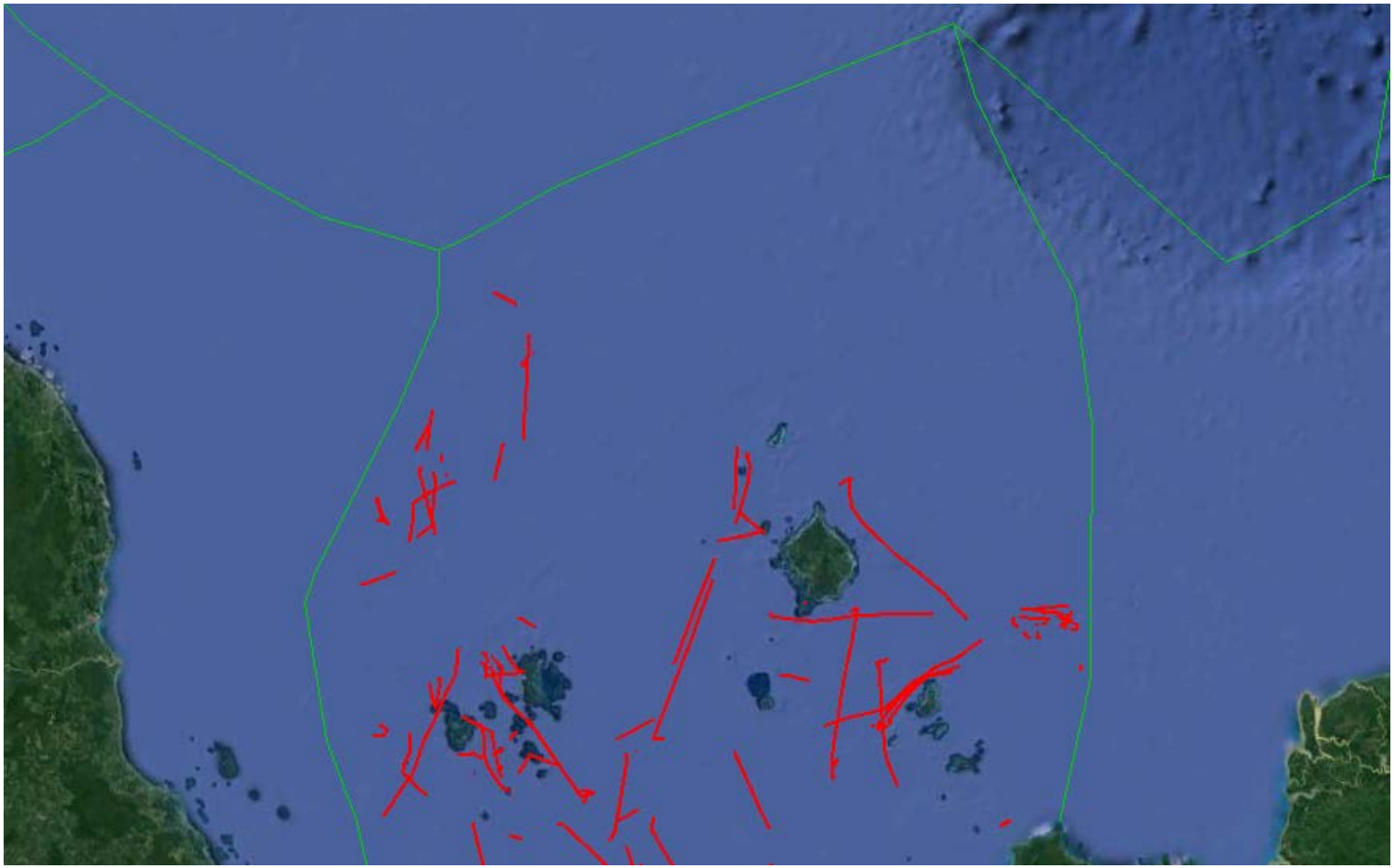
- Expanded from Asia-Pacific to global May, 2017.
- Temporal latency is ~4 hours, with last night's data files available at 06:00 local time.
- Files are available at: https://ngdc.noaa.gov/eog/viirs/download_boat.html
- Services running for 44 countries (in addition to global).
- Alerts running for MPAs, restricted coastal waters, and seasonal fishery closures in Indonesia and Philippines. BFAR region 5 (Philippines) reported 14 apprehensions in 2016 based on VBD alerts.
- Methods developed for identification of "dark" vessels that lack VMS (vessel monitoring system).

Detection of illegal fishing boats in restricted coastal waters

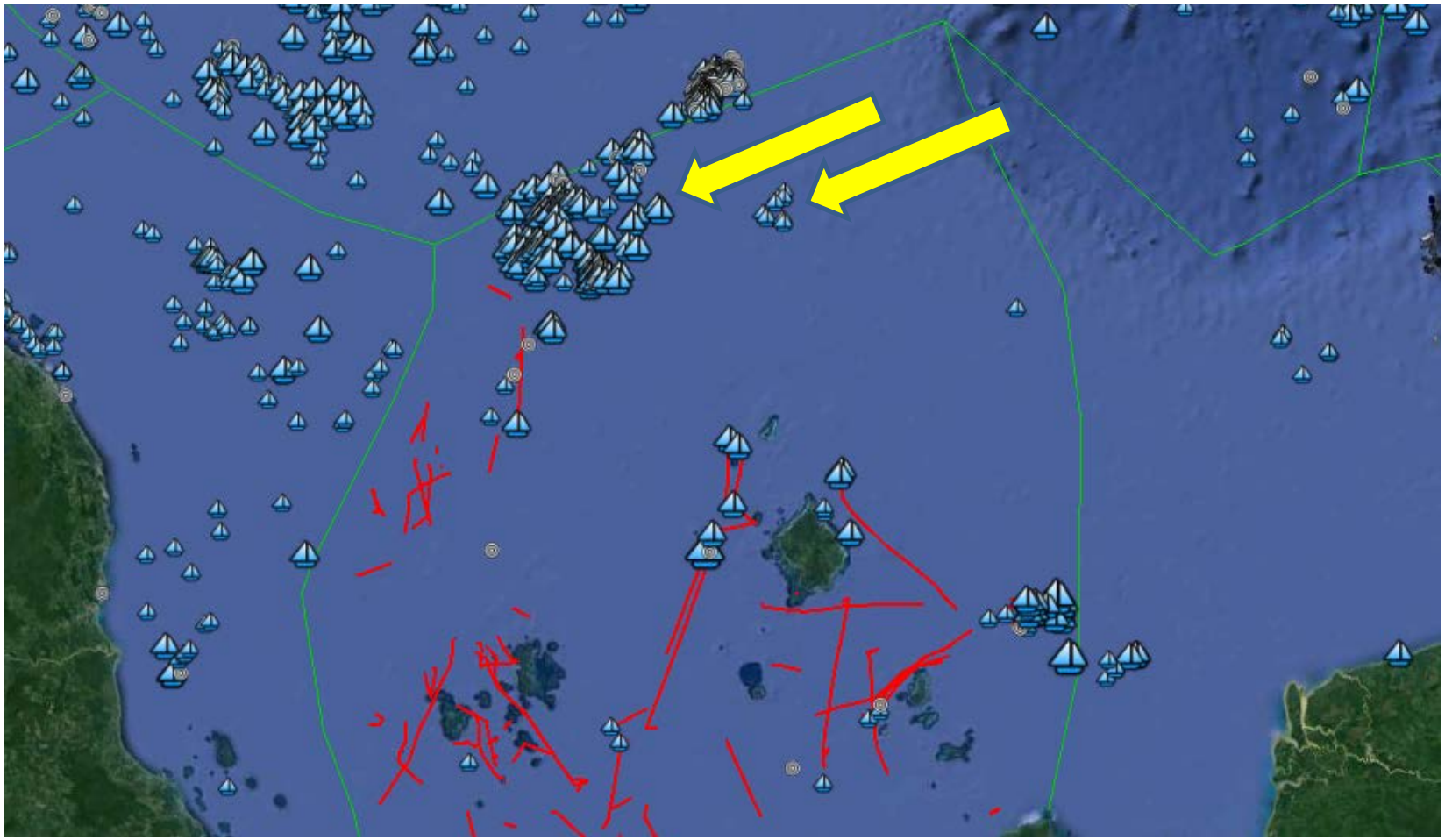


June 1, 2017 alert for municipal waters in the Philippines. Commercial fishing is banned in these coastal waters.

VMS Tracks in Natuna Sea
October 1, 2016



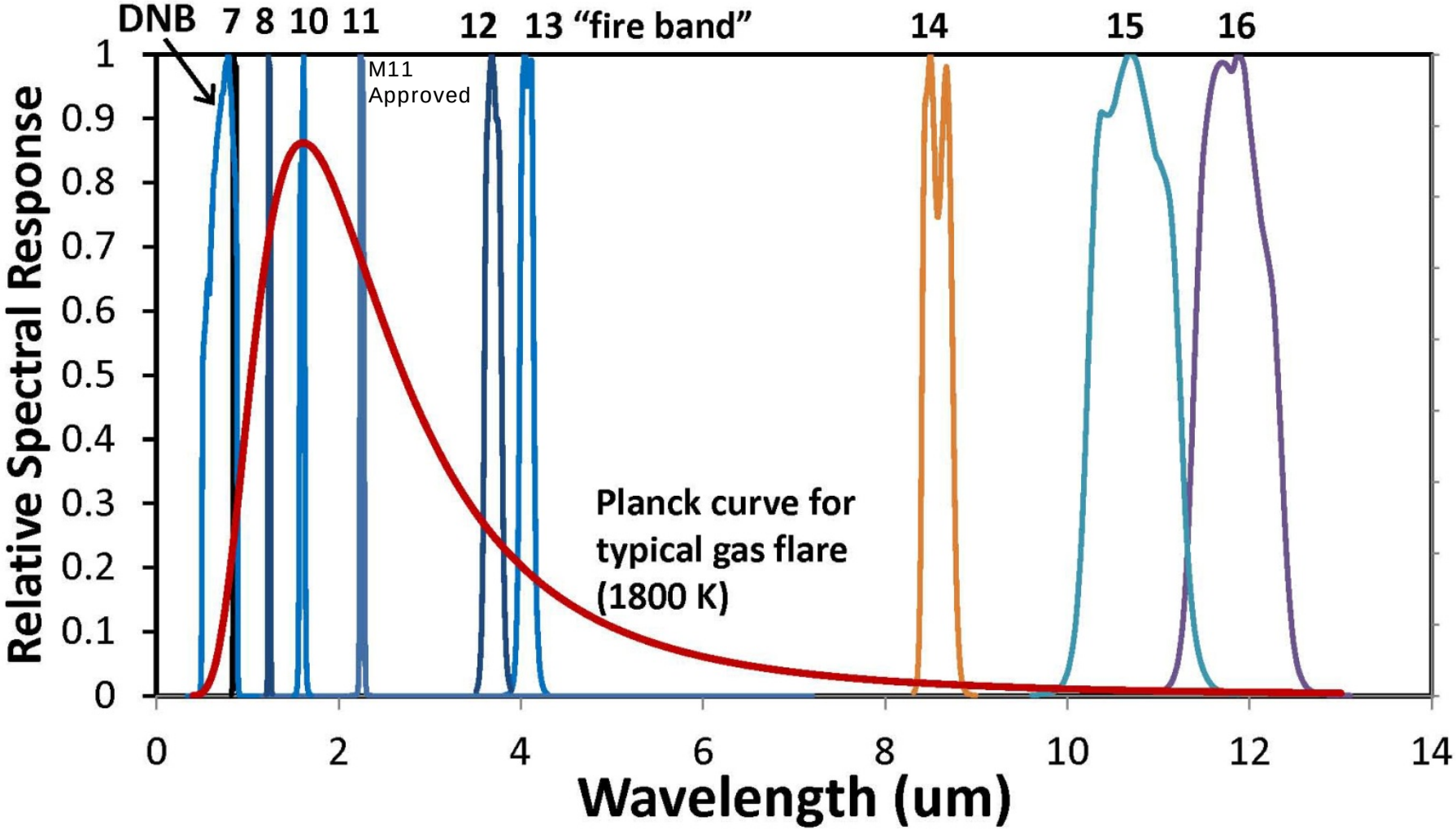
October 1, 2016 boats detected by VIIRS but lacking VMS are suspect



VIIRS Nightfire (VNF)

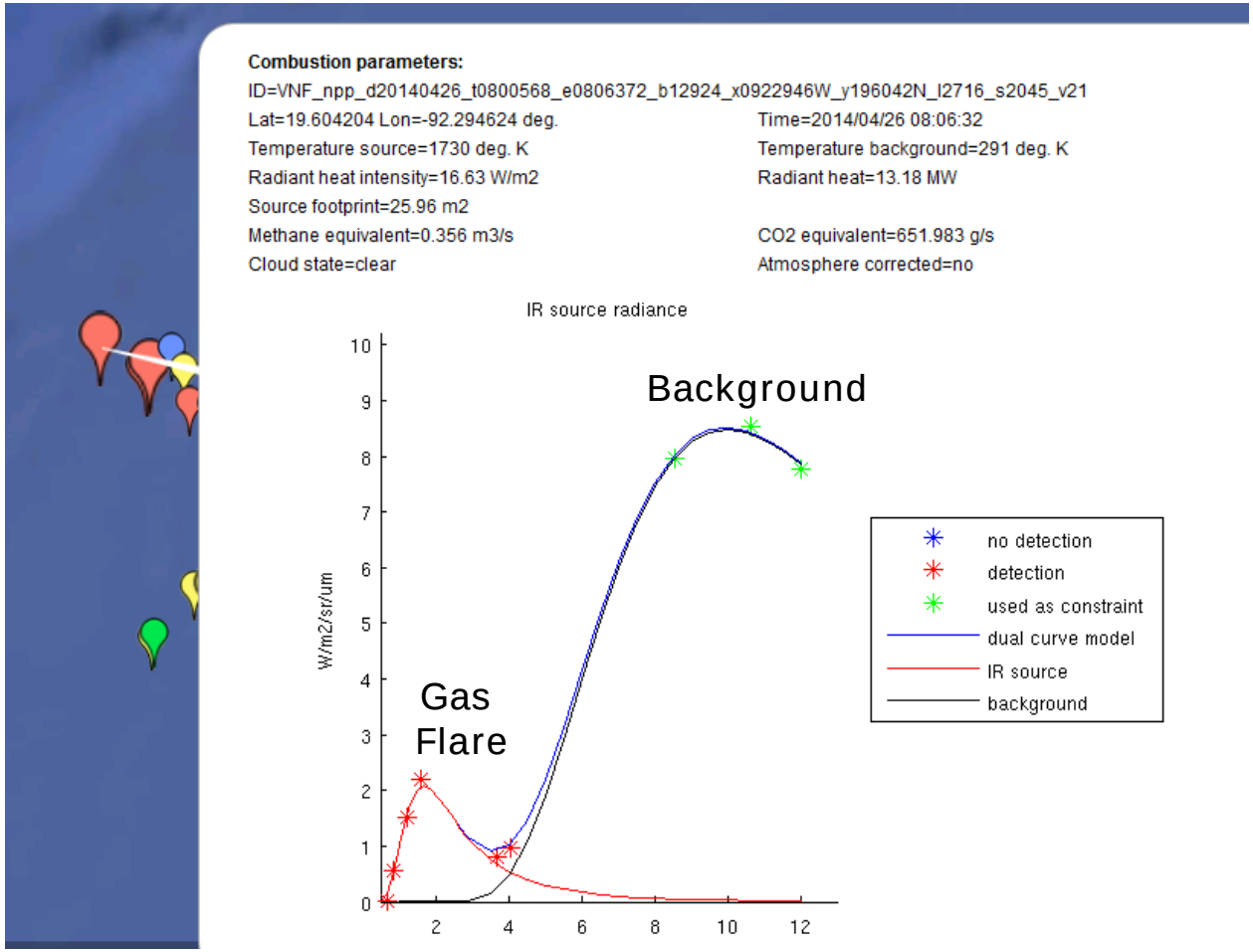
- A multispectral global fire product
- Makes use of near-infrared and shortwave infrared data.
- What is different from other global fire products?
  - Two independent hot source detection algorithms:
    - M10 in the shortwave infrared
    - M12-M13 in the midwave infrared
  - Dual Planck curve fitting (background and hot source) followed by calculations using physical laws
  - Temperature calculation based on Wien's Displacement Law
  - Source area estimation based on Planck's Law
  - Radiant heat (W/m2) calculated using the Stefan-Boltzmann Law
- Nightly global data are available at: http://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html
- Global gas flaring data are available at: http://www.ngdc.noaa.gov/eog/viirs/download_global_flare.html

VIIRS Nightfire (VNF): A global multispectral fire product
Nine channels of data collected at night



Nighttime collection of channel 11 is expected to start in 2017

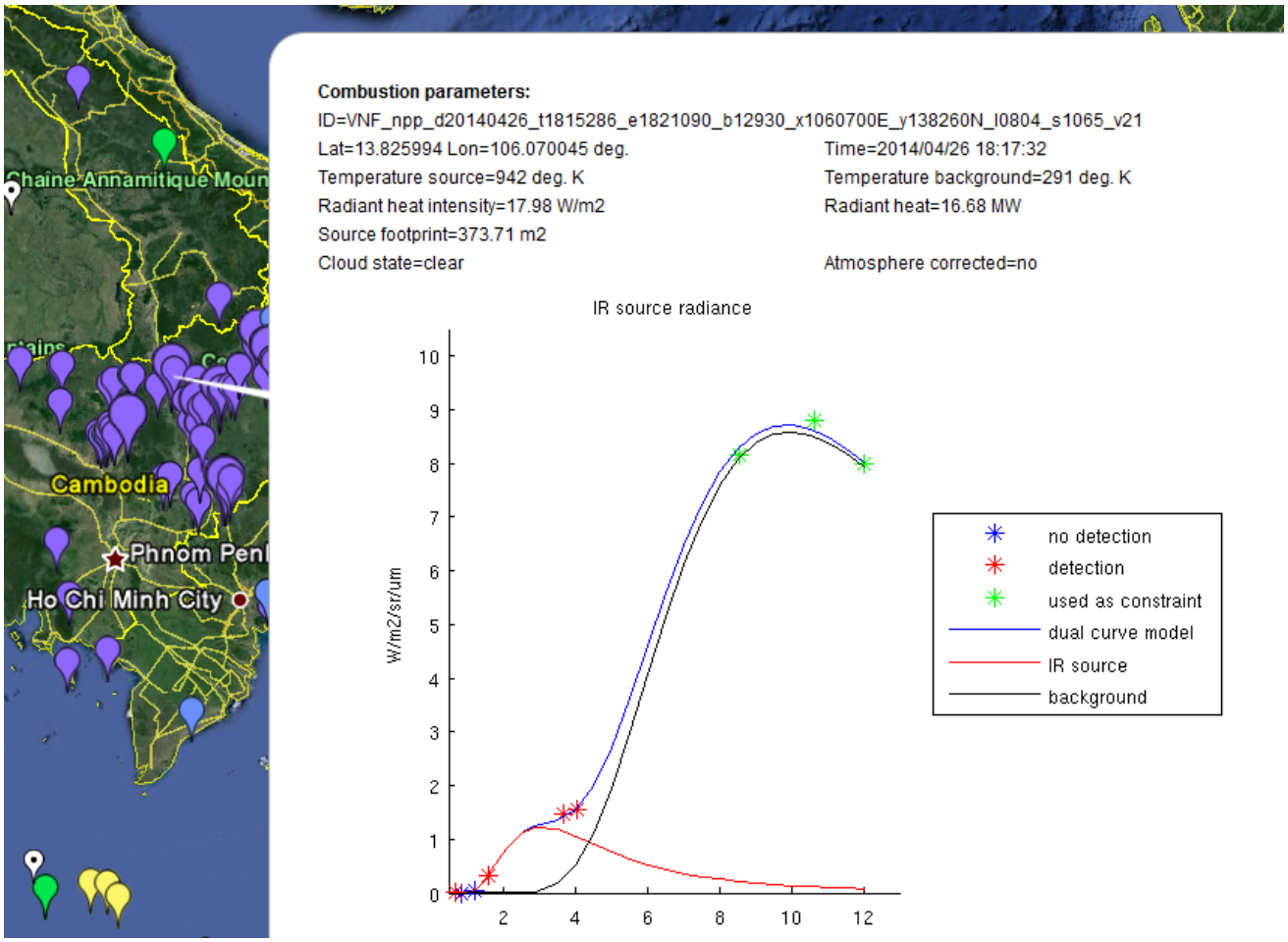
Why Multispectral?



To get at the Planck curves!

Daily files are in csv and kmz formats

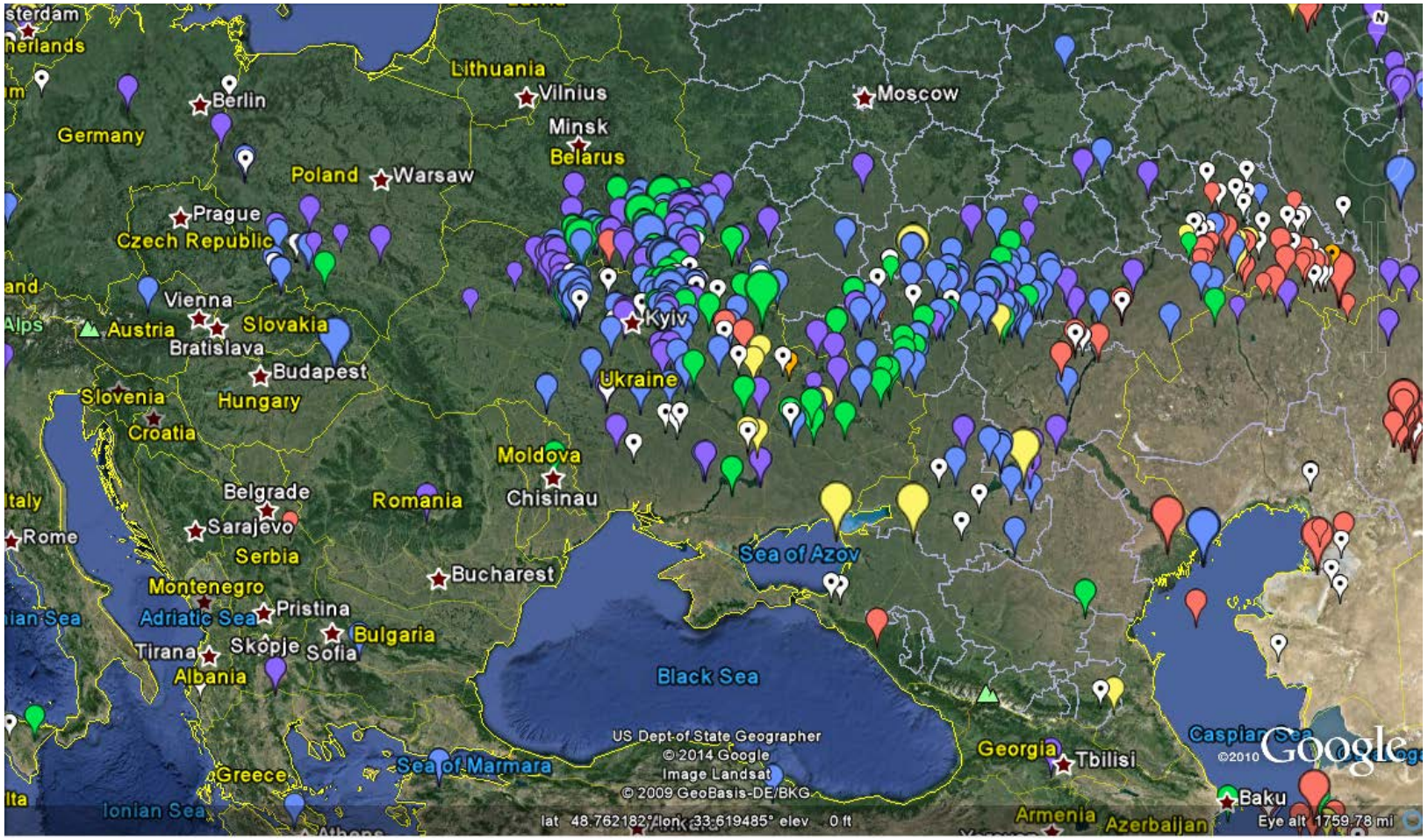
Typical Biomass Burning Detection



Lower temperature than gas flaring. Often these have larger source size than gas flares.

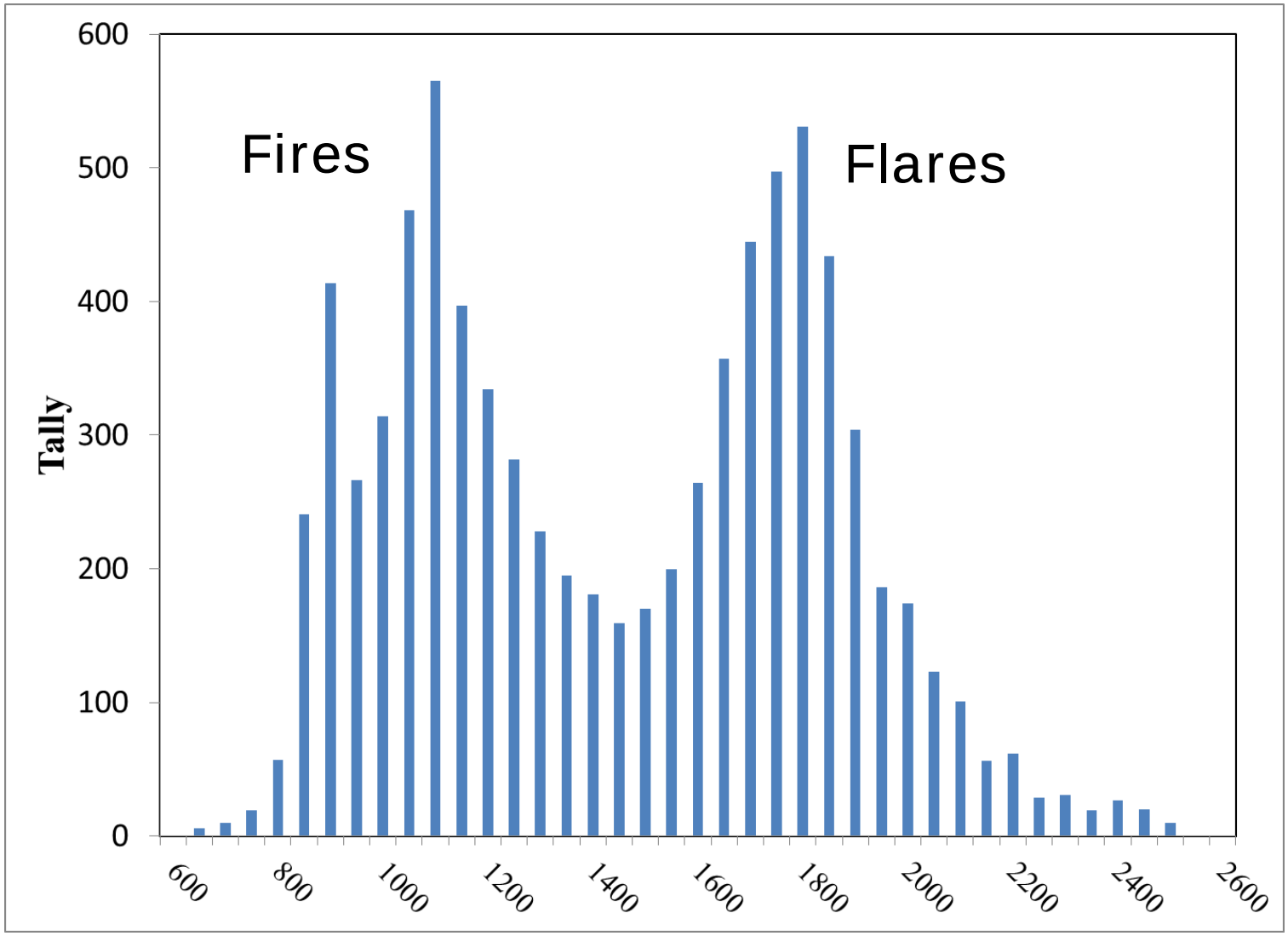
Daily VNF data are available at:

http://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html



Current processing typically runs with a four hour delay

Temperatures are bimodal



Gas Flaring

- A widely used practice to dispose of natural gas that cannot be utilized or brought to market due to lack of infrastructure.
- VNF is ideally suited for detecting and estimating flare volumes because the M10 band covers the peak radiant emissions for flares.
- Using VNF data we have identified 18,129 flares from 2012-2015.
- Russia has the largest flare volume.
- USA has the largest number of flares.
- VIIRS data can be used for Monitoring, Reporting, and Verification (MRV) of gas flaring reductions:
  - Greenhouse gas emission reduction commitments under the Paris Climate Agreement
  - UN & Worldbank “Zero routine flaring by 2030” inititative.

UN Initiative to end routine flaring by 2030

THE WORLD BANK
IBRD • IDA
Working for a World Free of Poverty

ABOUT DATA RESEARCH LEARNING NEWS PROJECTS & OPERATIONS PUBLIC

Zero Routine Flaring by 2030

TWEET LIKE SHARE +

FEATURED 2 / 2



The Zero Routine Flaring Initiative

May 22, 2015 — The initiative was launched by UNSG Ban Ki-moon and WBG President Jim Yong Kim with governments, oil
Read More »

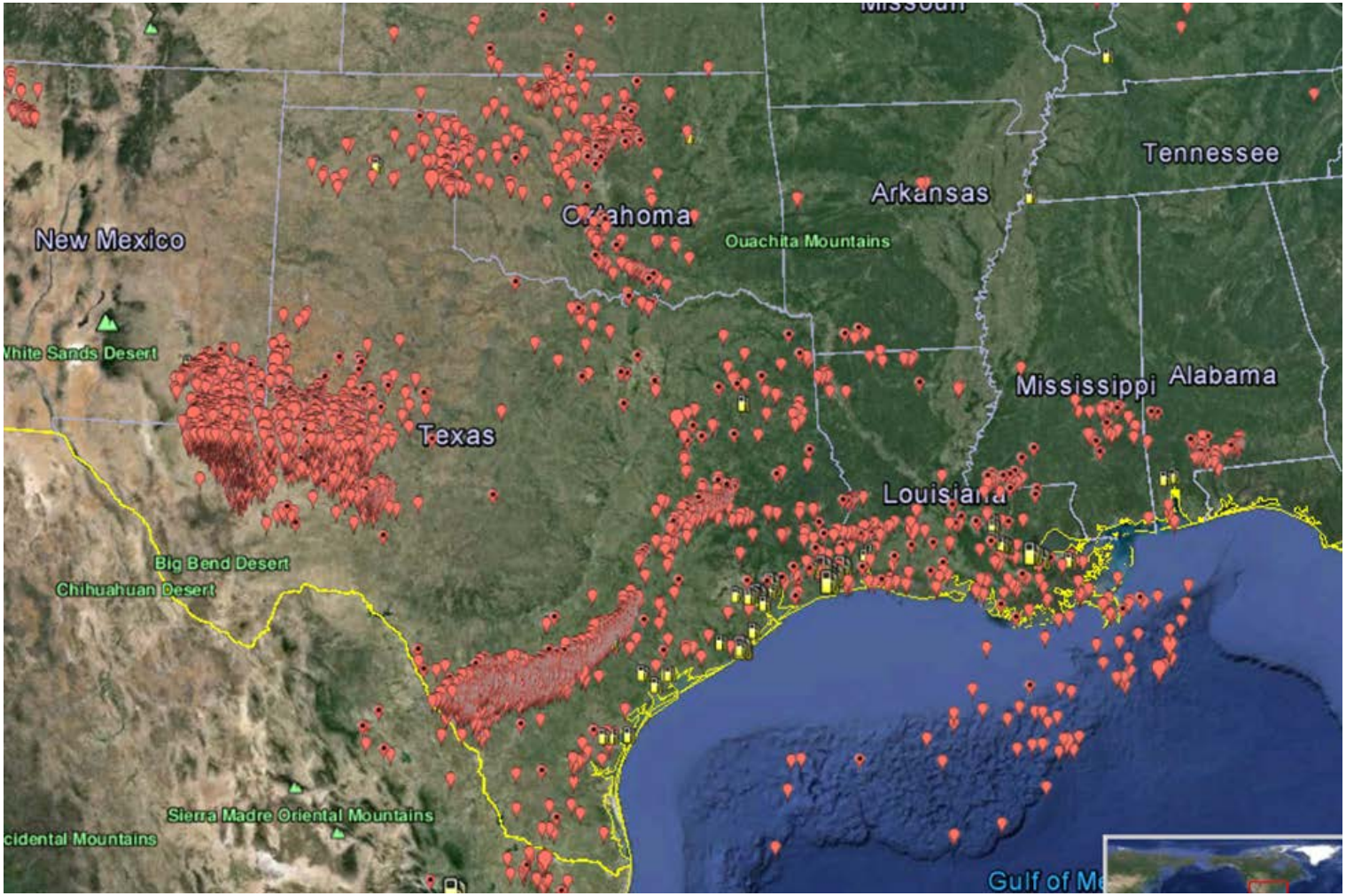
Initiative | Q&A | Quick Facts | Endorsers | Get Involved | Related Information | Flaring in the News

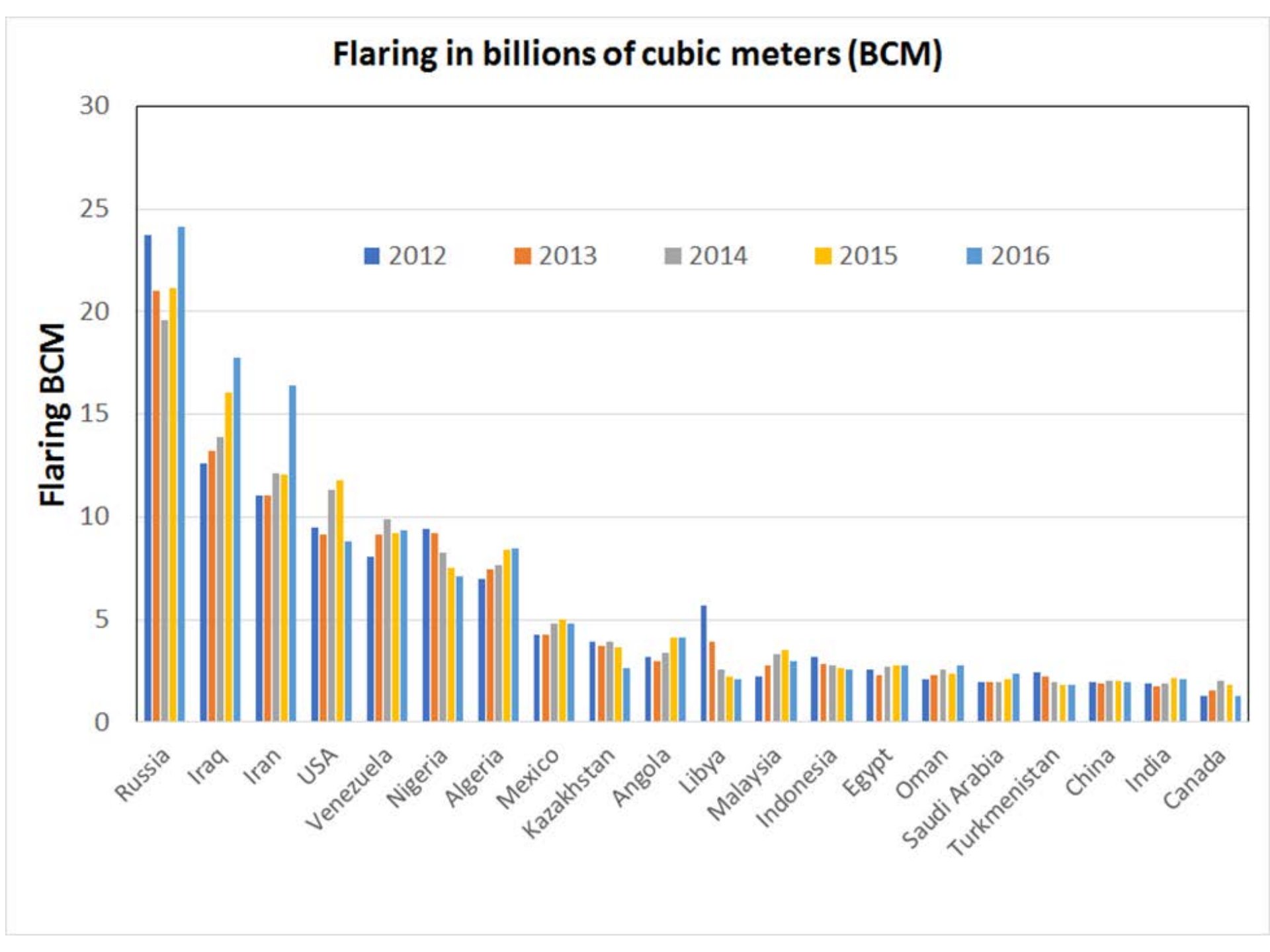
During oil production, associated gas is produced from the reservoir together with the oil.

How will progress be tracked? VIIRS!

Annual summaries of gas flare locations and gas flare volume estimates are available at:

https://ngdc.noaa.gov/eog/viirs/download_global_flare.html




Flaring in billions of cubic meters (BCM)
Flaring BCM
30
25
20
15
10
5
0
2012
2013
2014
2015
2016
Russia
Iraq
Iran
USA
Venezuela
Nigeria
Algeria
Mexico
Kazakhstan
Angola
Libya
Malaysia
Indonesia
Egypt
Oman
Saudi Arabia
Turkmenistan
China
India
Canada

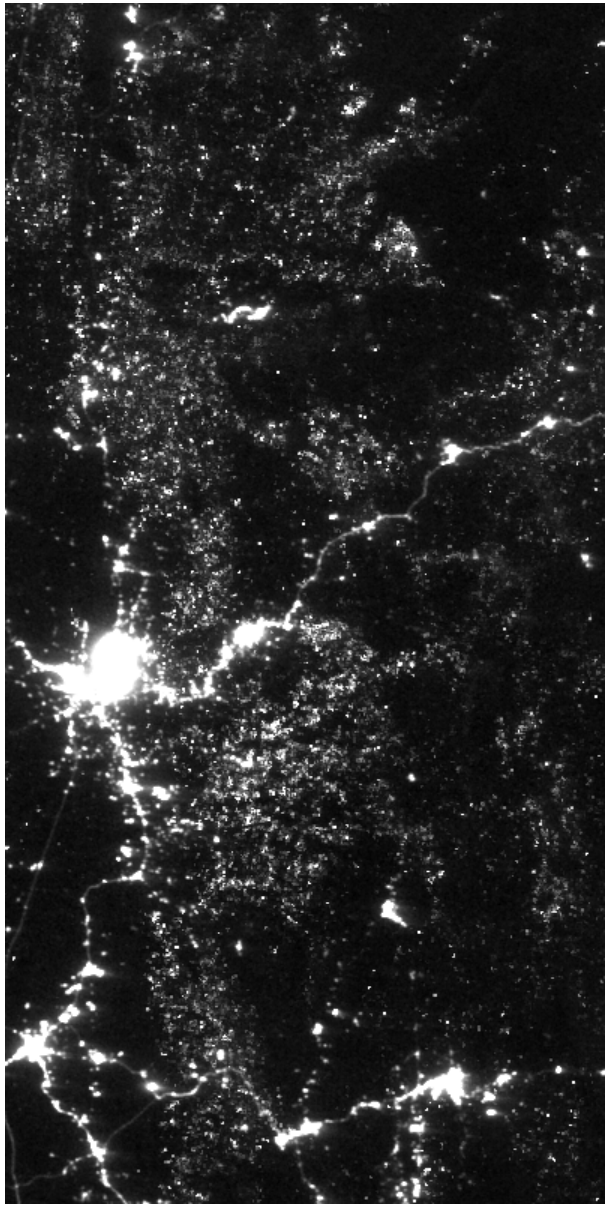
VIIRS Nighttime Lights (VNL)



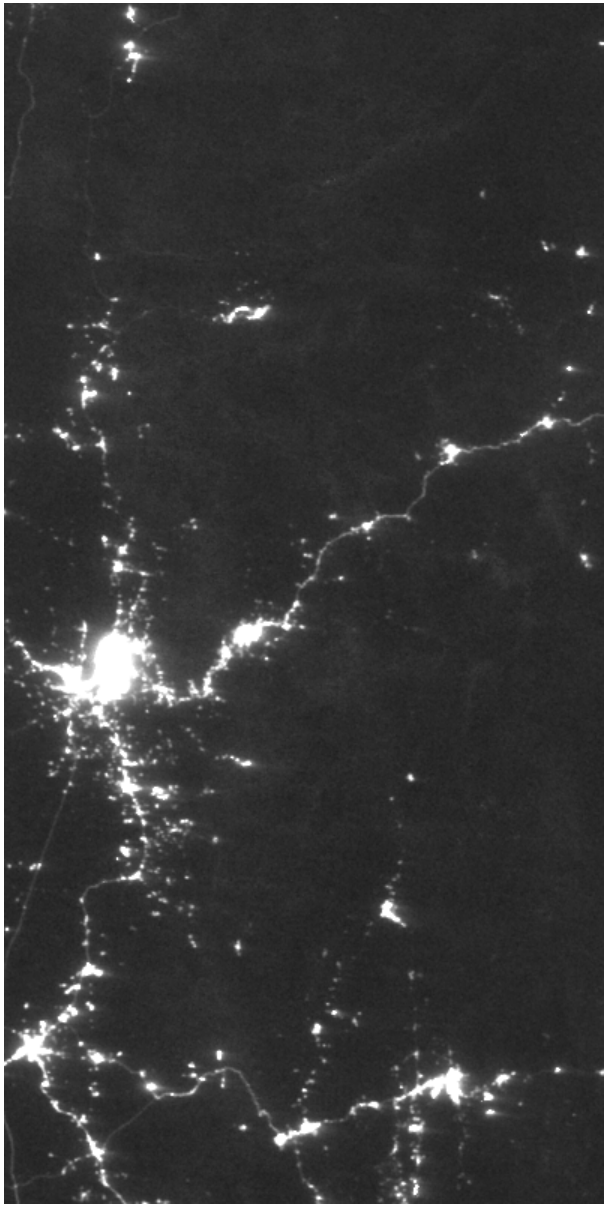
- Raw cloud-free composite: Average DNB radiance filtered to remove sunlit, moonlit, cloudy, and lightning.
- Outlier removal to filter out the biomass burning and most of the aurora contamination.
- VIIRS nighttime lights: Filtered to remove background noise and manual editing to removed remaining aurora features.

VIIRS Nighttime Lights (VNL)

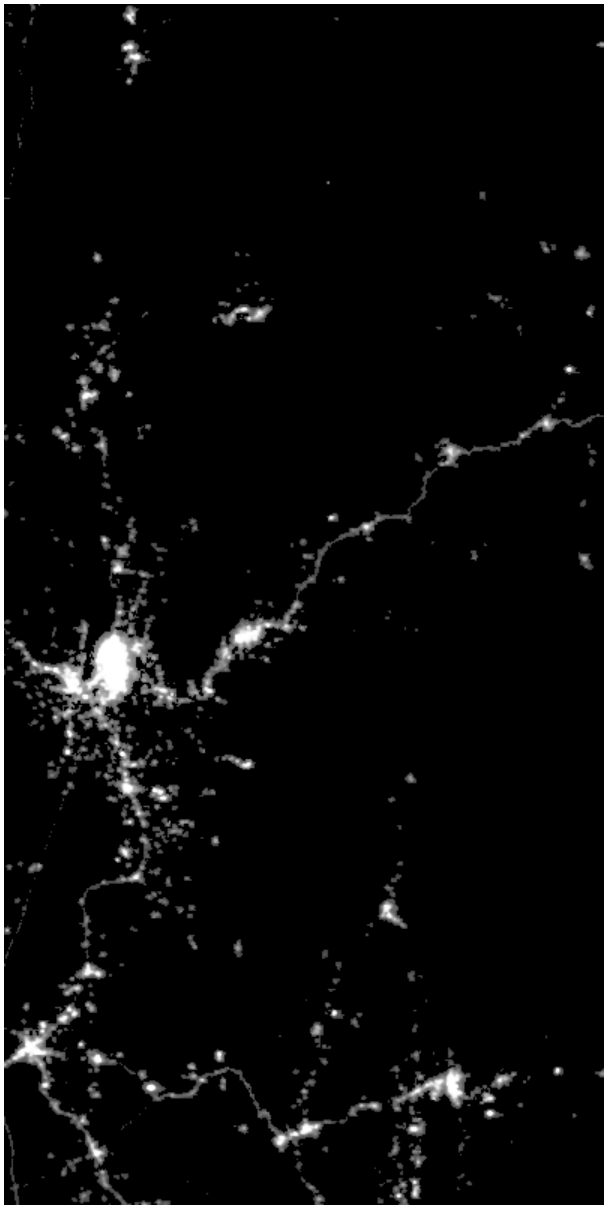
Raw cloud-free composite

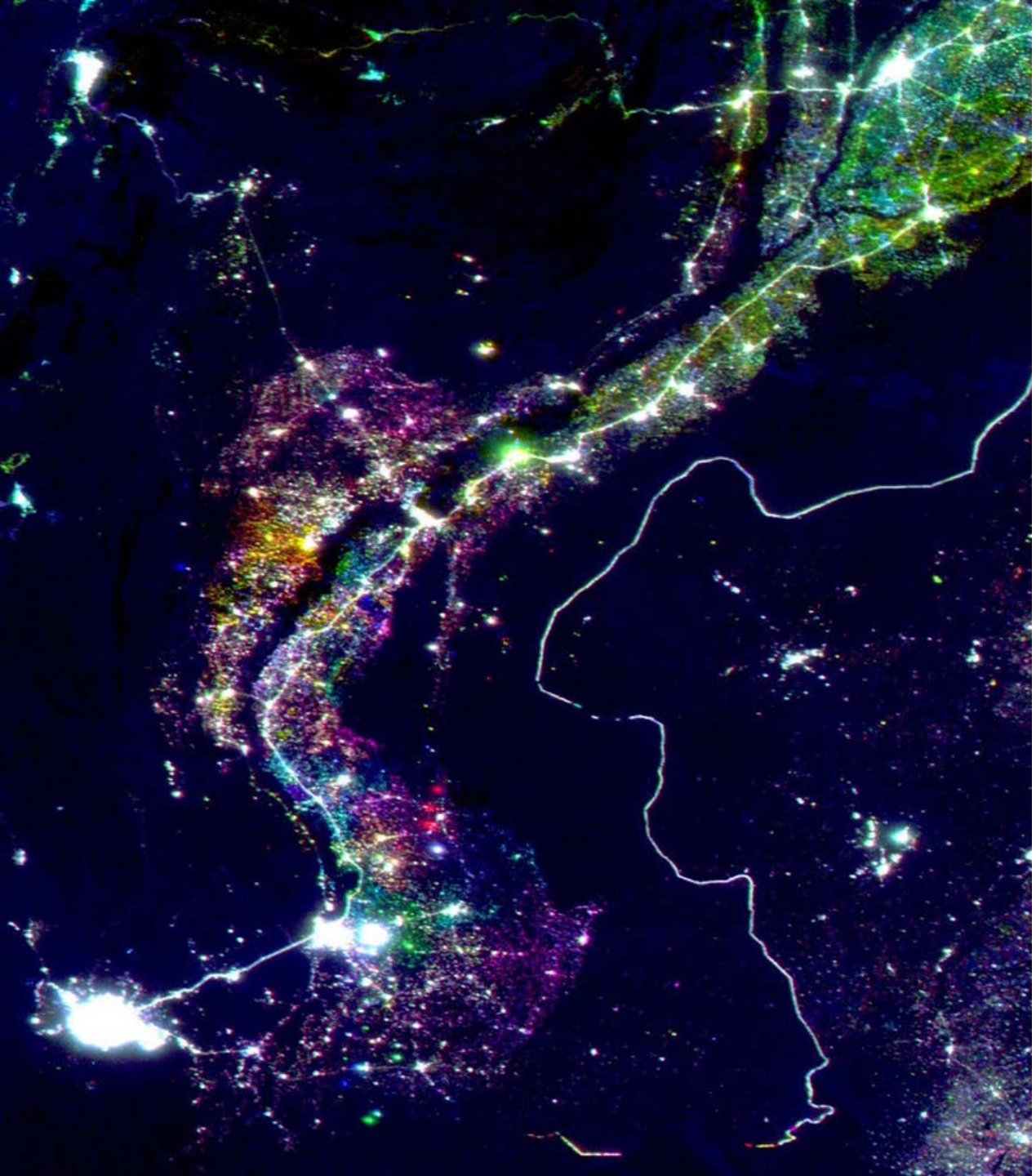


Outlier removed



Nighttime lights





Power grid behaviors uncovered by VIIRS in Pakistan. Three months as RGB (Jan. 2013 red, Oct. 2012 green, April 2012 blue).

Summary: Three global products

- VBD: Nightly VIIRS boat detection (VBD) data produced with 4 hour latency. Alerts for closures and protected areas. ID of boats lacking tracking records from VMS or AIS. Monthly and annual summary grids. Data access:
  - https://ngdc.noaa.gov/eog/viirs/download_boat.html
- VIIRS nightfire.
  - Nightly data: https://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html
  - Annual gas flaring data: https://ngdc.noaa.gov/eog/viirs/download_global_flare.html
- VIIRS nighttime lights – monthly and annual cloud-free composites.
  - https://ngdc.noaa.gov/eog/viirs/download_dnb_composites.html

Publications

- 2017: VIIRS nighttime lights:. IJRS doi:10.1080/01431161.2017.1342050
- 2017: Potential Role of Gas Flaring Reductions in Meeting Paris Climate Agreement Targets. Submitted to Energy Strategy Reviews, May 2017.
- 2016: Methods for Global Survey of Natural Gas Flaring from Visible Infrared Imaging Radiometer Suite Data Energies doi:10.3390/en9010014
- 2015: Automatic Boat Identification System for VIIRS Low Light Imaging Data . Remote Sensing doi:10.3390/rs70303020
- 2013: VIIRS Nightfire: Satellite pyrometry at night . Remote Sensing doi:10.3390/rs5094423
- 2013: What is so great about nighttime VIIRS data for the detection and characterization of combustion sources? doi: 10.7125/APAN.35.5
- 2013: Using the short-wave infrared used for nocturnal detection of combustion sources in VIIRS data. doi: 0.7125/APAN.35.6
- 2013: Why VIIRS data are superior to DMSP for mapping nighttime lights. doi:10.7125/APAN.35.7
- 2013: Nighttime lights compositing using the VIIRS day-night band: Preliminary results . doi: 0.7125/APAN.35.8
- 2013: Steve Miller's Illuminating the capabilities of the Suomi NPP VIIRS Day/Night Band. doi: 0.3390/rs5126717

U.S. NAVAL RESEARCH LABORATORY

Supporting the NWS in San Juan, Puerto Rico with VIIRS-derived Products

Arunas P. Kuciauskas, Peng Xian, Edward J. Hyer,
James R. Campbell, and Mayra I. Oyola*

Naval Research Laboratory, Marine Meteorology Division, Monterey, CA
* American Society for Engineering Education, Washington, DC

U.S. NAVAL RESEARCH LABORATORY

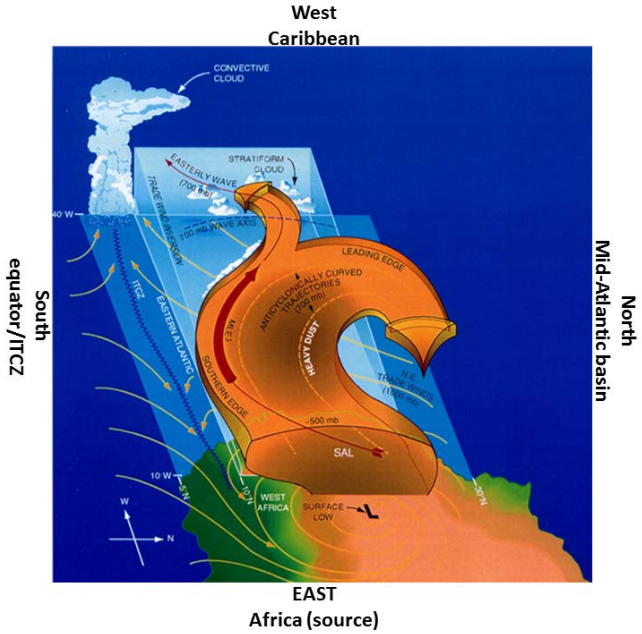
Outline of Saharan Air Layer (SAL) project

Improvements in Predicting Saharan Air Layer (SAL) Events over the Greater Caribbean using Modeling and Satellite Resources

1. **Project description & recent activities**
   - What is SAL?
   - Milestones during 2017
2. **Customer interaction**
   - NWS San Juan, Puerto Rico site visit
   - SAL event: a) operational perspective b) NRL resources
3. **Current and planned activities**
   - Modeling
   - Satellite products
   - JPSS instruments

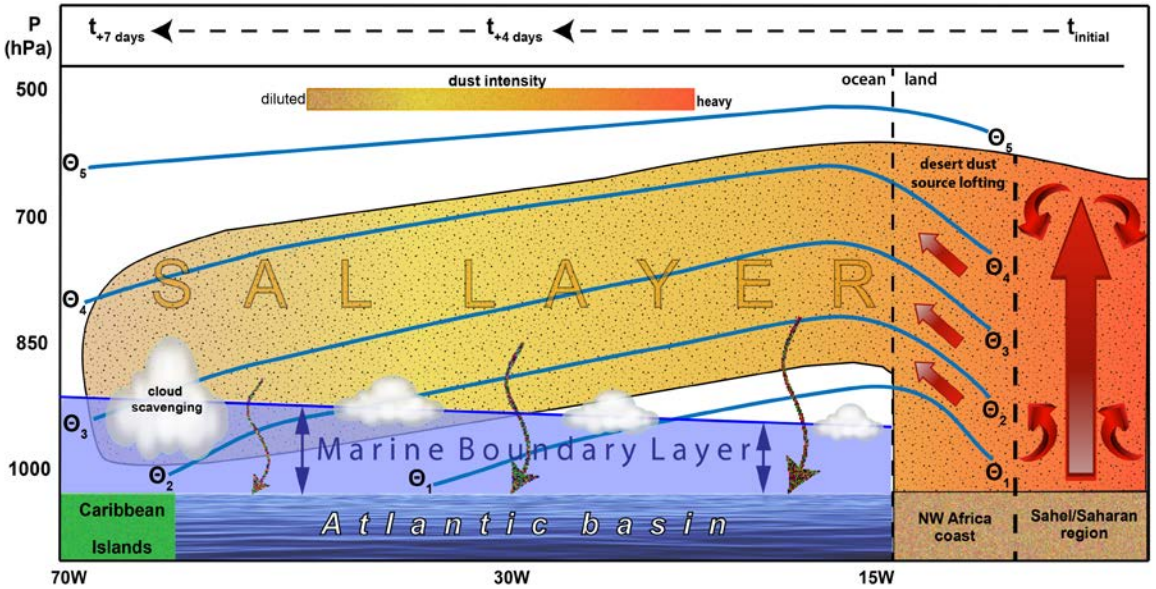
Defining SAL

3D cutout



Karyampudi and Carlson, J. Atmos. Sci., 1988

Isentropic diagram



Kuciauskas et al., BAMS, 2017 (accepted for publication)

NRL-MRY SAL website

"SAL-WEB"

www.nrlmry.navy.mil/SAL.html

Product suite

Satellite Imagery:

- Visible
- IR
- True & Natural and GEO Color
- Nocturnal Low Clouds
- Dust (Bluelight, DEBRA, AOD, RGB)
- TPW (NRL, NESDIS/CIRA, MIMIC)
- Water Vapor

Lidar Instruments: * currently unavailable

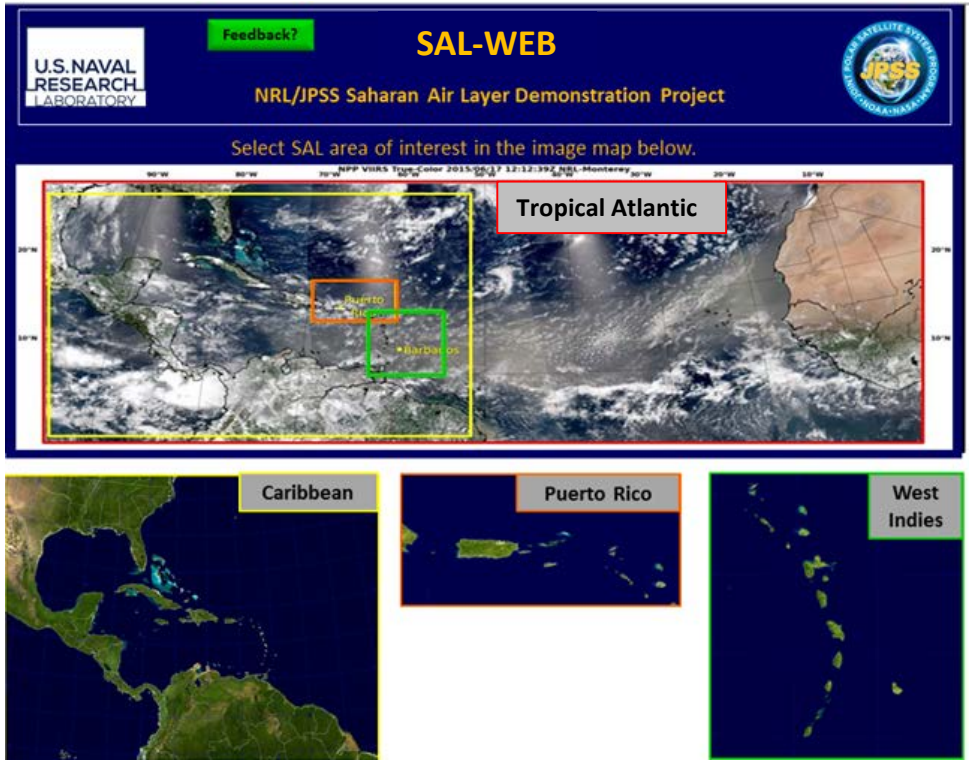
- CALIPSO/CALIOP *
- MPLNET *

Ground-based instruments:

- AQ ($PM_{2.5}$, PM_{10}, pollution level measurements)
- AERONET

Modeling (dust):

- NAAPS MODIS + VIIRS AOD
- Navy NWP Model wind overlays
- CIMH (WRF-Chem), ICAP, NGAC



Project Recent Activities

- R&D: SAL chemistry, thermodynamics, predictability, public impacts
  - ✓ Satellite-based product development (focus: VIIRS)
  - ✓ Model-based forecast products (focus: VIIRS AOD as Data Assimilation)
  - ✓ In-situ measurements that are not readily available
  - ✓ Hosted (near real time) and maintained on NRL website (SAL-WEB)
  - ✓ BAMS Publication: project summary
- Conducted NWS site visit (31 July – 03 August)
  - ✓ Overview of forecast operations: weather impacts, social interaction
  - ✓ Product feedback
  - ✓ SAL impacts
  - ✓ Forecaster needs outside of AWIPS-II
  - ✓ Future collaboration, including other Caribbean agencies
- Blend environment with health aspects
  - ✓ Puerto Rico/West Indies: among the world's worst asthma conditions
  - ✓ Participated with various environment/health agencies throughout Greater Caribbean
    - o Caribbean Institute for Meteorology and Hydrology, Barbados (CIMH)
    - o Caribbean Aerosol and Health Network (CAHN)
    - o University of Puerto Rico

Customer Interaction: NWS Site Visit
San Juan, Puerto Rico



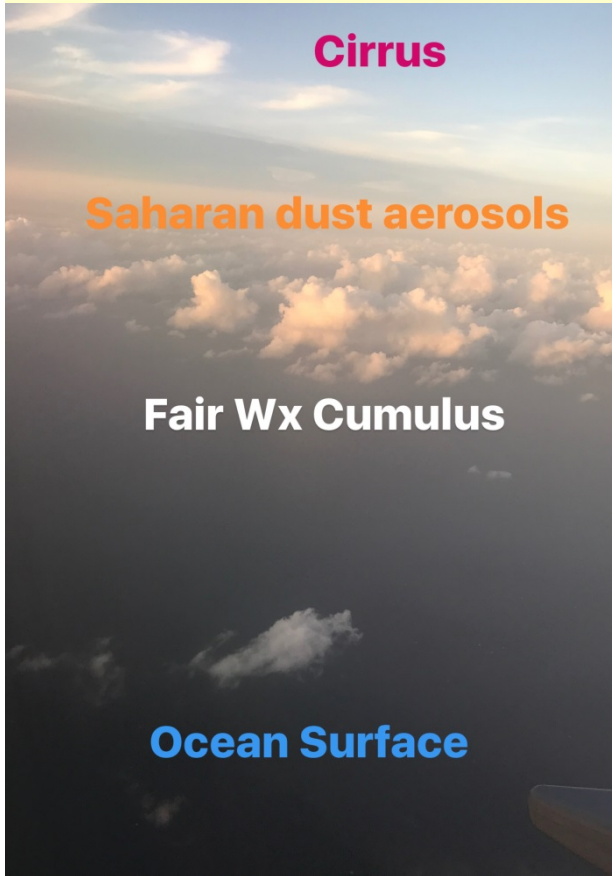
Highlights of Site Visit

- Overall, very positive feedback
  - ✓ SAL-WEB applied as resource of daily analysis
  - ✓ Growing interest/concern during SAL events, mainly during summertime
- AQ/Dust Aerosol Modeling
  - ✓ No aerosol model in AWIPS-2
  - ✓ NWS, San Juan unaware of NGAC dust model
  - ✓ NWS has been reliant on NAAPS and GEOS-5
  - ✓ NAAPS will be 1st to incorporate Enterprise VIIRS AOD into data assimilation (DA)
- Surface observations
  - ✓ Greater access to site containing AQ measurements in NRT
  - ✓ Lidar (MPLNET): *currently unavailable*
    - Backup in Key Biscayne
- Public Awareness/Social media
  - ✓ SAL has gained notoriety, but concepts are distorted
    - Need better definition
    - NWS is evolving toward Facebook, Twitter, media interaction
- Environment & Health impacts of SAL
  - ✓ Dr. Olga Mayol-Bracero, Professor at U of P.R.
    - Widely known as expert in Caribbean environment
    - Lidar installation in Capo San Juan (northeast P.R.)
    - Wealth of instruments throughout P.R.
  - ✓ Dr. Bolaños, Professor at U of P.R. 13 year study
    - little correlation between African dust events and respiratory ailments
    - spore production within rain forests major asthma contributor during fall/winter & nighttime conditions
    - African dust can act as an irritant for the respiratory system
- Future support
  - ✓ Satellite needs: Atmospheric profiling
    - GOES-16 products
    - JPSS-1 launch
    - Ozone (pollution) research: OMPS
    - CrIS sensing
  - ✓ Training: “Just-in-time” as SAL events occur

SAL Case Study:
An Operational Perspective

Clouds and Aerosols over Puerto Rico

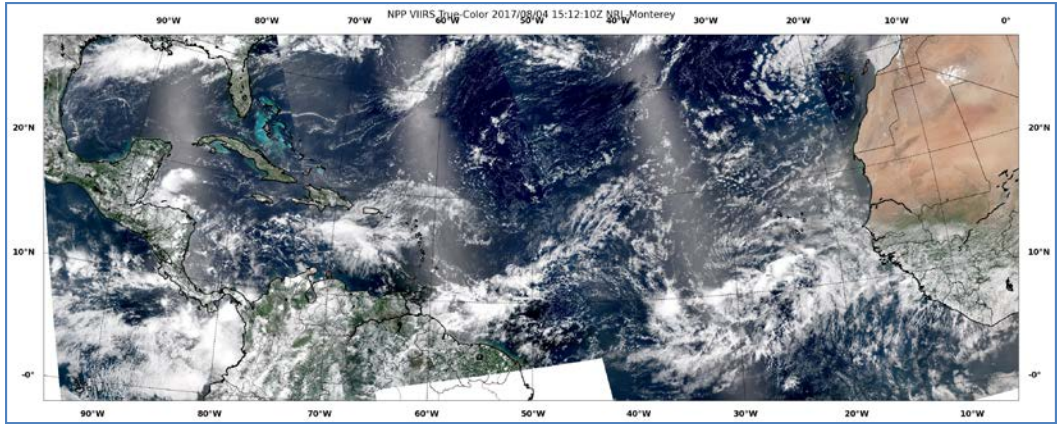
takeoff from San Juan a/p, 02 August



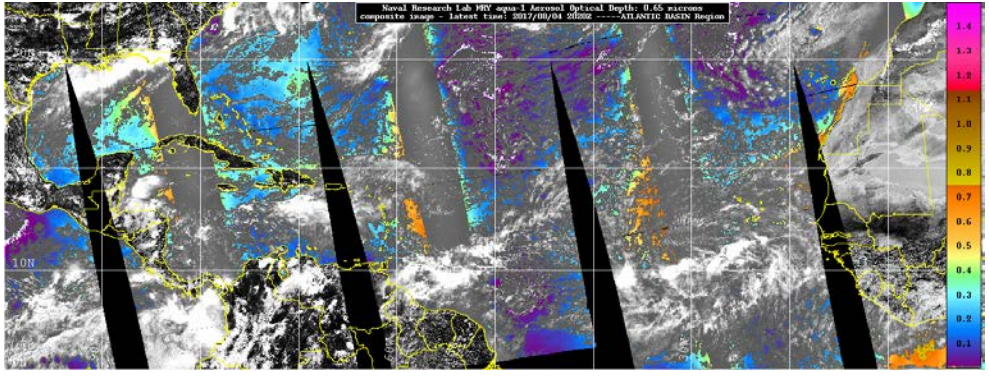
29 July – 04 August

Showcase NRL resources

Case Study: 29 July – 04 August 2017



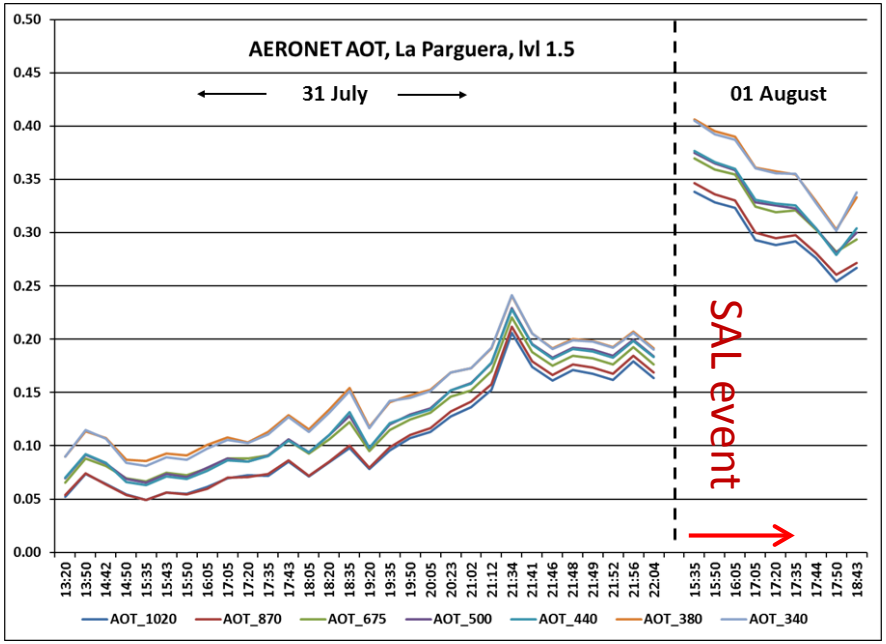
VIIRS true color



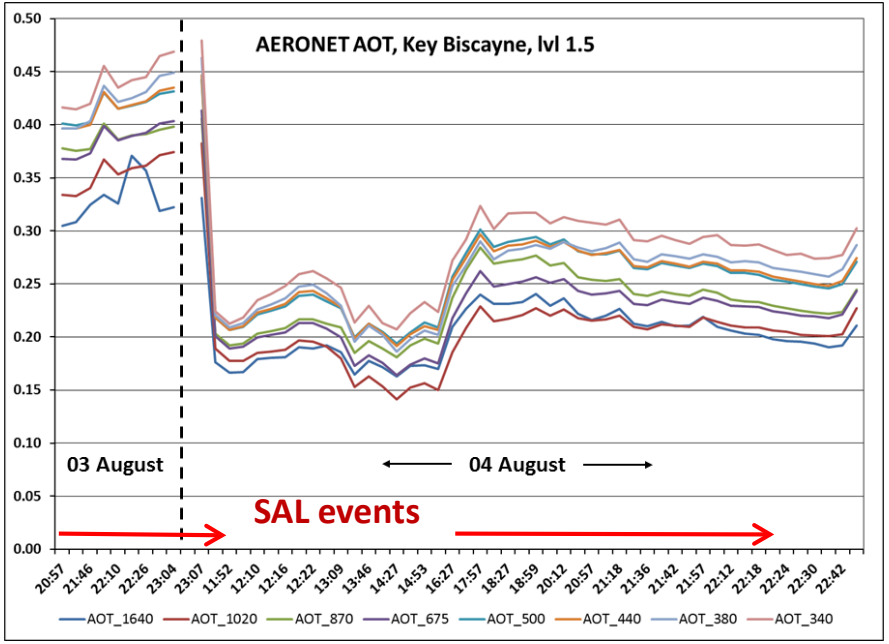
MODIS AOD

SAL impacts: AERONET

Puerto Rico

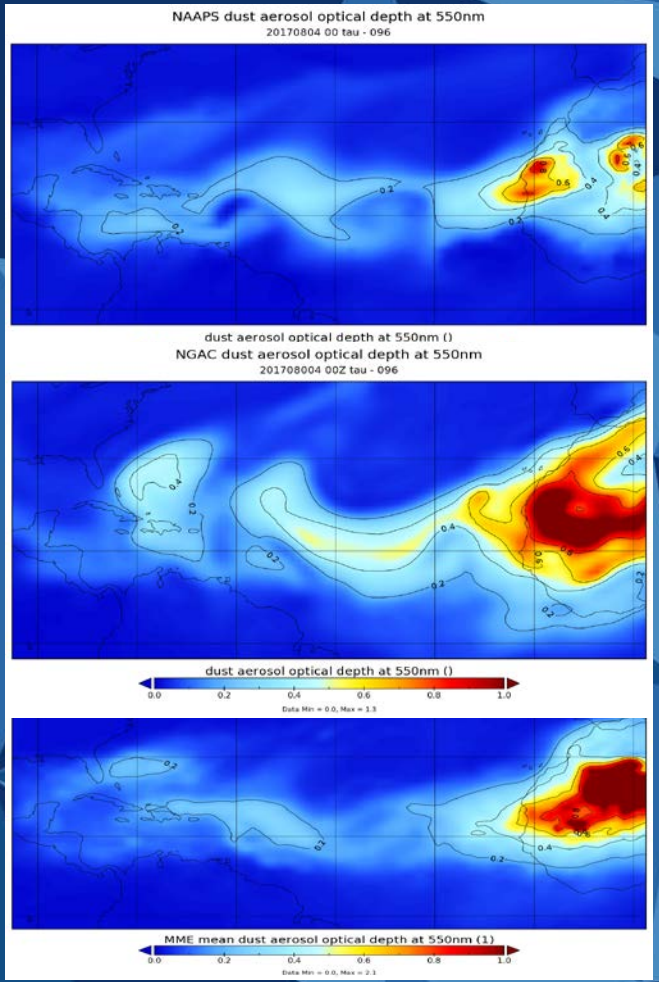


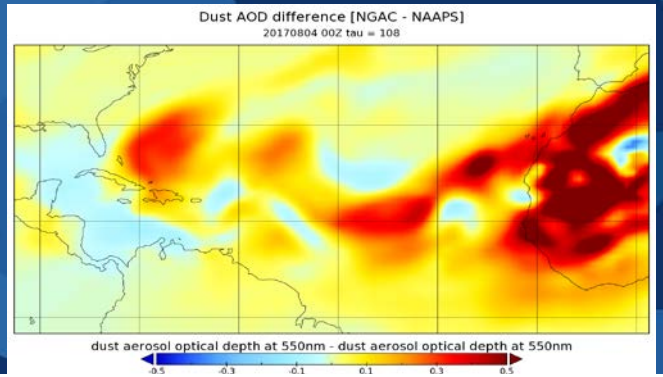
Key Biscayne, FL

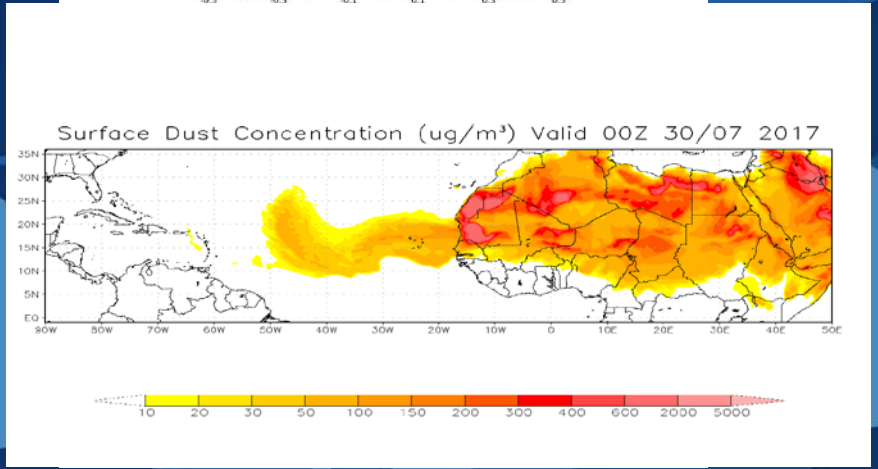


AERONET courtesy: Brent Holben

Model Perspective

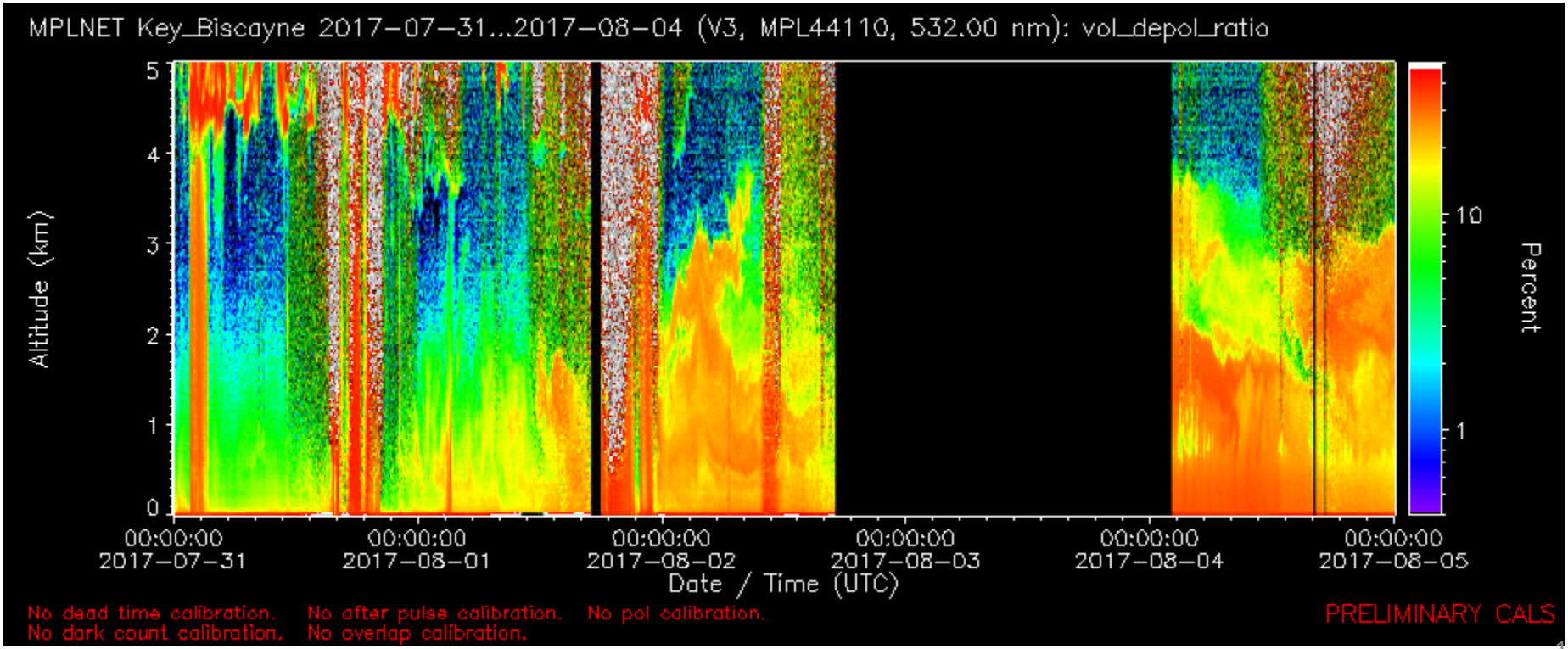




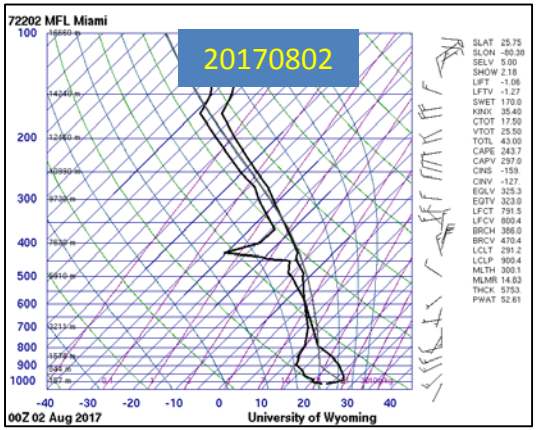


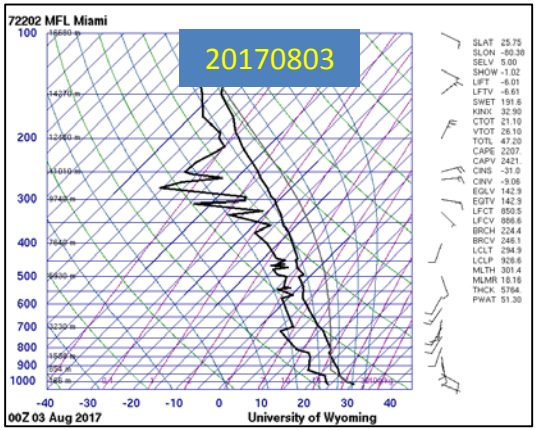
Case Study: Lidar sensing Key Biscayne, FL

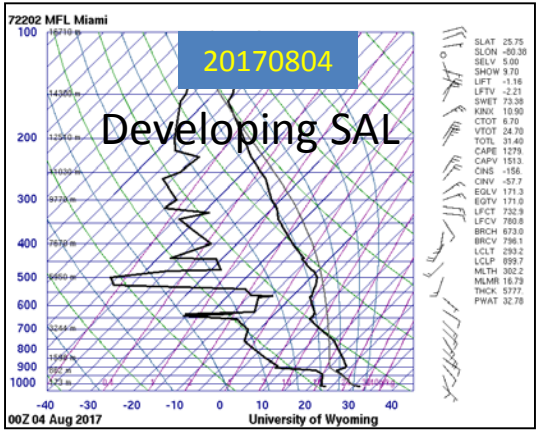
31 July – 04 August

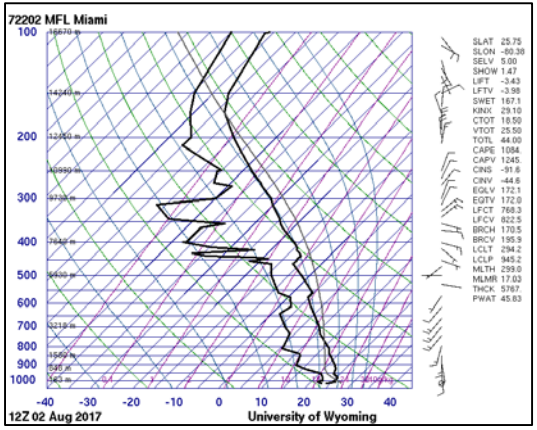


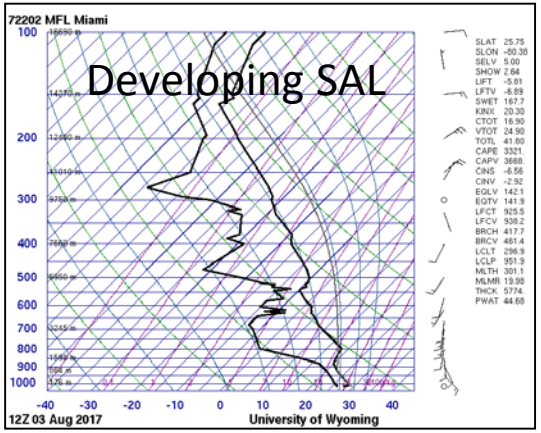
Evolving SAL Over Miami

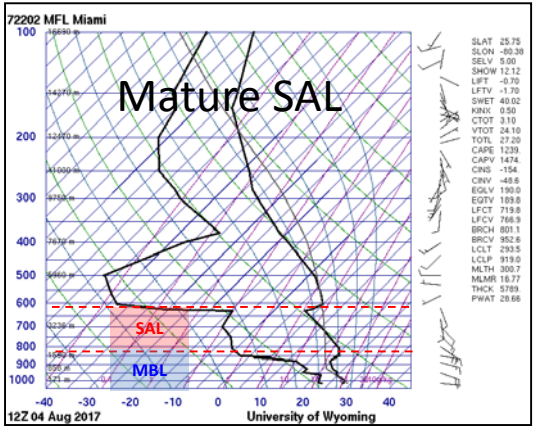




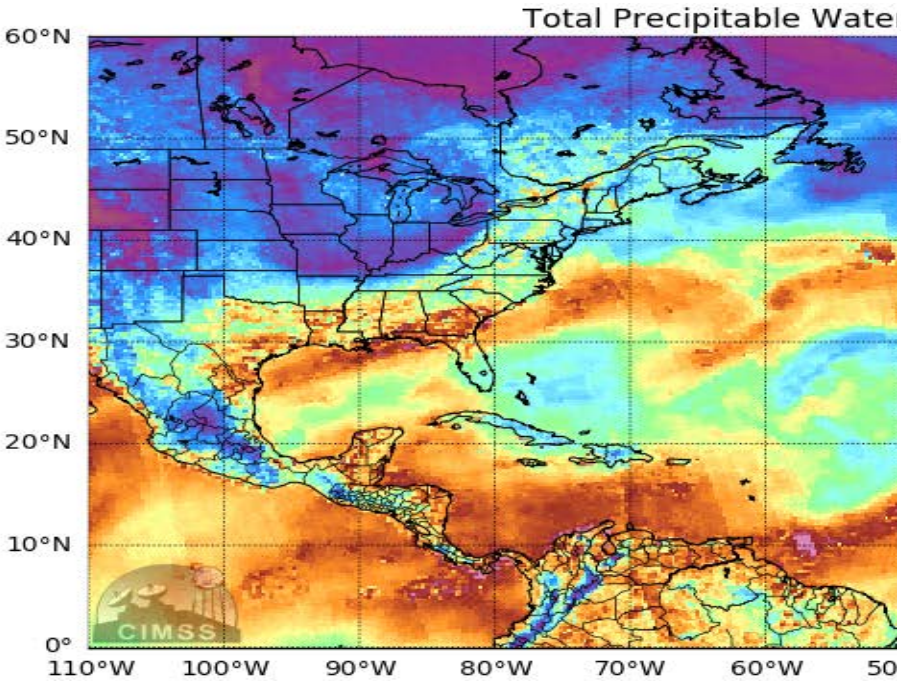


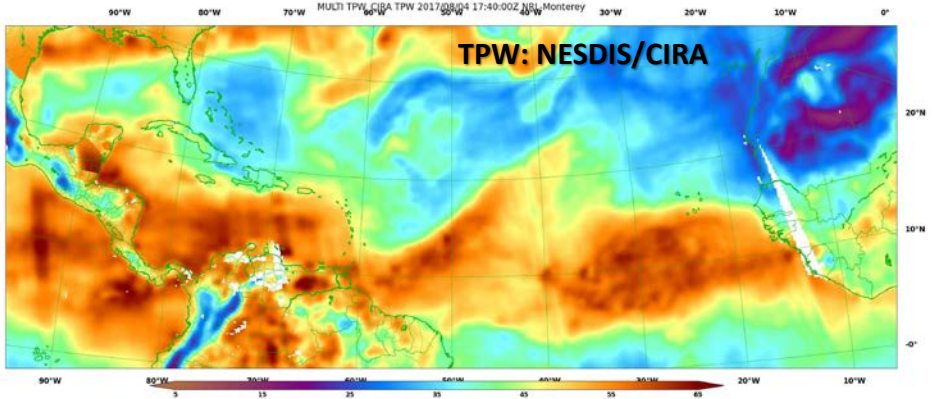


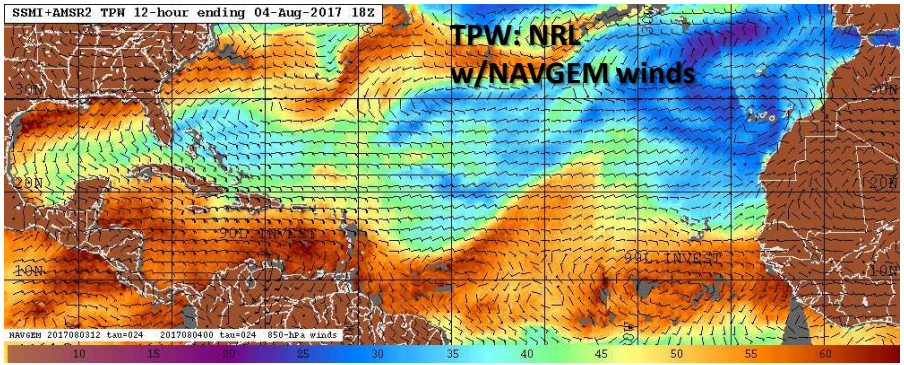




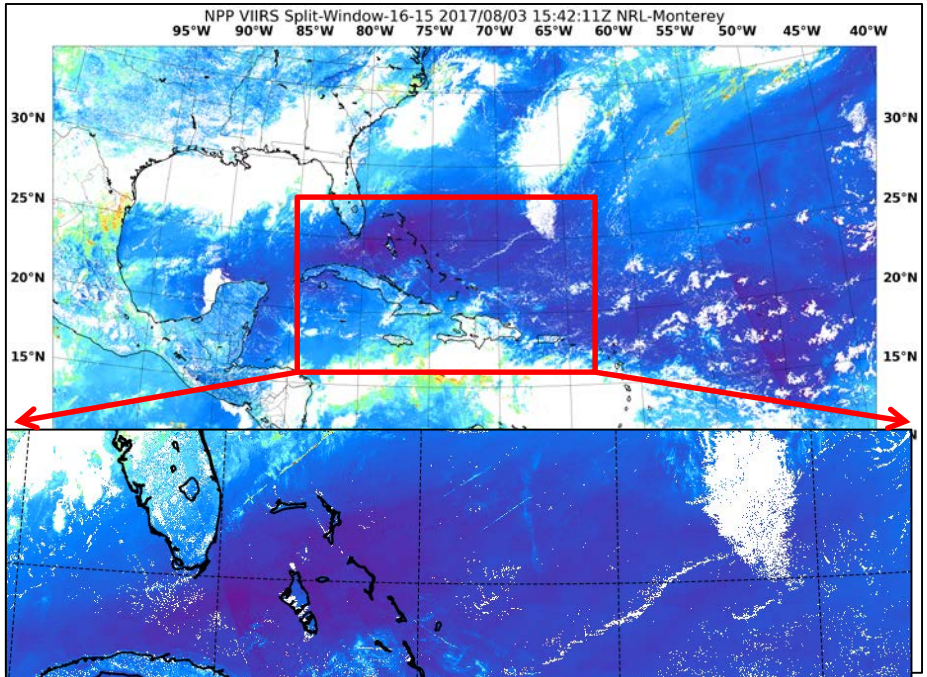
TPW Perspective
03 – 04 August 2017

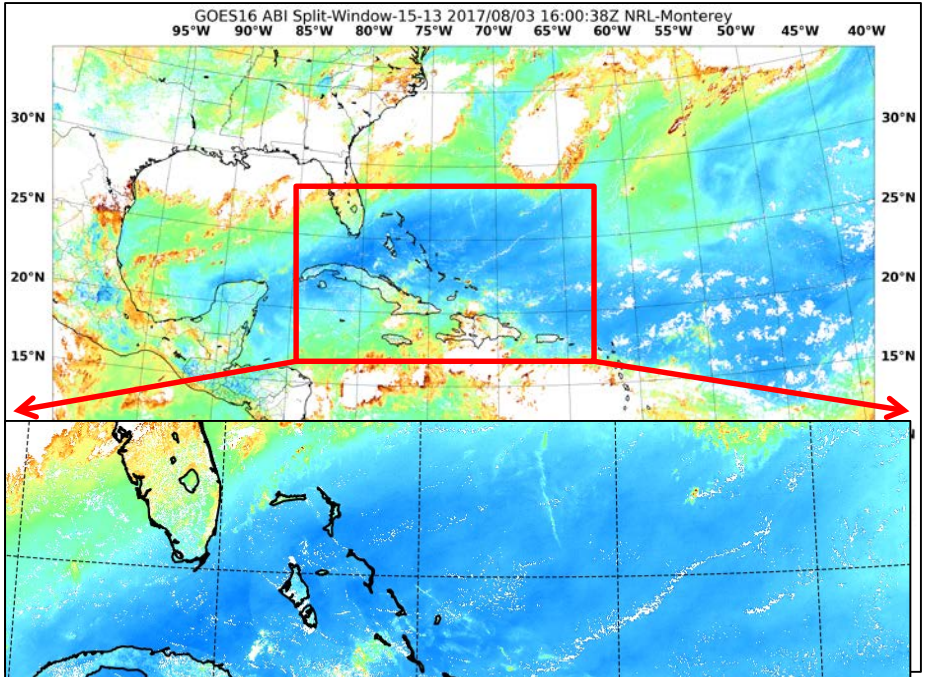






Split Window SAL Views

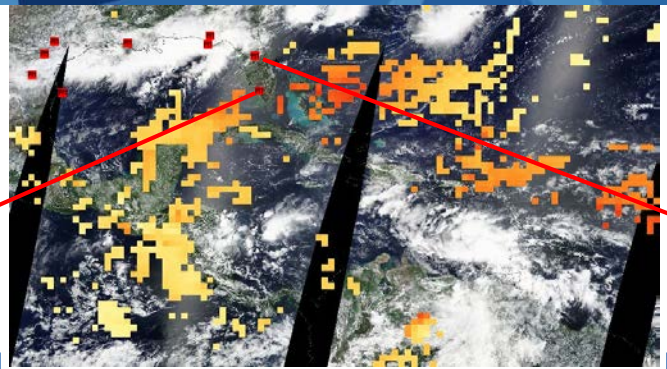


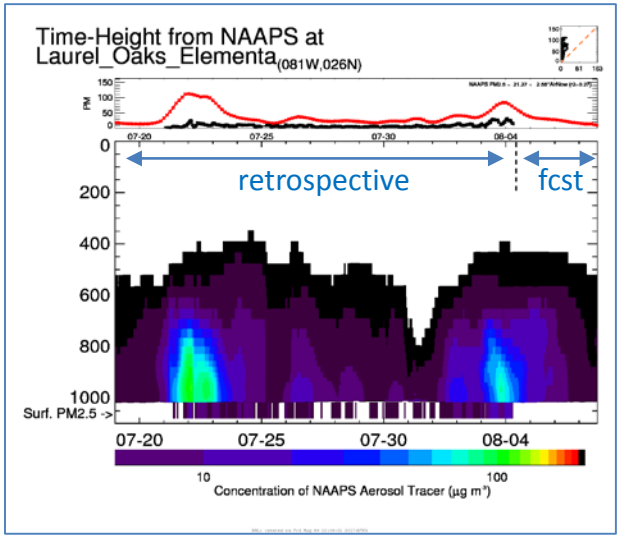


Better spectral/spatial resolution

NAAPS Vertical Profile Forecasts during SAL

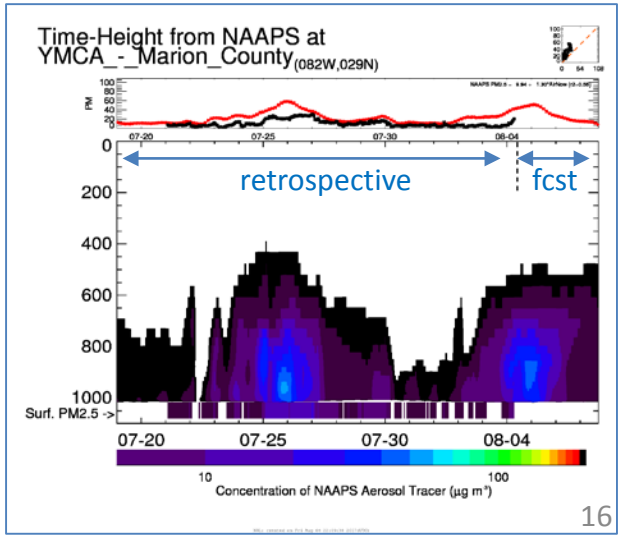
Florida EPA AirNow Sites ($PM_{2.5}$)



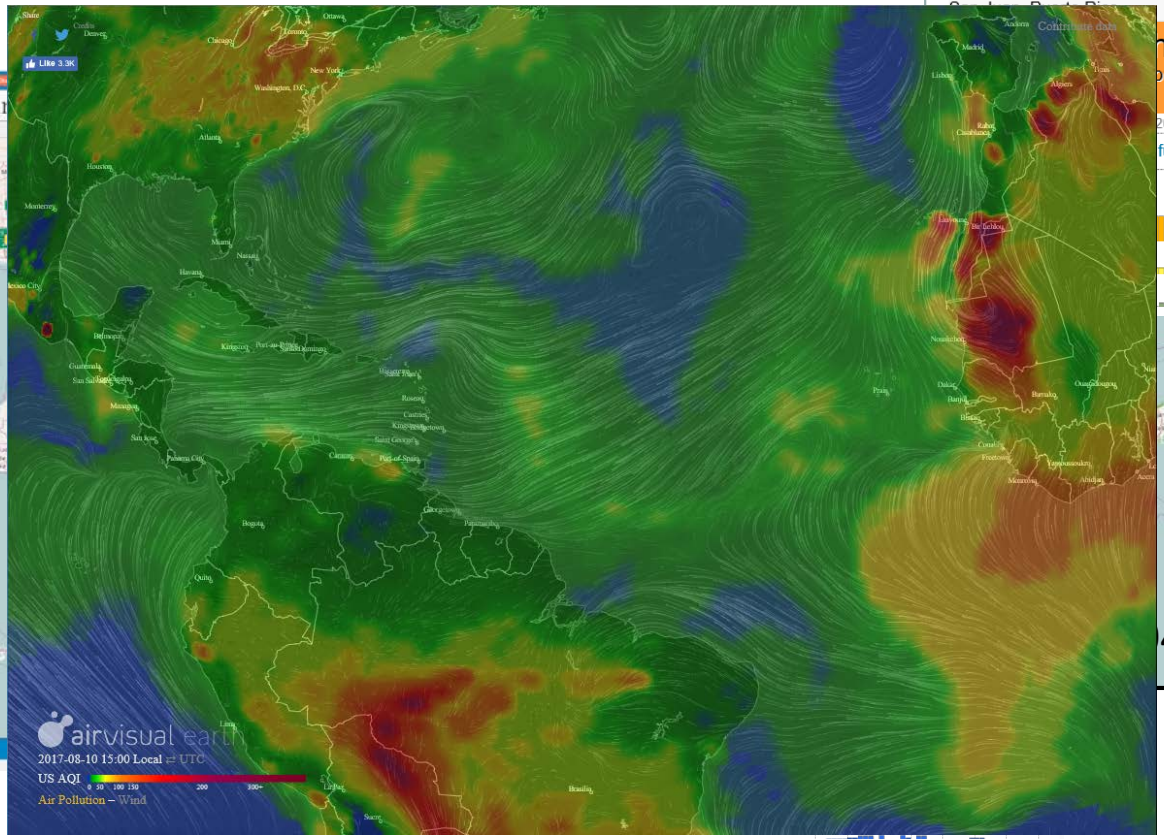


NAAPS (red) vs sfc TEOM sites (black)

NAAPS profile: total PM mass concentration from dust, smoke, sea salt, and anthropogenic aerosol tracers



Global Air Quality Resources



4 Aug 2017

Summary

1. Coordination with NWS:
    a) Evolve SAL into higher impact status -> forecast discussions, social media
        i. Better understanding of SAL
        ii. Training => forecasters/public/gov. agencies: weather & health impacts
        iii. Beyond VIIRS: acquire additional resources from NEXGEN sensors
            - GOES-16 fusing with polar orbiters, models, in-situ measurements

2. Improve Navy dust model:
    a) Incorporate Enterprise VIIRS AOD into NAAPS
    b) Integrate international dust models (ICAP)

3. Leverage Navy funding: R&D toward Caribbean dust/pollution/health:
    a) SAL dust vs localized pollutants characterization
        i. Ozone studies related to detecting/discriminating pollution from dust
        ii. Apply OMPS retrievals
    b) Visibility aspects related toward trafficability

Summary

US Navy Requirements Related to the Tropical Atlantic Environment



Support tactical and operational environment

- Trafficability
- Helicopter operations
- UAV operations
- Search and Rescue
- Reconnaissance
- Weapons systems

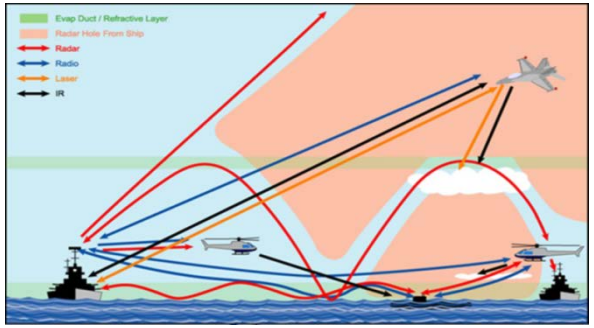


Improve tactical prediction of near-surface weather

- Boundary Layer Clouds
- Fog
- Aerosol Loading
- Visibility

"We must *advance* our technological expertise to predict how electromagnetic waves will move through the physical battlespace."

~ RDML Tim Gallaudet, USN



Clouds affect, or are indicators of, tropospheric boundary layer conditions and EM/EO propagation.

NRL Monterey VIIRS imagery comparisons with other sensors

Kim A. Richardson, Melinda L. Surratt, Arunas P. Kuciauskas, Richard L. Bankert

U.S. Naval Research Laboratory
Marine Meteorology Division
Monterey, CA

U.S. NAVAL RESEARCH LABORATORY

NRL-MMD Satellite Constellation

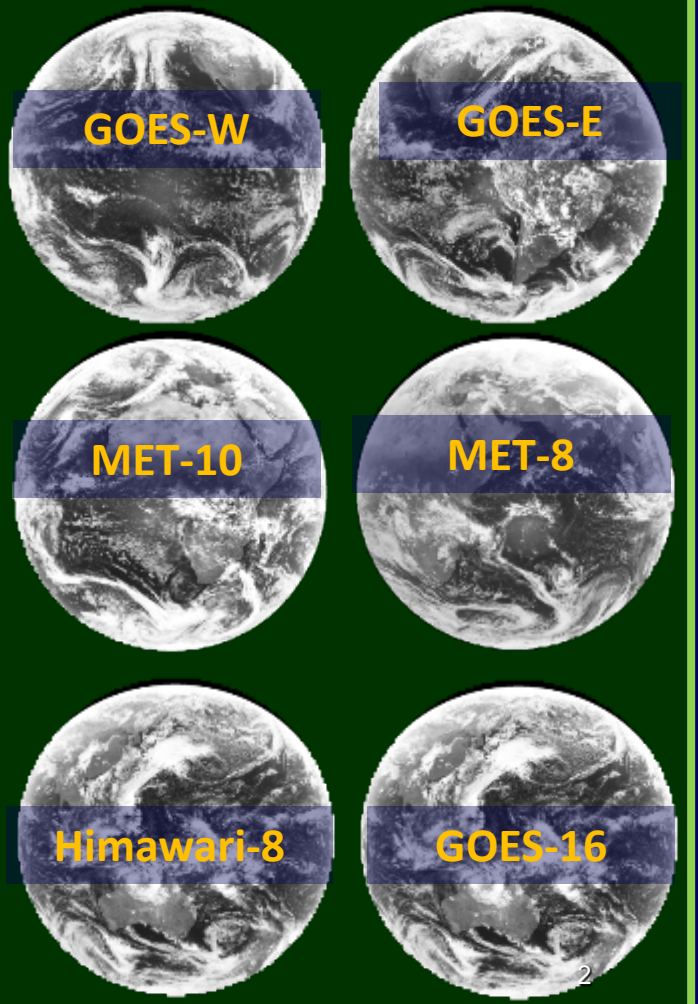
Total Sensors: 36

Low Earth Orbiting (LEO): 30

IR/Vis Imagers:	NOAA	- AVHRR (4)
	METOP	- AVHRR (2)
	DMSP	- OLS (4)
	NASA	- MODIS (2)
	NOAA	- VIIRS
Microwave Imagers:	DMSP	- SSM/I , SSMIS (3)
	NASA	- AMSR-2, GMI, SMOS
	NRL	- WindSat
Micro Sounders:	NOAA	- AMSU (2), MHS (2), ATMS
	METOP	- AMSU (2)
	MeghaTropiques - SAPHIR	
Microwave Radar:	NASA	- GPM
	Foreign	- ASCAT (2), OceanSat-2

Collaborations: FNMOC, AFWA, NASA, NOAA, CIRA

GEO Sensors: 6



U.S. NAVAL RESEARCH LABORATORY

NexSat Products

Standard Products
Visible (daytime)
Visible (night time)
Infrared
Water Vapor
True Color
Pseudo/GEO True Color
Rain Rates
Rain Totals • 3, 6, 12, 24 hours • 2, 3, 4, 5, 6, 7, 10, 12, 14 days
*Winds • Scatterometer (sfc) • GEO o low level o middle level o upper level

Cloud Products
Cloud layers (snow, low-middle, high)
Cirrus cloud detection
Contrail detection
Low cloud detection (night)
Convective cloud top height
Cloud properties • effective radius • optical depth • cloud top temperature • cloud top height • cloud type

Environmental Products
Aerosol amounts (optical depth)
Biomass (vegetation type)
Dust detection • MODIS • VIIRS • MSG (DEBRA)
Fire detection (hot spots)
Lightning detection

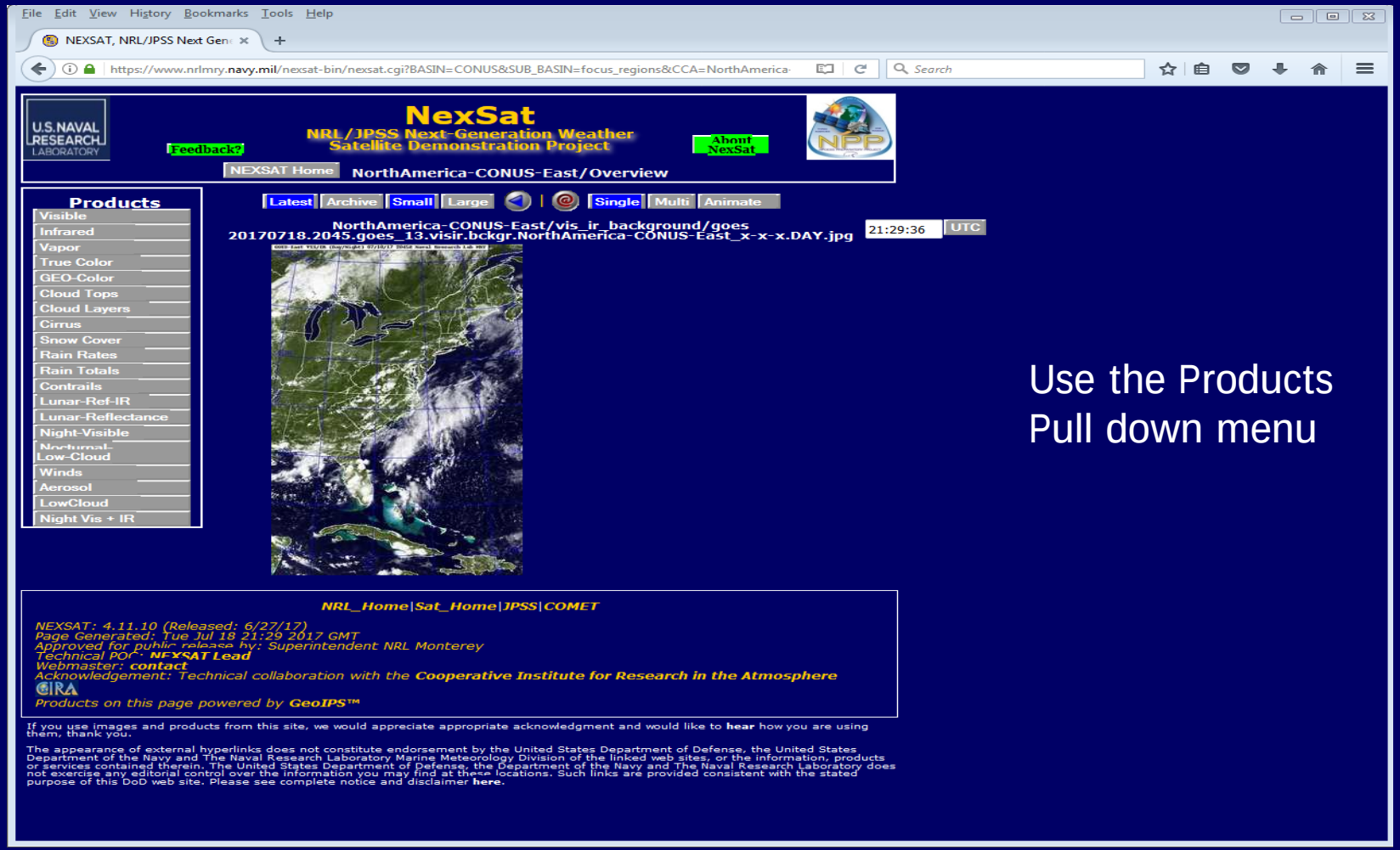
Models	
Navy global (NAVGEM)	NAAPS dust model
Sea Level Pressure	Total AOD
500 mb Heights	Coarse AOD
sfc, 700 500 300 mb Winds	Fine AOD
1000-500 mb Thickness	Concentration [dust]
Surface Temperature	
Jet Stream	

NexSat Home Page

https://www.nrlmry.navy.mil/NEXSAT.html

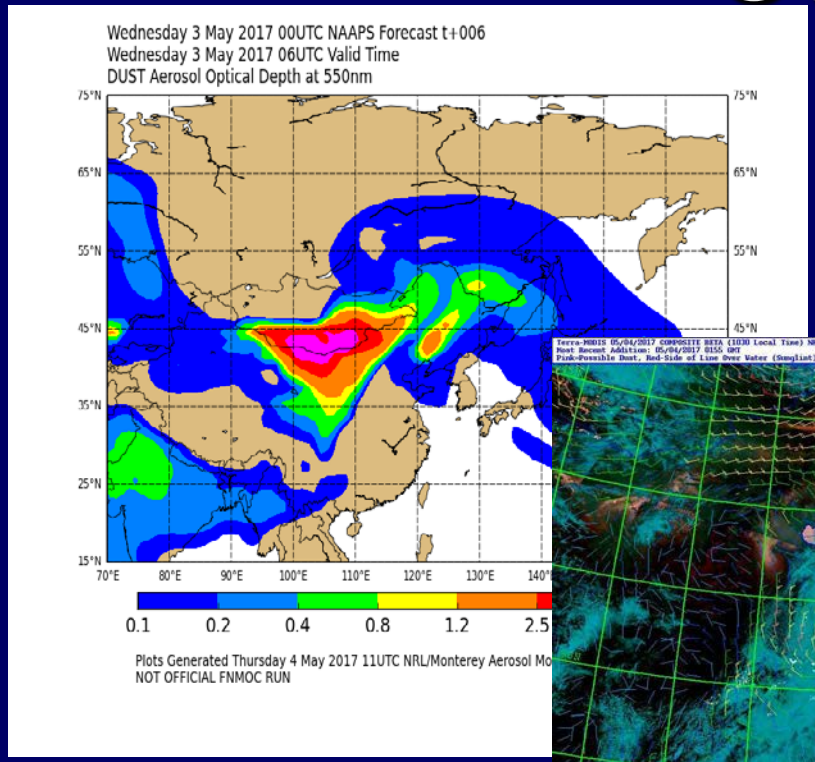


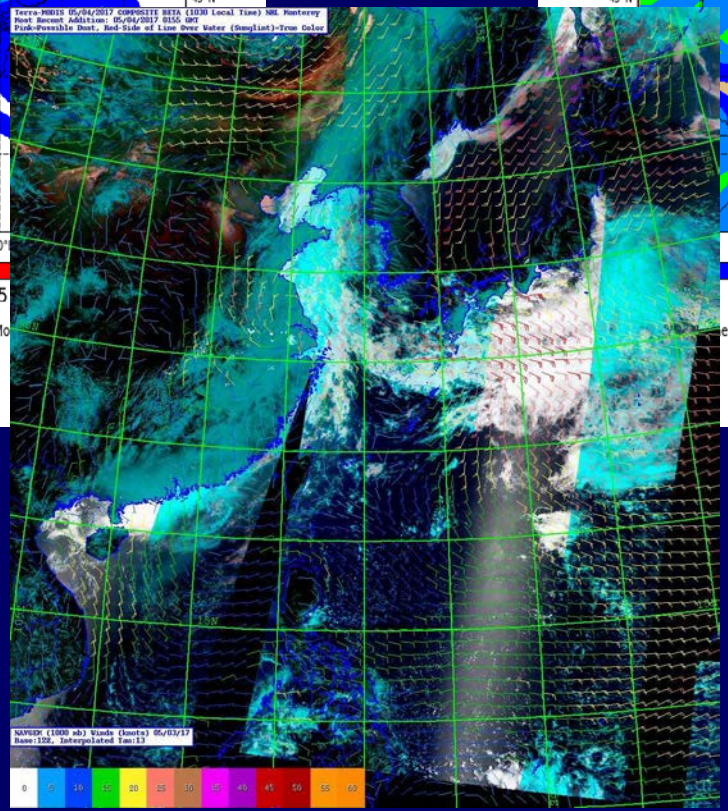
How to find VIIRS imagery on NexSAT

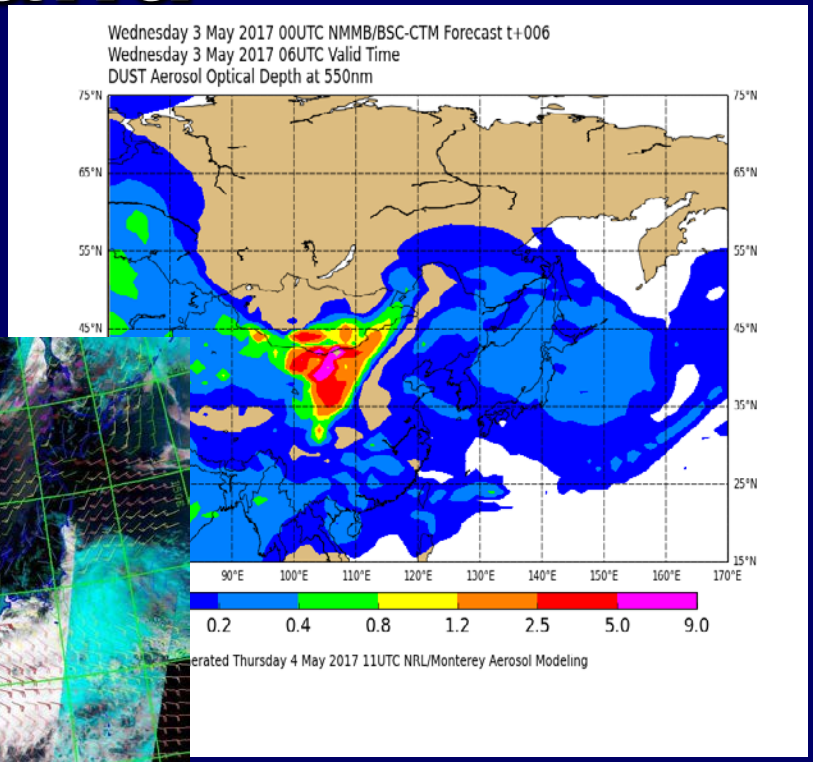


Use the Products Pull down menu

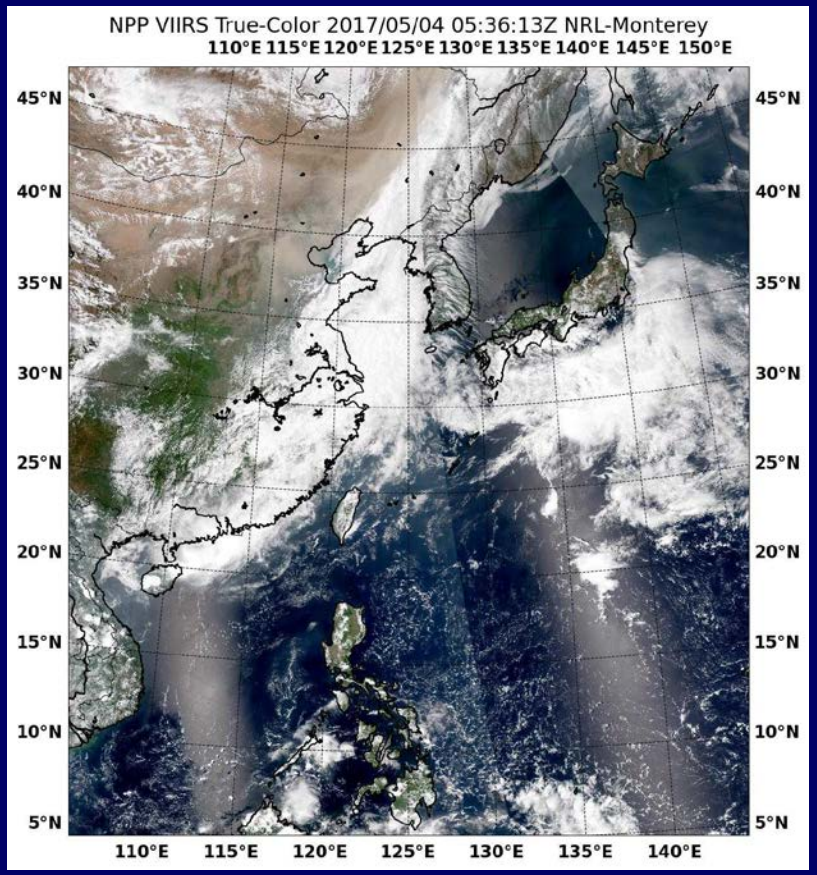
Dust case study over land

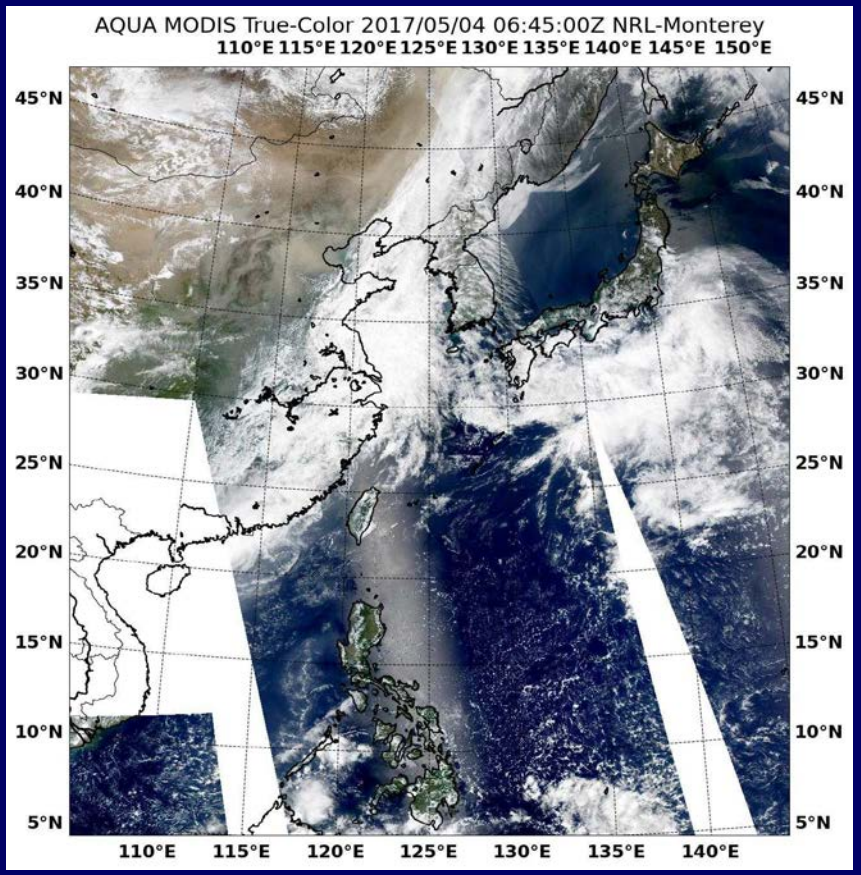




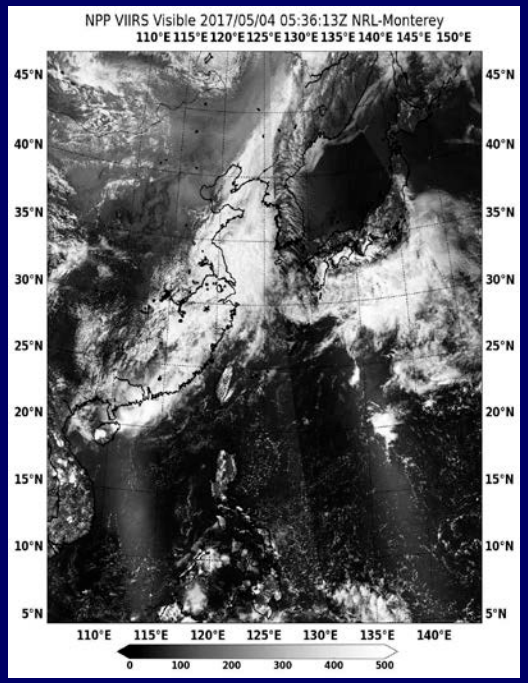


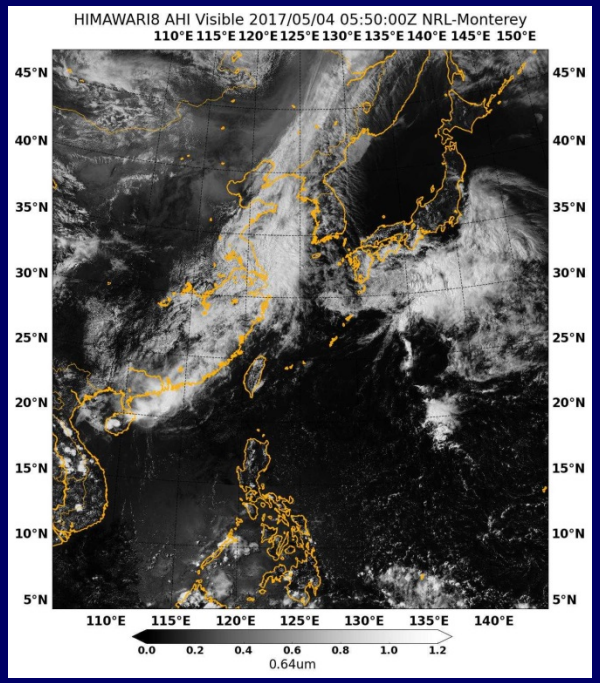
True Color
VIIRS/MODIS

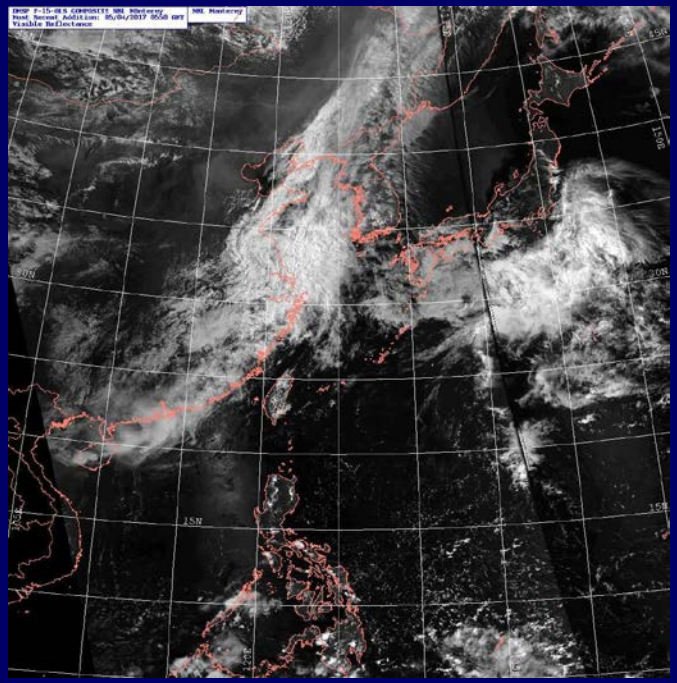




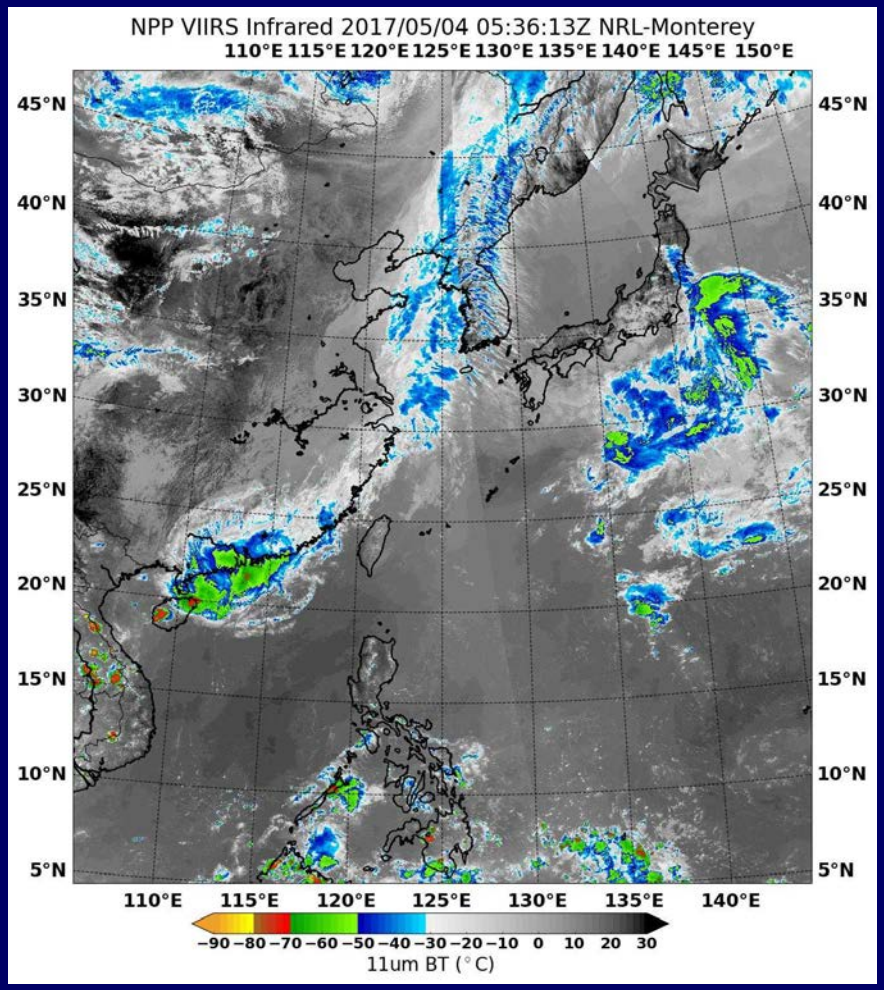
Visible Imagery
VIIRS / Himawari-8 / DMSP

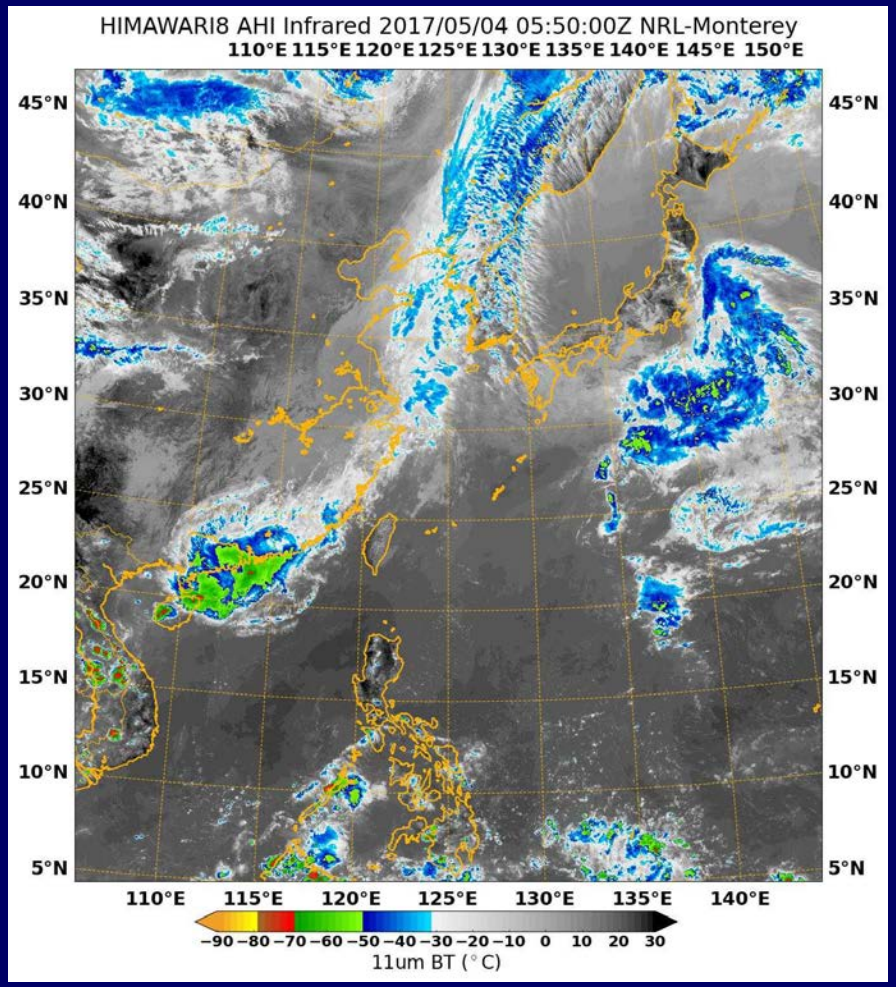




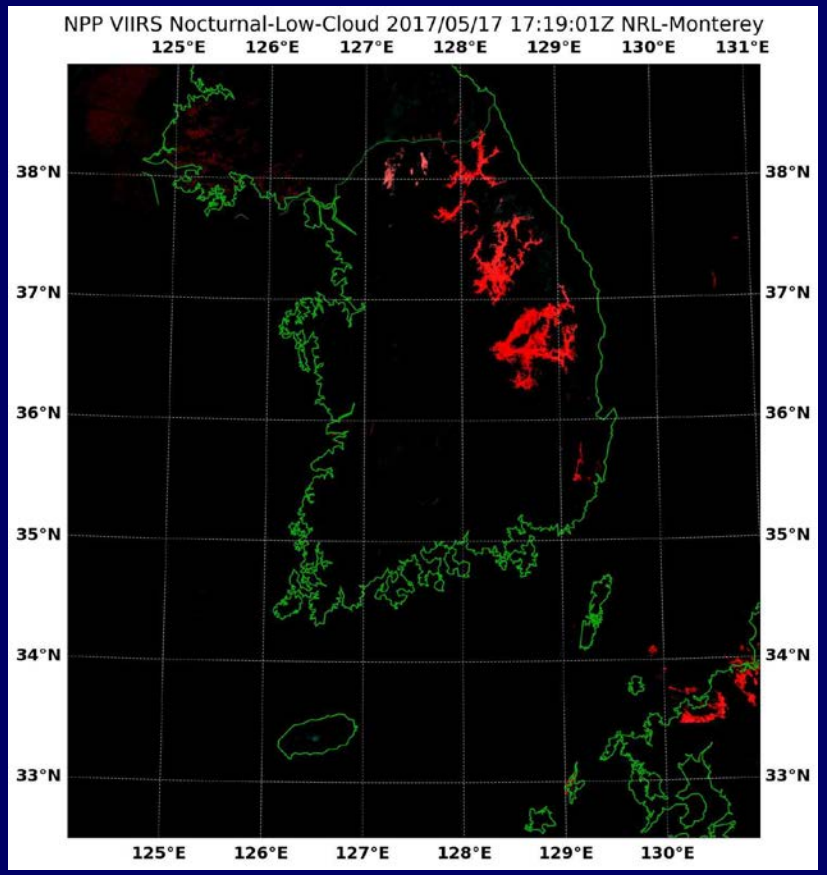


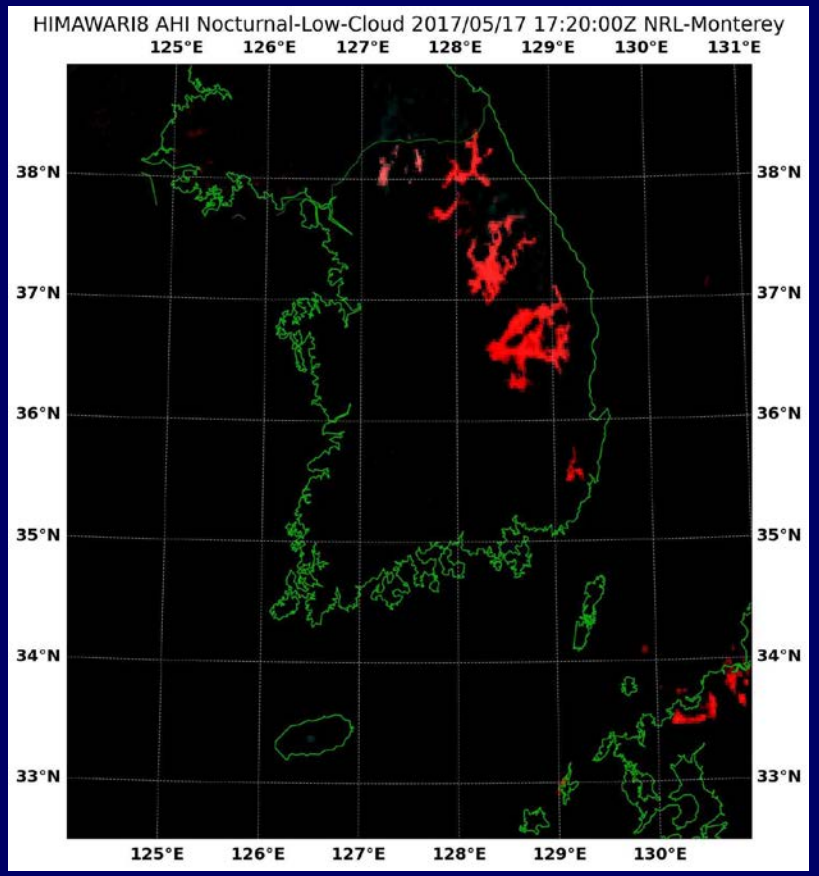
Infrared
VIIRS/AHI





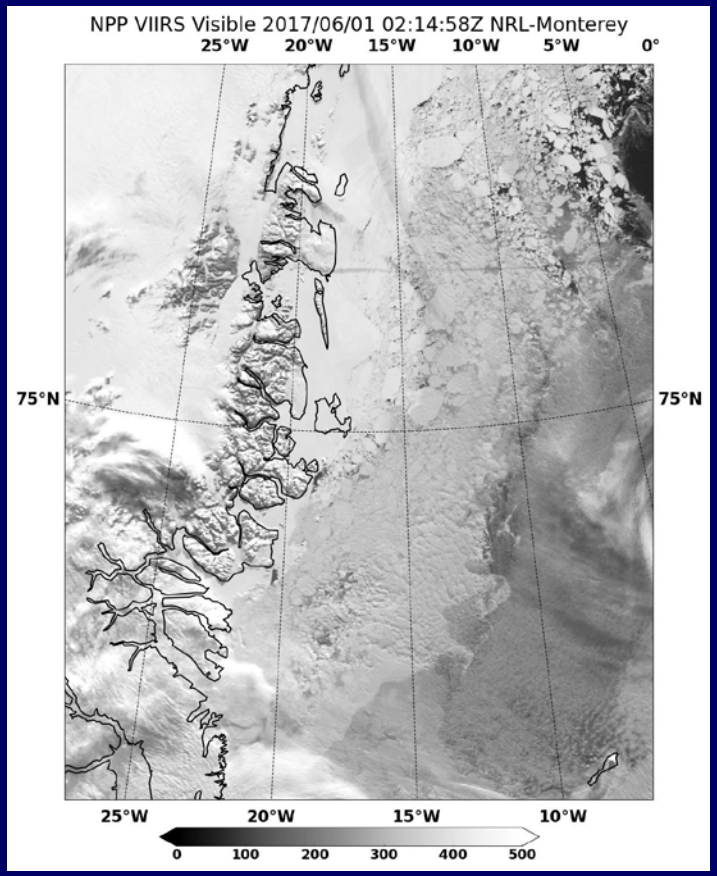
Low Cloud VIIRS/AHI

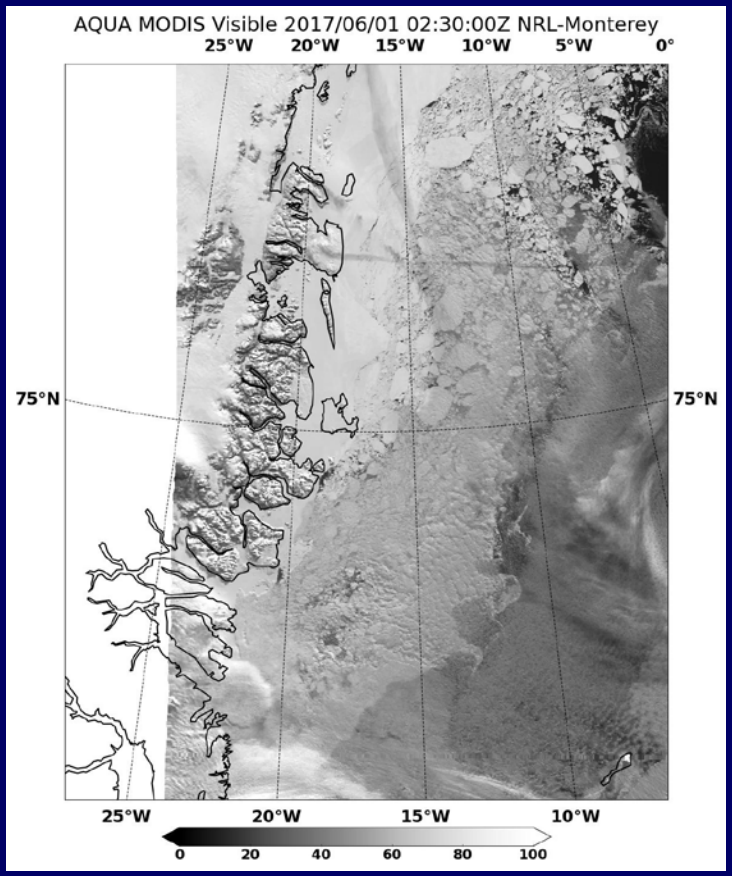




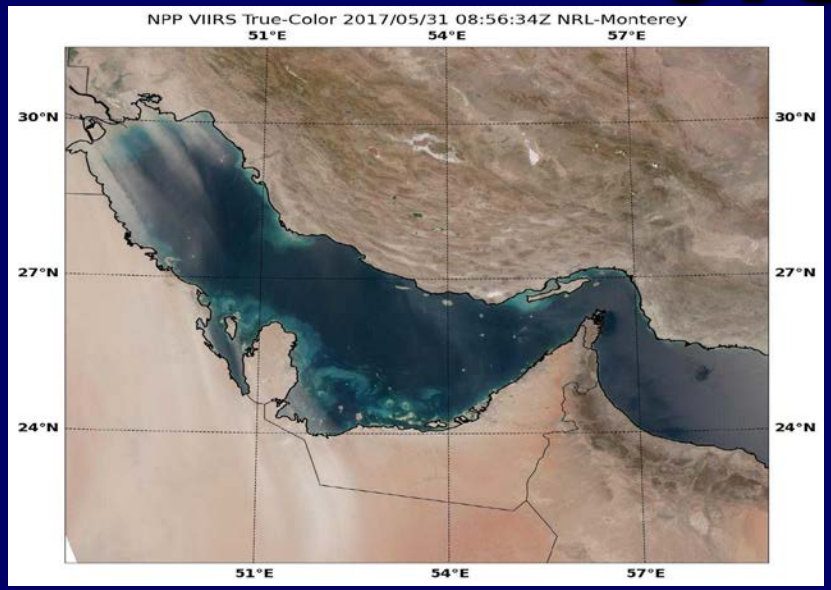
Greenland offshore ice movement

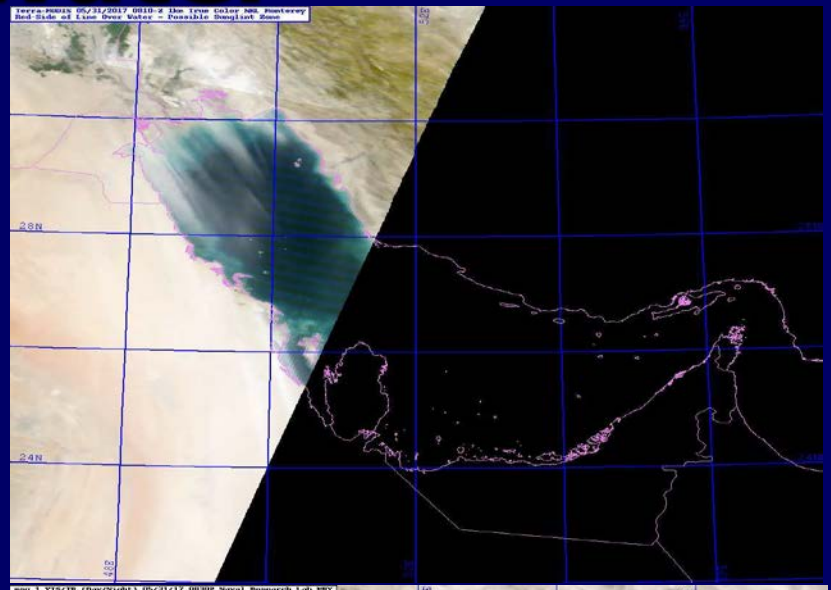
VIIRS/MODIS

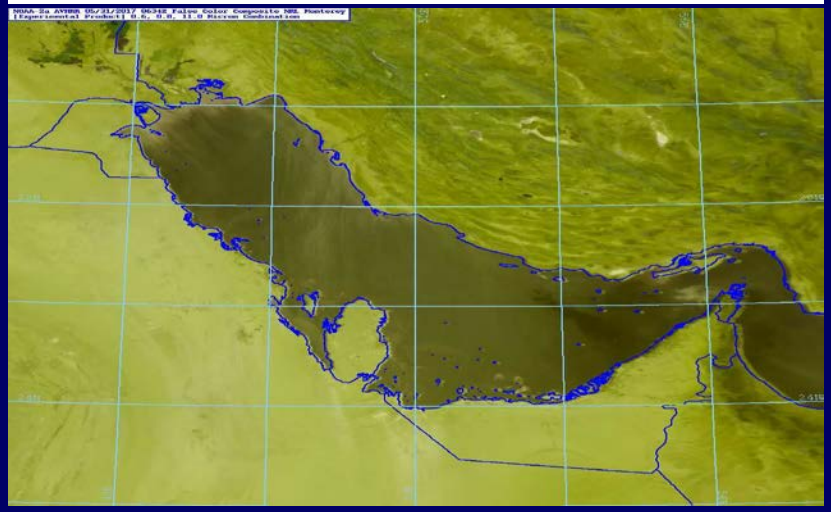


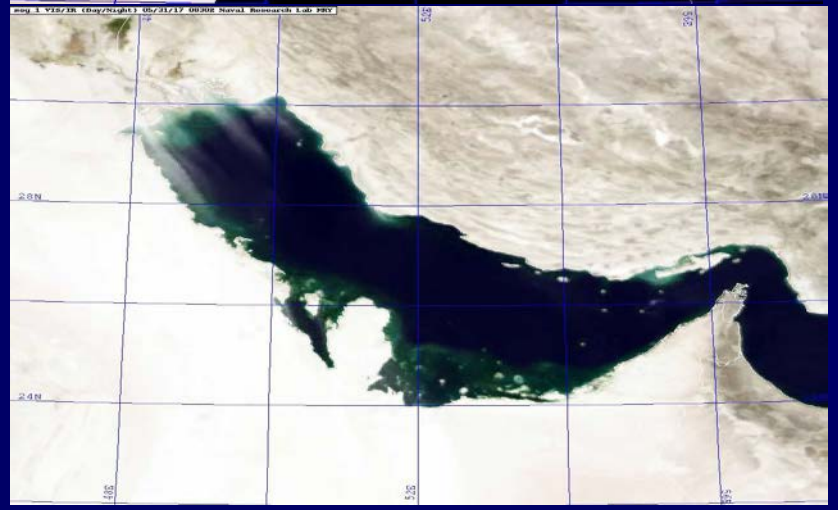


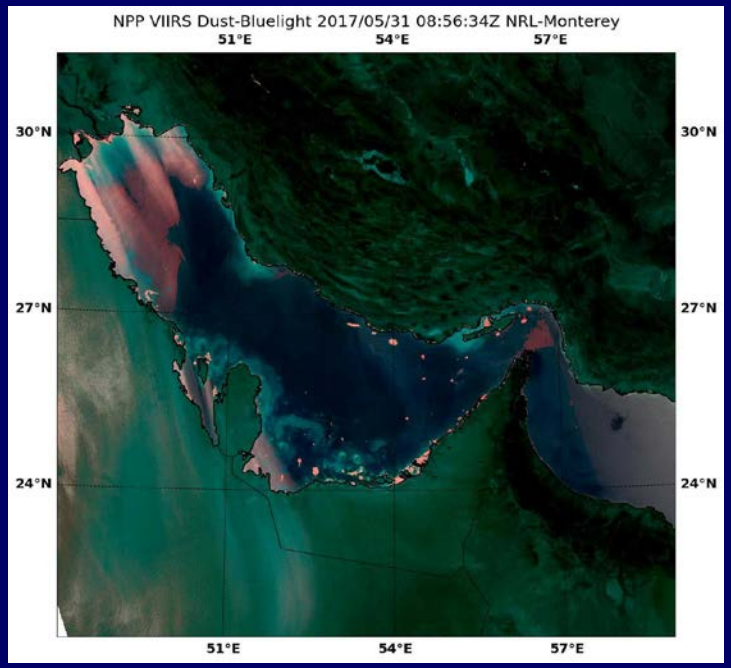
Dust case study over water



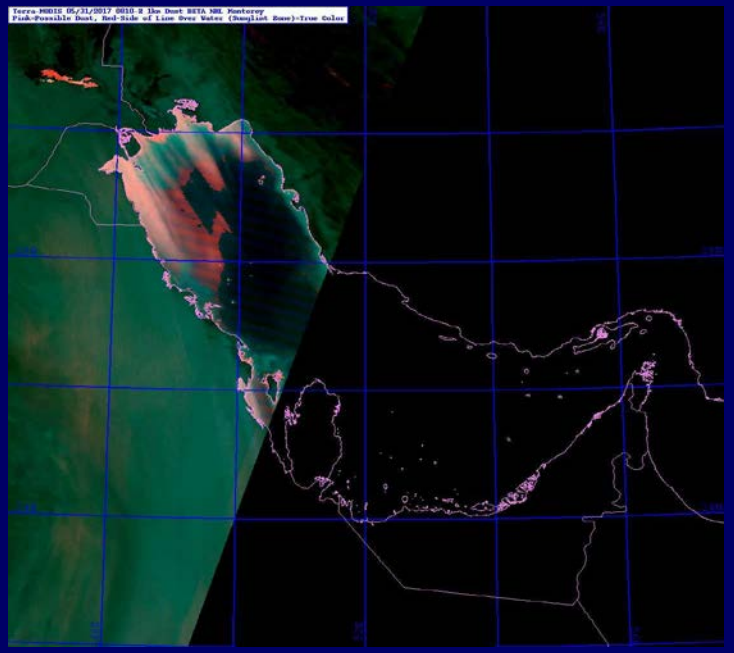


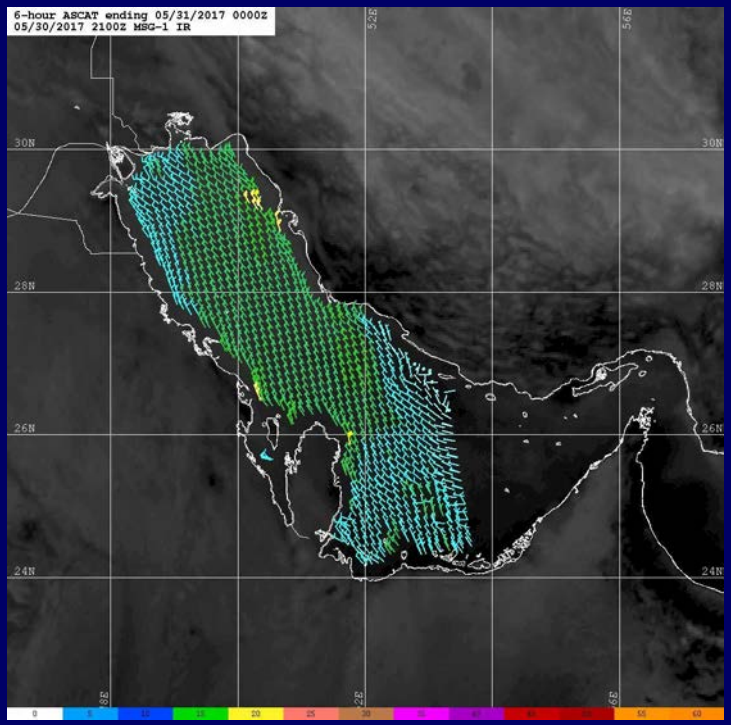




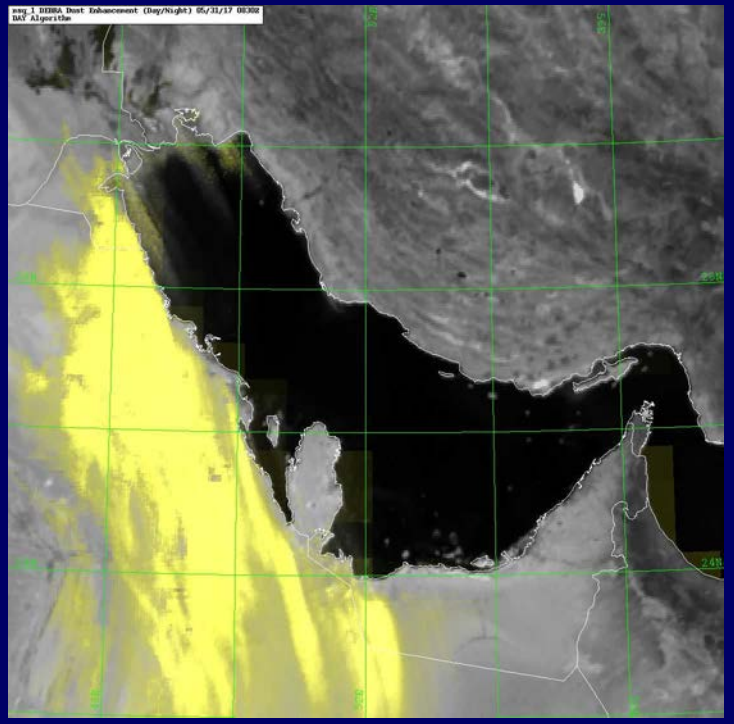


Bluelight
Dust
VIIRS/MODIS

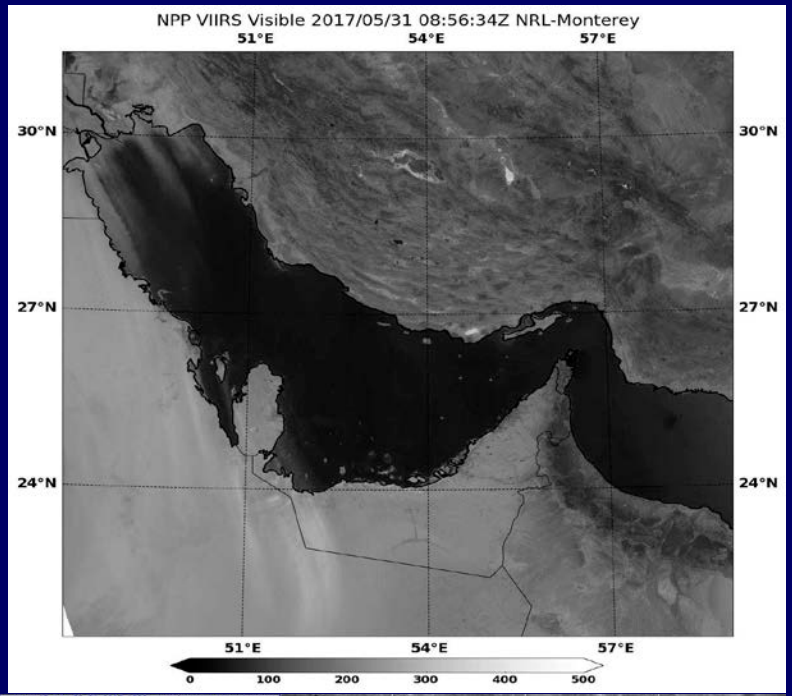


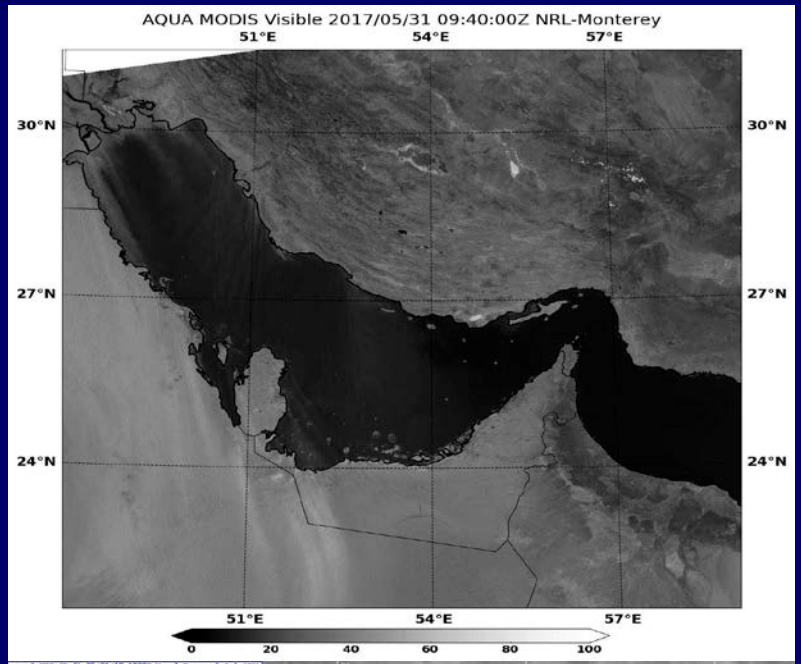


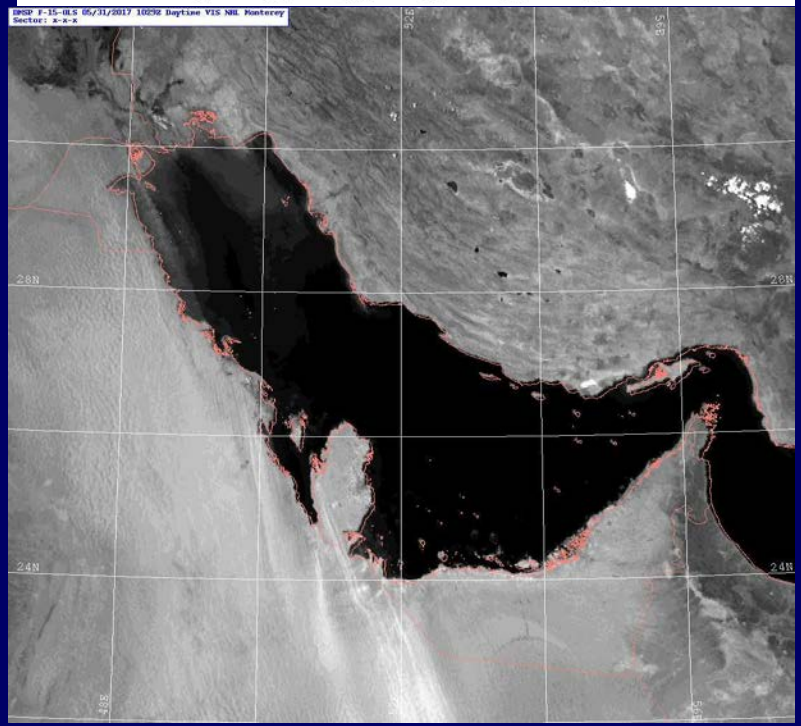
MSG-1
DEBRA

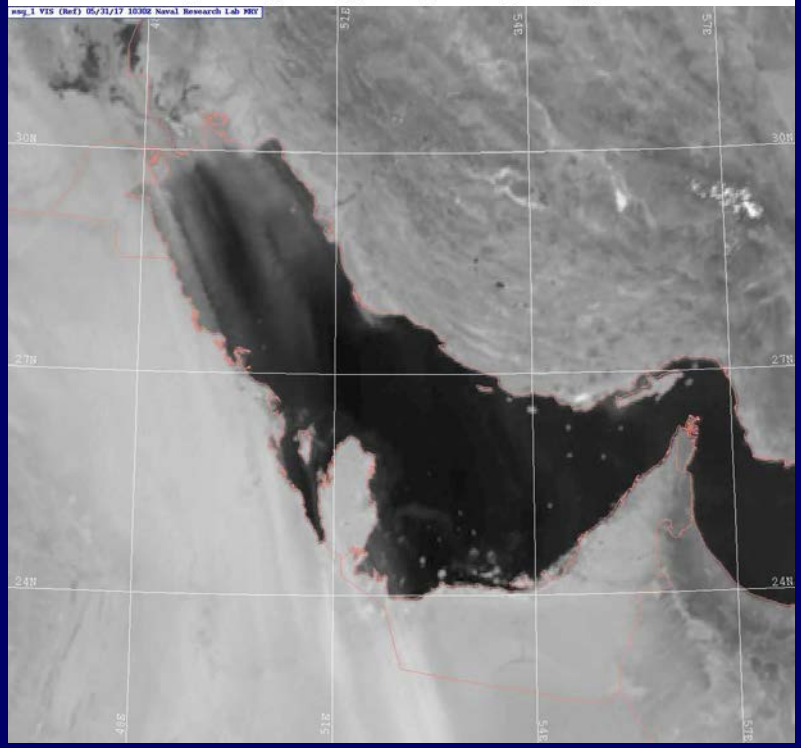


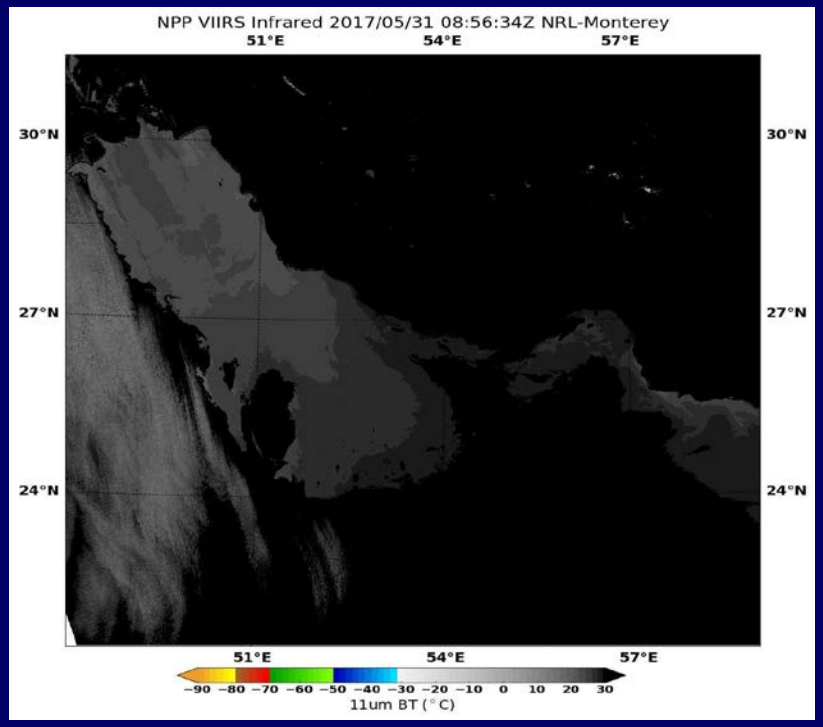
Scatterometer
ASCAT

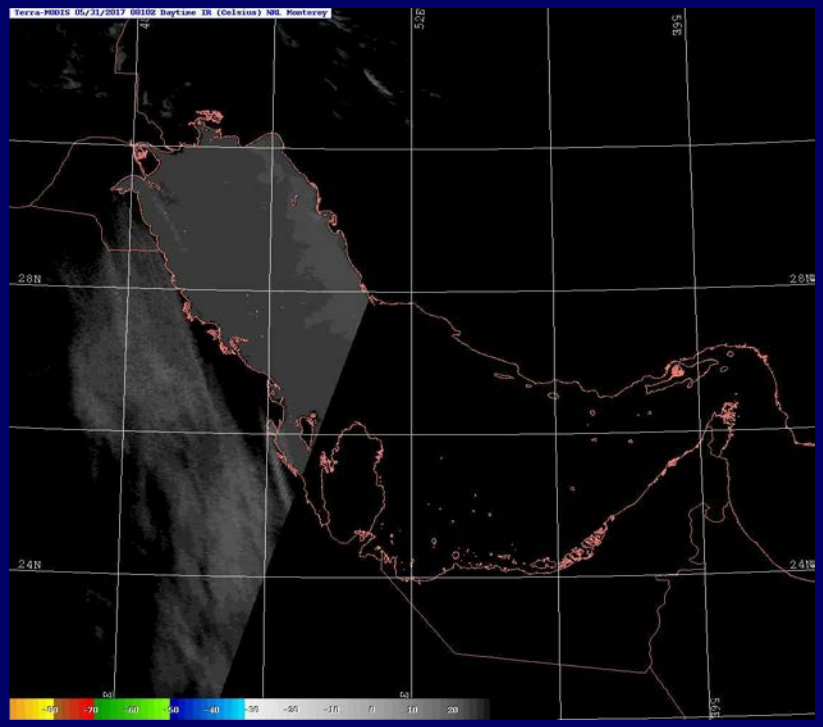

NPP VIIRS Visible 2017/05/31 08:56:34Z NRL-Monterey
51°E
54°E
57°E
30°N
27°N
24°N
0
100
200
300
400
500

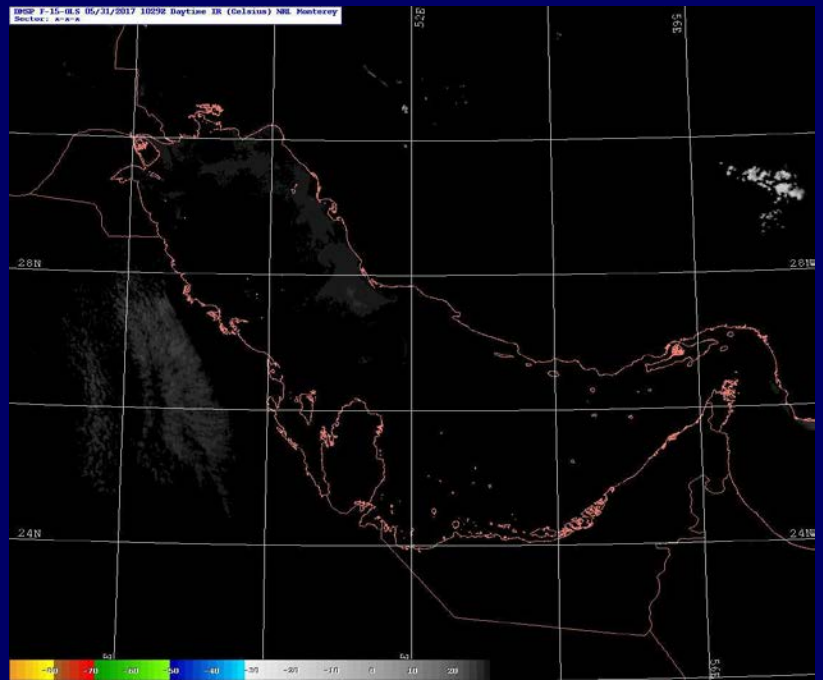

AQUA MODIS Visible 2017/05/31 09:40:00Z NRL-Monterey
51°E
54°E
57°E
30°N
27°N
24°N
0
20
40
60
80
100

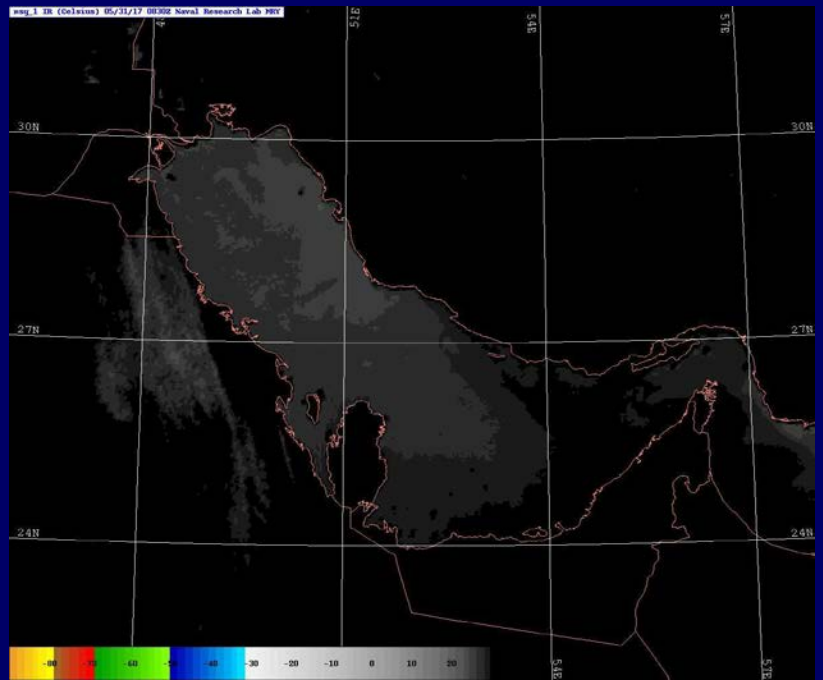

DMSP F-15-OLS 05/31/2017 10292 Daytime VIS NRL Monterey
Sector: x-x-x
28N
24N

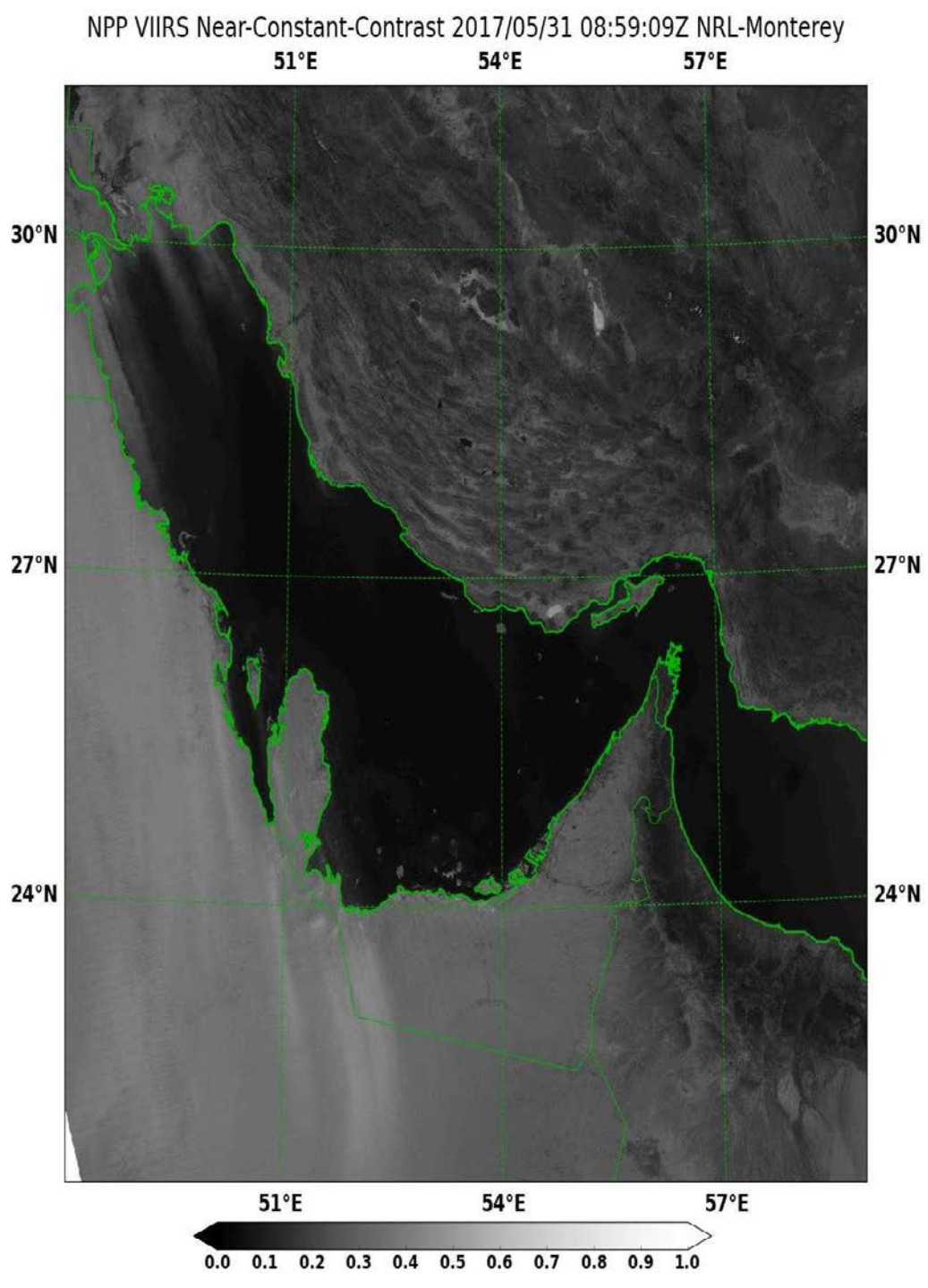

msg_1 VIS (Ref) 05/31/17 10302 Naval Research Lab MRY
30N
27N
24N

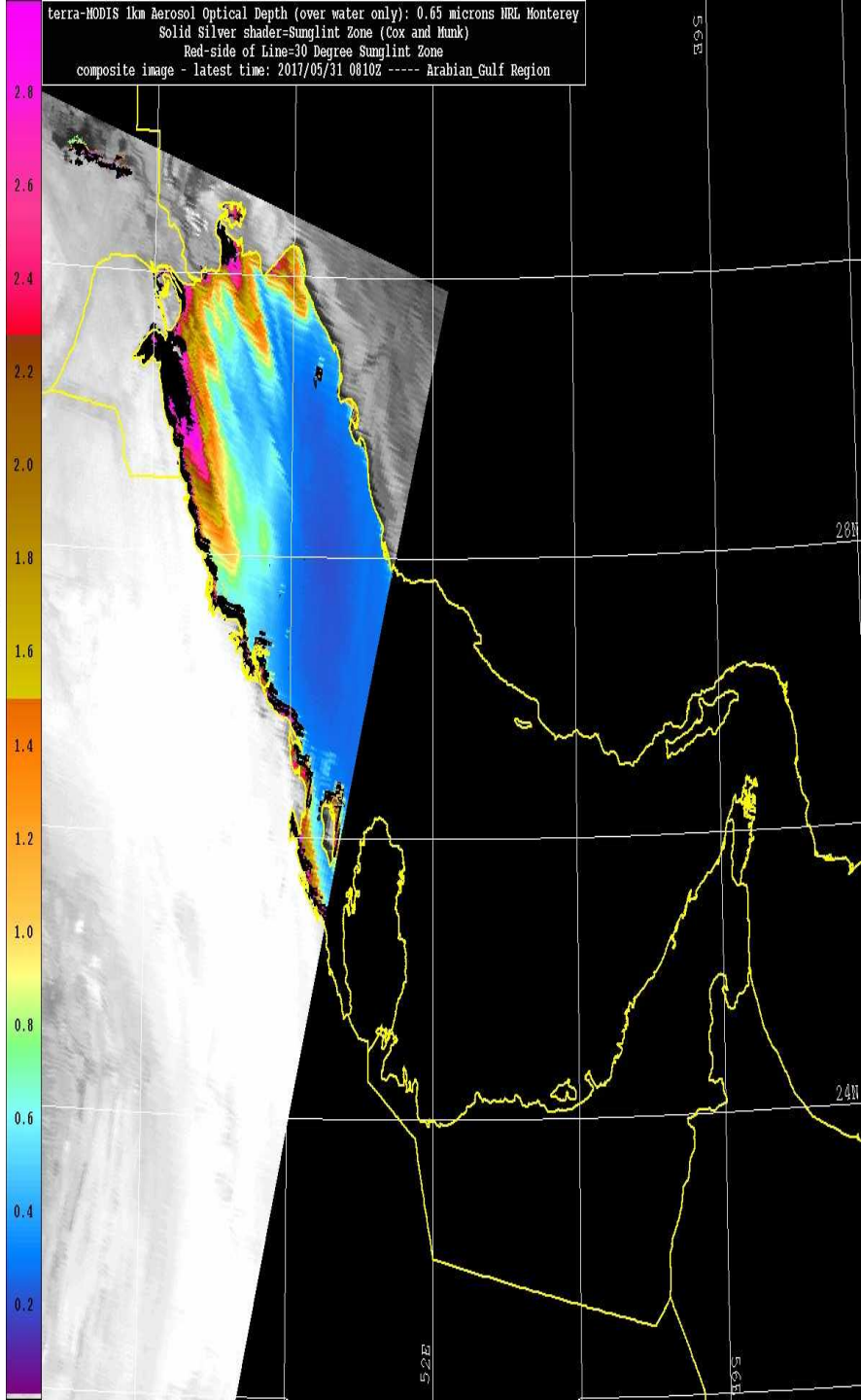

NPP VIIRS Infrared 2017/05/31 08:56:34Z NRL-Monterey
51°E
54°E
57°E
30°N
27°N
24°N
−90 −80 −70 −60 −50 −40 −30 −20 −10 0 10 20 30
11um BT (°C)


Terra-MODIS 05/31/2017 08:10Z Daytime IR (Celsius) NRL Monterey
28N
24N

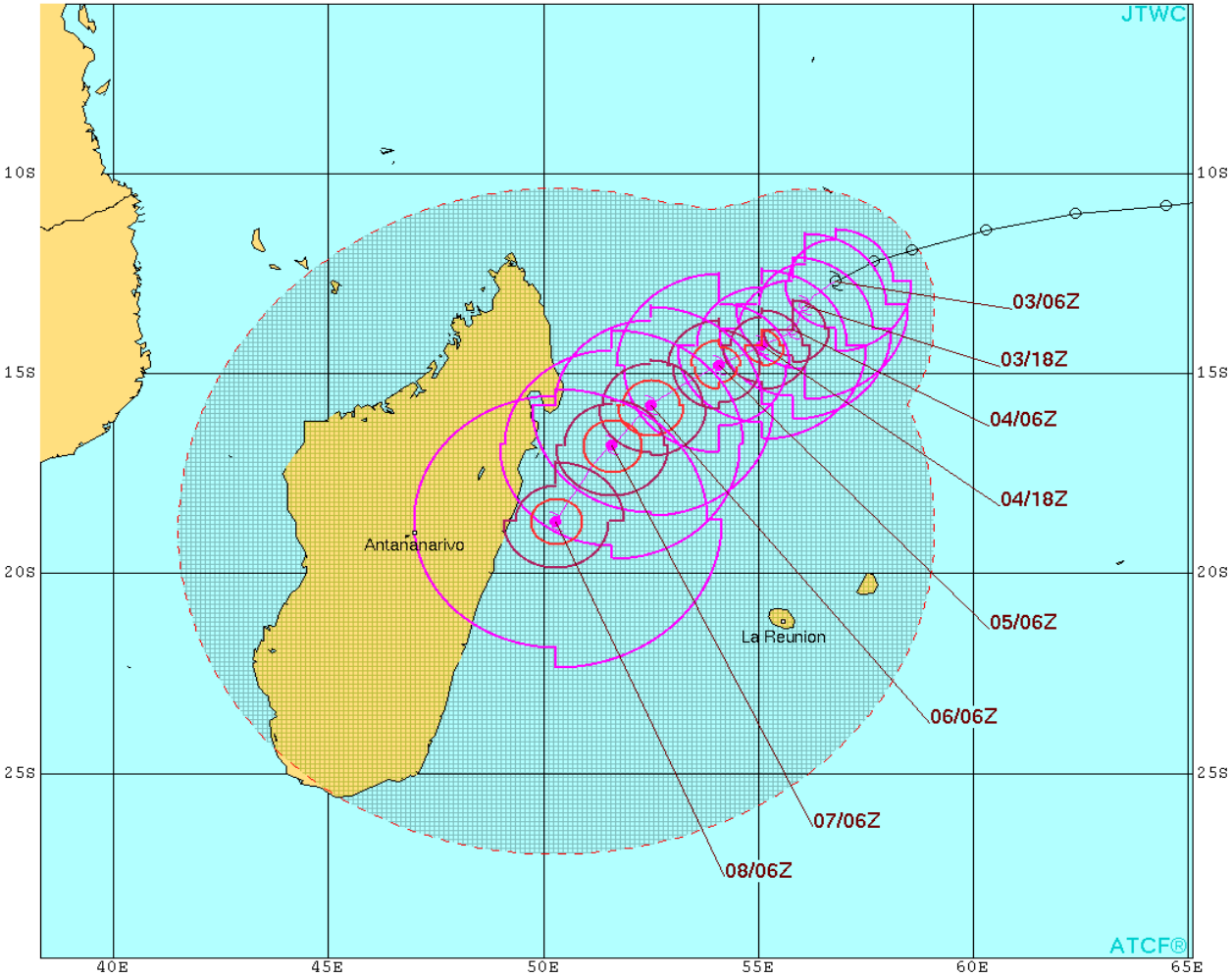

28N
24N


30N
27N
24N


NPP VIIRS Near-Constant-Contrast 2017/05/31 08:59:09Z NRL-Monterey
51°E
54°E
57°E
30°N
27°N
24°N
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0


terra-MODIS 1km Aerosol Optical Depth (over water only): 0.65 microns NRL Monterey
Solid Silver shader=Sunglint Zone (Cox and Munk)
Red-side of Line=30 Degree Sunglint Zone
composite image - latest time: 2017/05/31 0810Z ----- Arabian_Gulf Region
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
56E
28N
24N
52E
56E

Tropical cyclone 09S.ENAWO

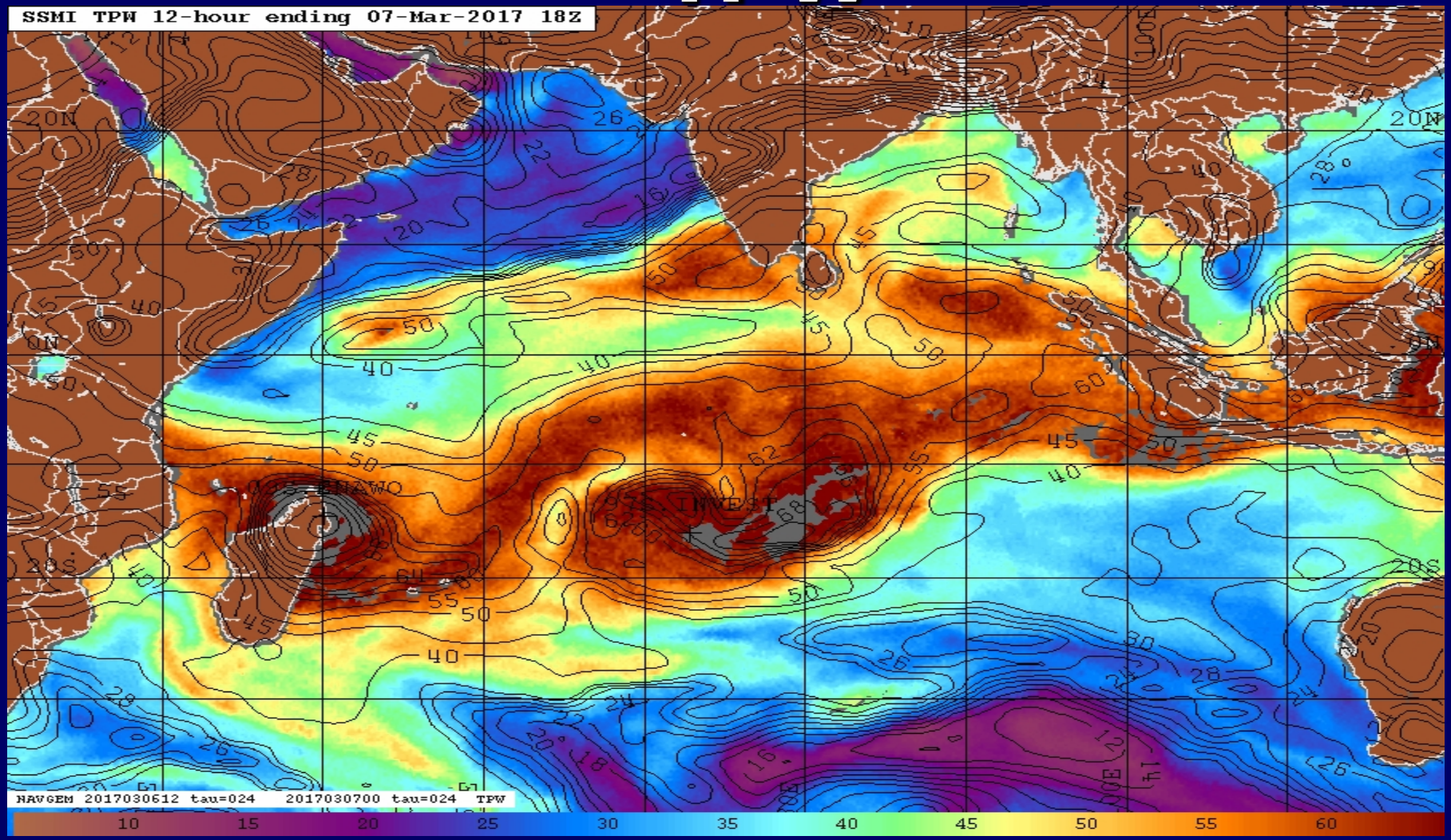


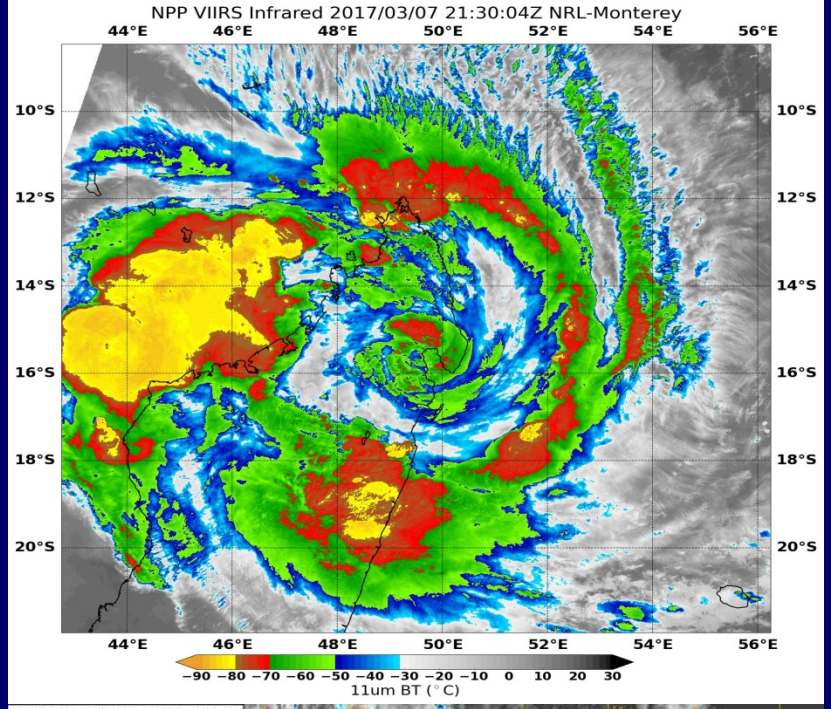
TROPICAL CYCLONE 09S (NINE) WARNING #1
WTXS31 PGTW 030900
030600Z POSIT: NEAR 12.7S 56.8E
MOVING 240 DEGREES TRUE AT 10 KNOTS
MAXIMUM SIGNIFICANT WAVE HEIGHT: 8 FEET
03/06Z, WINDS 035 KTS, GUSTS TO 045 KTS
03/18Z, WINDS 045 KTS, GUSTS TO 055 KTS
04/06Z, WINDS 055 KTS, GUSTS TO 070 KTS
04/18Z, WINDS 070 KTS, GUSTS TO 085 KTS
05/06Z, WINDS 085 KTS, GUSTS TO 105 KTS
06/06Z, WINDS 105 KTS, GUSTS TO 130 KTS
07/06Z, WINDS 120 KTS, GUSTS TO 145 KTS
08/06Z, WINDS 125 KTS, GUSTS TO 150 KTS

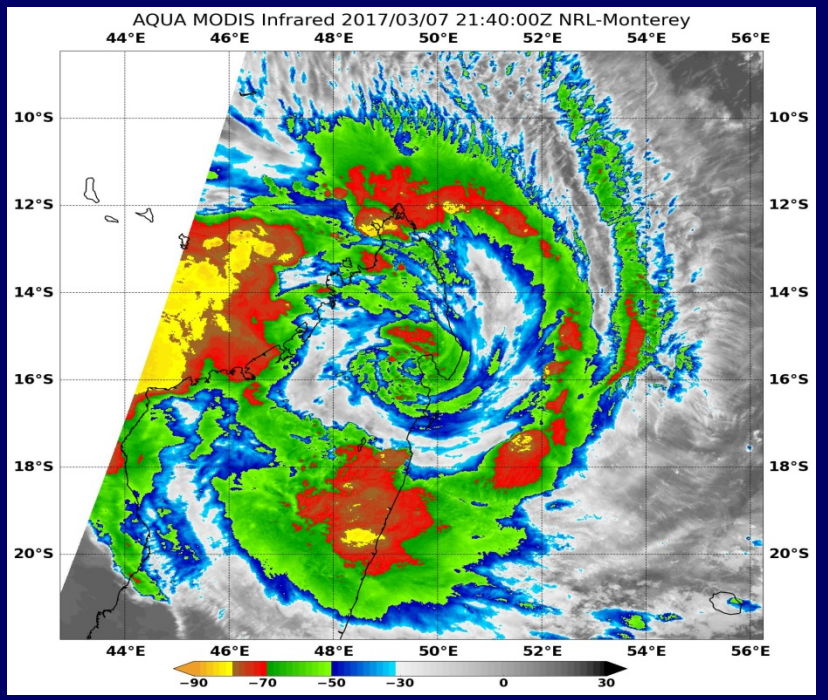
CPA TO:	NM	DTG
PORT_LOUIS	367	05/07Z
ST_DENIS	298	07/21Z

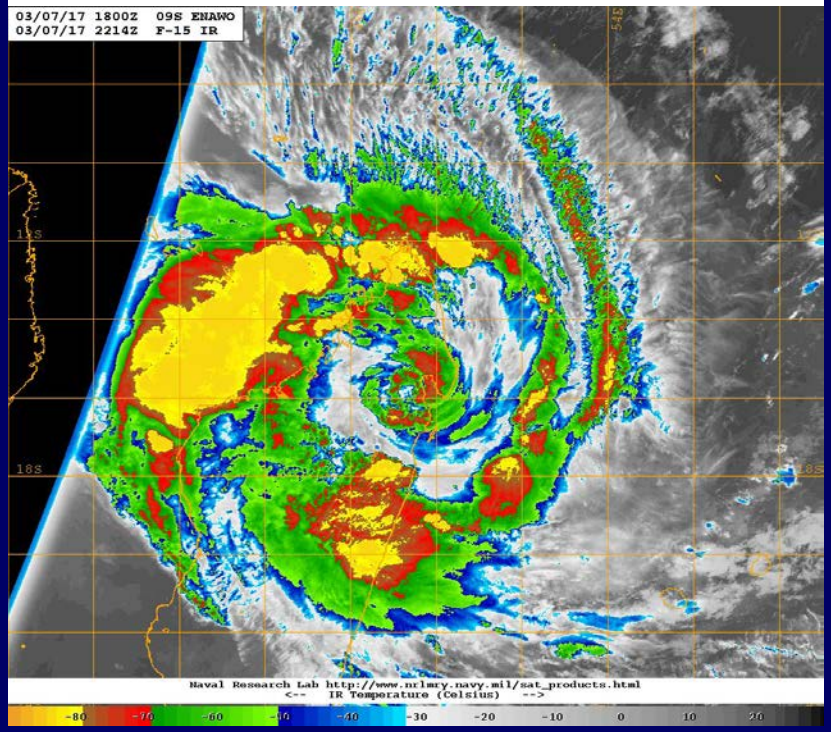
○ LESS THAN 34 KNOTS
◔ 34-63 KNOTS
● MORE THAN 63 KNOTS
PAST 6 HOURLY CYCLONE POSITS IN BLACK
FORECAST CYCLONE POSITS IN COLOR

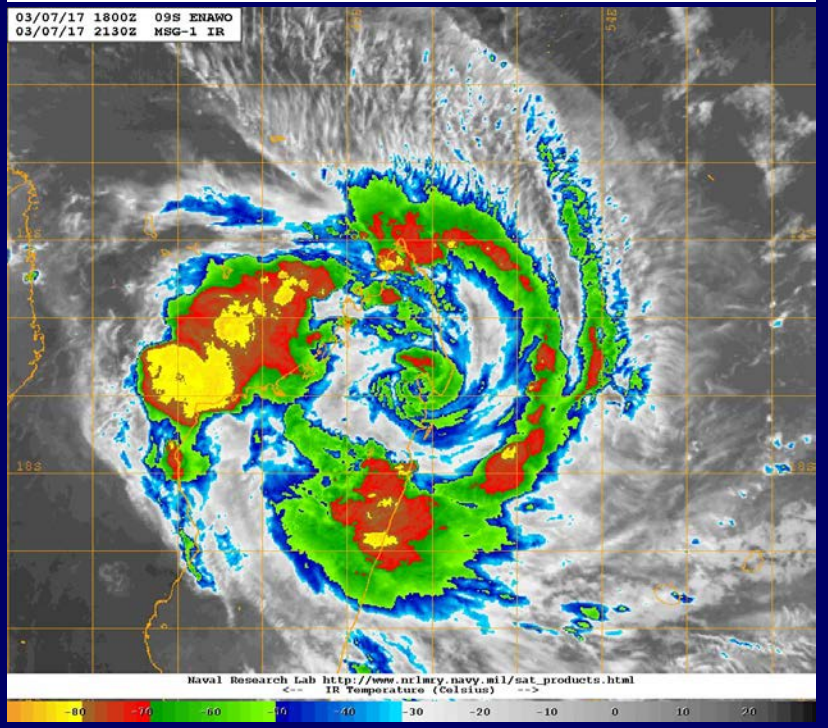
09S.ENAWO
TPW



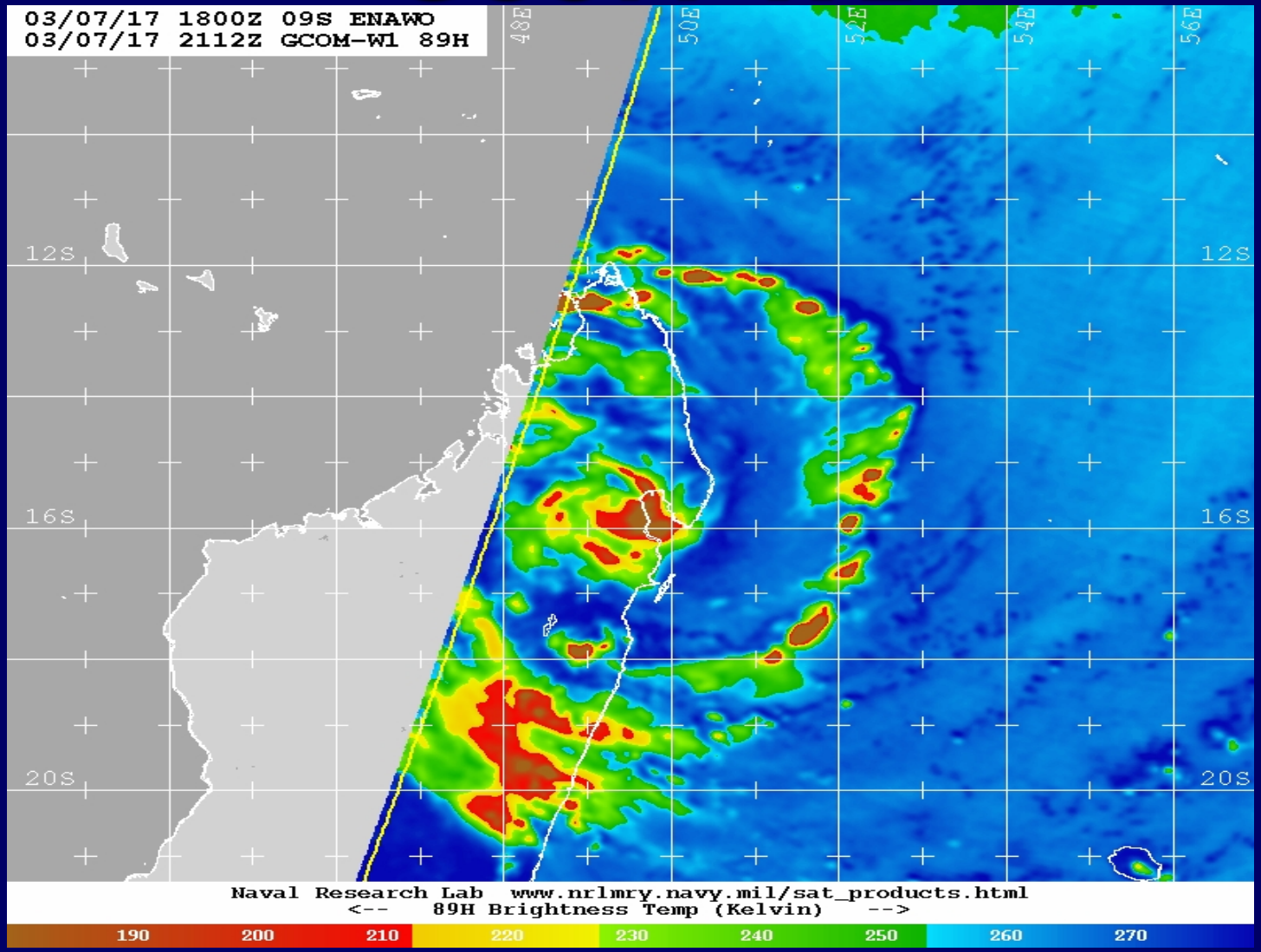

NPP VIIRS Infrared 2017/03/07 21:30:04Z NRL-Monterey
44°E 46°E 48°E 50°E 52°E 54°E 56°E
10°S 12°S 14°S 16°S 18°S 20°S
−90 −80 −70 −60 −50 −40 −30 −20 −10 0 10 20 30
11um BT (°C)

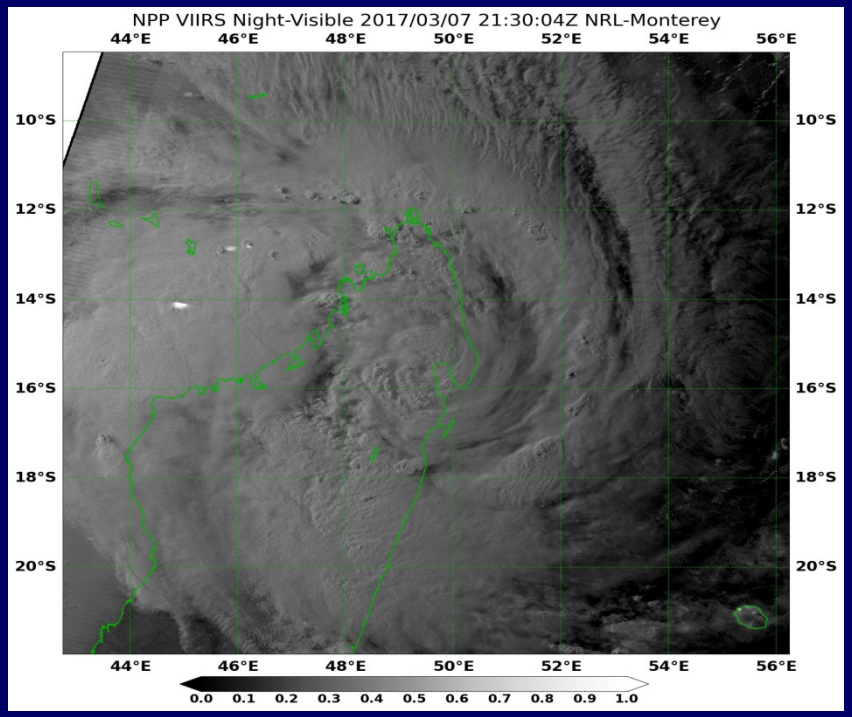

AQUA MODIS Infrared 2017/03/07 21:40:00Z NRL-Monterey
44°E 46°E 48°E 50°E 52°E 54°E 56°E
10°S 12°S 14°S 16°S 18°S 20°S
−90 −70 −50 −30 0 30

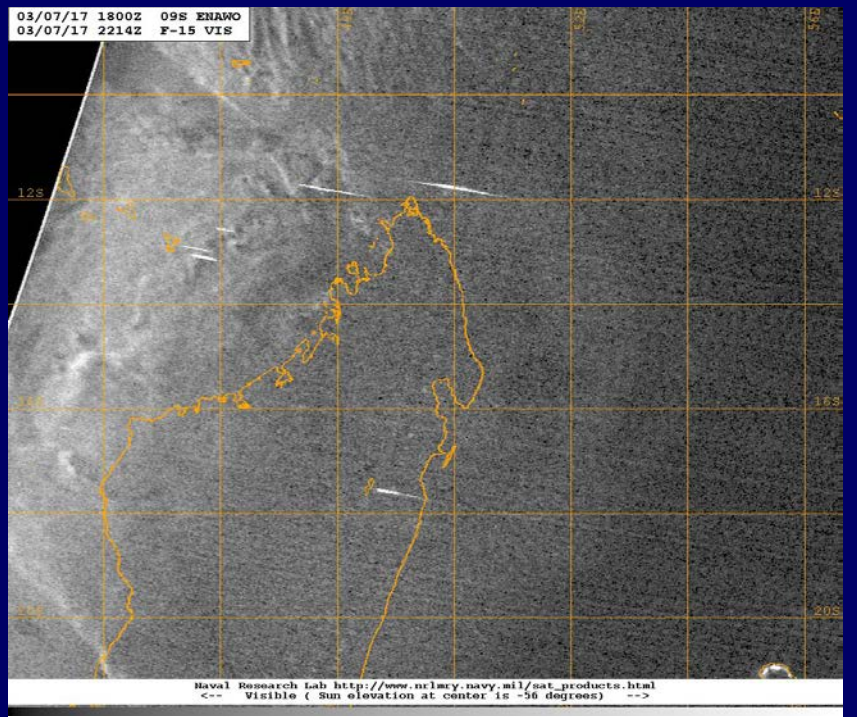

03/07/17 1800Z 09S ENAWO
03/07/17 2214Z F-15 IR
Naval Research Lab http://www.nrlmry.navy.mil/sat_products.html
<-- IR Temperature (Celsius) -->
-80 -70 -60 -50 -40 -30 -20 -10 0 10 20

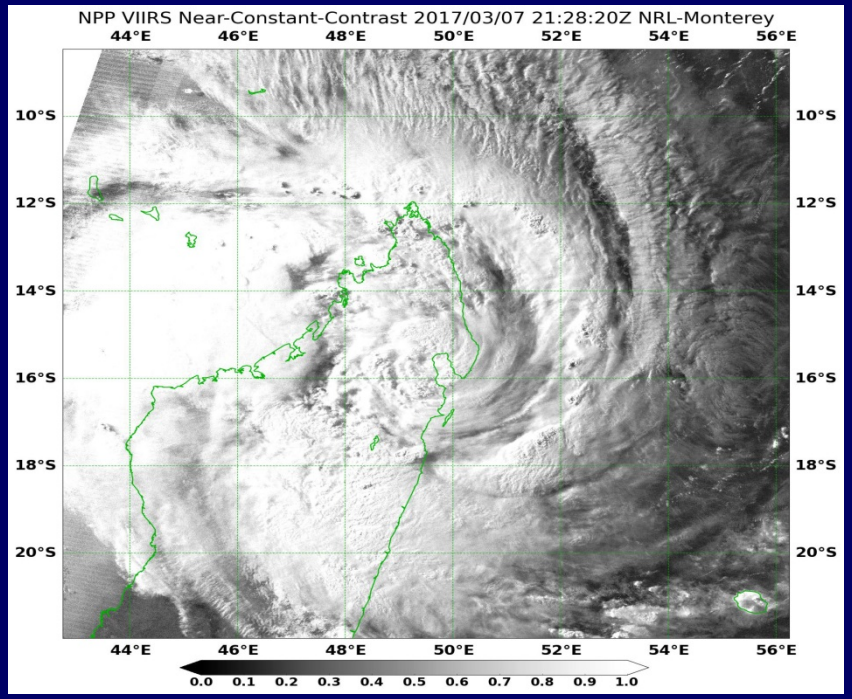

03/07/17 1800Z 09S ENAWO
03/07/17 2130Z MSG-1 IR
Naval Research Lab http://www.nrlmry.navy.mil/sat_products.html
<-- IR Temperature (Celsius) -->
-80 -70 -60 -50 -40 -30 -20 -10 0 10 20

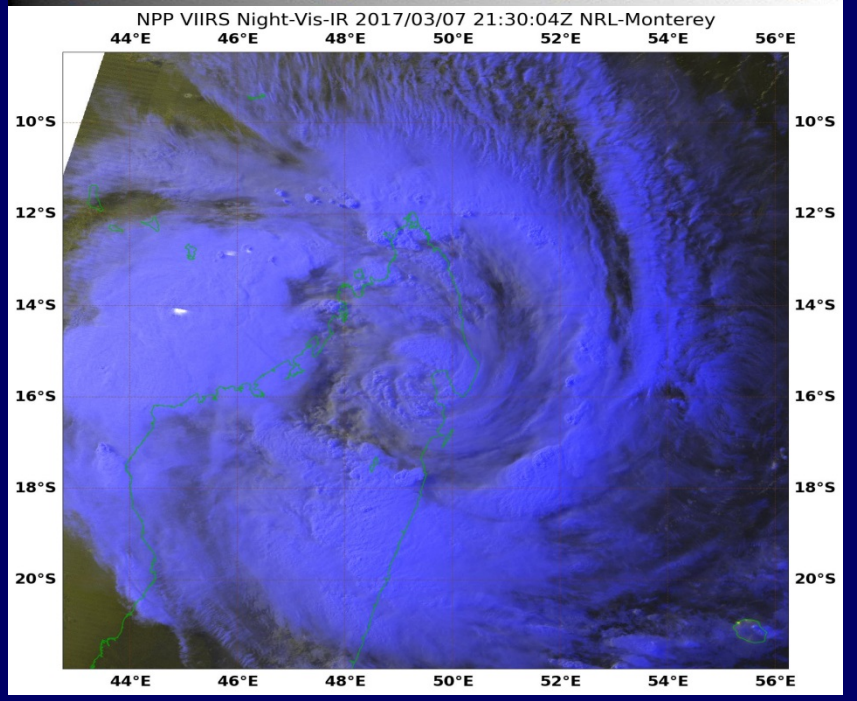
GCOM-W1


03/07/17 1800Z 09S ENAWO
03/07/17 2112Z GCOM-W1 89H
48E
50E
52E
54E
56E
12S
16S
20S
Naval Research Lab www.nrlmry.navy.mil/sat_products.html
<-- 89H Brightness Temp (Kelvin) -->
190
200
210
220
230
240
250
260
270


NPP VIIRS Night-Visible 2017/03/07 21:30:04Z NRL-Monterey
44°E 46°E 48°E 50°E 52°E 54°E 56°E
10°S 12°S 14°S 16°S 18°S 20°S
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0


03/07/17 1800Z 09S ENAWO
03/07/17 2214Z F-15 VIS
12S
16S
20S
Naval Research Lab http://www.nrlmry.navy.mil/sat_products.html
<-- Visible (Sun elevation at center is -56 degrees) -->


NPP VIIRS Near-Constant-Contrast 2017/03/07 21:28:20Z NRL-Monterey
44°E 46°E 48°E 50°E 52°E 54°E 56°E
10°S 12°S 14°S 16°S 18°S 20°S
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0


NPP VIIRS Night-Vis-IR 2017/03/07 21:30:04Z NRL-Monterey
44°E 46°E 48°E 50°E 52°E 54°E 56°E
10°S 12°S 14°S 16°S 18°S 20°S