NOAA-20 VIIRS EDR IMAGERY/NCC

Don Hillger, PhD
Don.Hillger@noaa.gov
VIIRS EDR Imagery Team
(with contributions from other Imagery Team members)
2018-08-29

Outline

- Cal/Val Team Members
- Sensor/Algorithm Overview
- S-NPP/N-20 Product(s) Performance
- Major Issues and Mitigation
- Milestones and Deliverables
- Future Plans/Improvements

Imagery Cal/Val Team Members/Major Contributors

Name	Organization	Major Task
Don Hillger	**NESDIS/StAR**	Imagery Product Lead
Tom Kopp	**Aerospace**	Imagery Cal/Val Lead
Curtis Seaman	**CIRA**	Imagery/DNB expert
Steven Miller	**CIRA**	DNB/Imagery expert
Jorel Torres	**CIRA**	JPSS Liaison / trainer
Steve Finley	**CIRA**	IT/data expert
William Straka III	**CIMSS/SSEC**	Imagery/DNB expert
Rosalie Marley	**GST**	Imagery JAM
Chris Elvidge	**NCEI-Boulder**	Operational DNB products online
Arunas Kuciauskas	**NRL-Monterey**	VIIRS Online (for Naval use in particular)
Eric Stevens, Melissa Kreller, Carl Dierking, Nate Eckstein, Jay Cable	**Alaska: GINA and NWS**	NWS (use in analysis and forecasting)
John Evans, John Paquette	**NWS**	AWIPS ingest and display

VIIRS Environmental Data Record (EDR)s

VIIRS Band	Central Wavelength (µm)	Bandwidth (µm)	Wavelength Range (µm)	Band Explanation	Spatial Resolution (m) @ nadir
M1	0.412	0.02	0.402 - 0.422	Visible	750 m
M2	0.445	0.018	0.436 - 0.454		
M3	0.488	0.02	0.478 - 0.488		
M4	0.555	0.02	0.545 - 0.565		
M5	0.672	0.02	0.662 - 0.682		
M6	0.746	0.015	0.739 - 0.754	Near IR	
M7	0.865	0.039	0.846 - 0.885		
M8	1.240	0.020	1.23 - 1.25	Shortwave IR	
M9	1.378	0.015	1.371 - 1.386		
M10	1.61	0.06	1.58 - 1.64		
M11	2.25	0.05	2.23 - 2.28		
M12	3.7	0.18	3.61 - 3.79	Medium-wave IR	
M13	4.05	0.155	3.97 - 4.13		
M14	8.55	0.3	8.4 - 8.7	Longwave IR	
M15	10.763	1.0	10.26 - 11.26		
M16	12.013	0.95	11.54 - 12.49		
DNB / NCC	0.7	0.4	0.5 - 0.9	Visible	750 m across full scan
I1	0.64	0.08	0.6 - 0.68	Visible	375 m
I2	0.865	0.039	0.85 - 0.88	Near IR	
I3	1.61	0.06	1.58 - 1.64	Shortwave IR	
I4	3.74	0.38	3.55 - 3.93	Medium-wave IR	
I5	11.45	1.9	10.5 - 12.4	Longwave IR	

M-bands EDRs are highlighted in pale yellow, in addition to I-band EDRs.
True-color component bands are highlighted in red, green, and blue.

Requirements (continued)

The **Imagery** product consists of:

- **Visible/IR radiances/reflectances** remapped to the **Ground Track Mercator (GTM**) grid, eliminating overlapping pixels and bowtie deletions.
  - I-band and M-band Imagery
- **NCC Imagery** that is a **pseudo-albedo** derived from the DNB, creating an image product that removes large contrasts in DNB from day to night across the terminator.

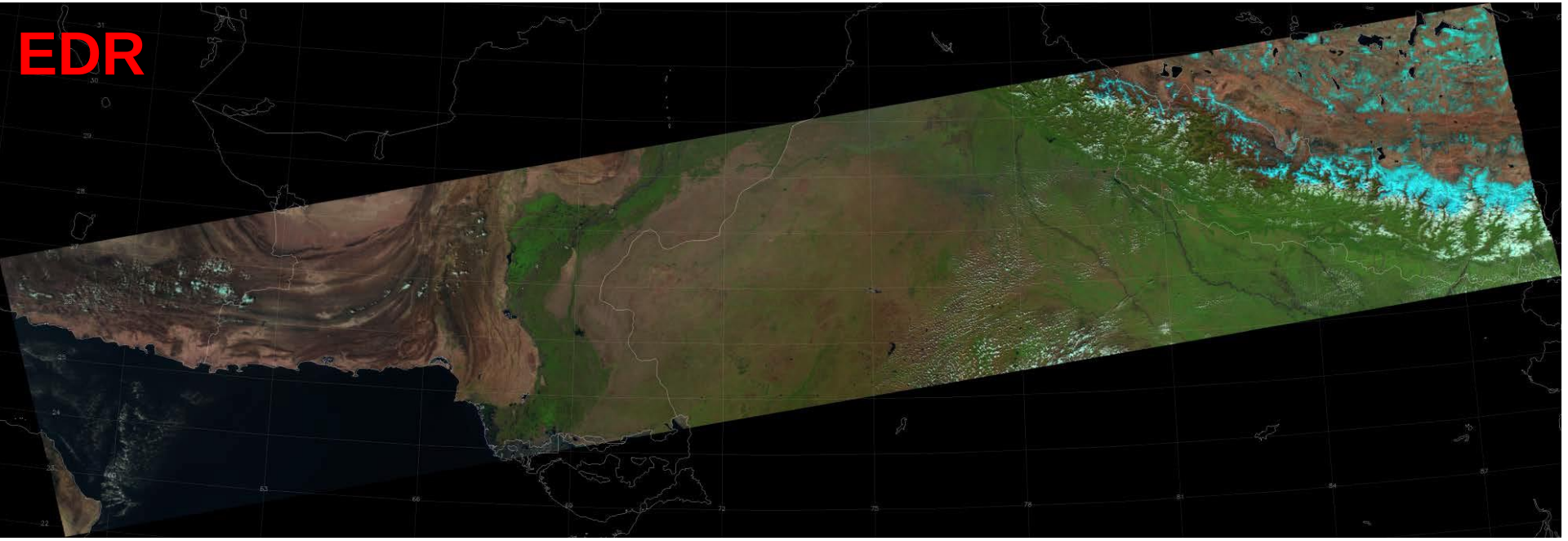
Imagery is a Key Performance Parameter (KPP)

VIIRS Imagery EDR for (8) bands I1, I3, I4, I5, M14, M15, M16, and DNB for latitudes greater than 60°N in the Alaskan region (I3 and DNB bands added post SNPP launch)

- There are **no (quantitative) Imagery requirements** that address the **quality** of the Imagery products.
- **Imagery users** decide if the quality is acceptable, therefore **including the users is a key consideration**

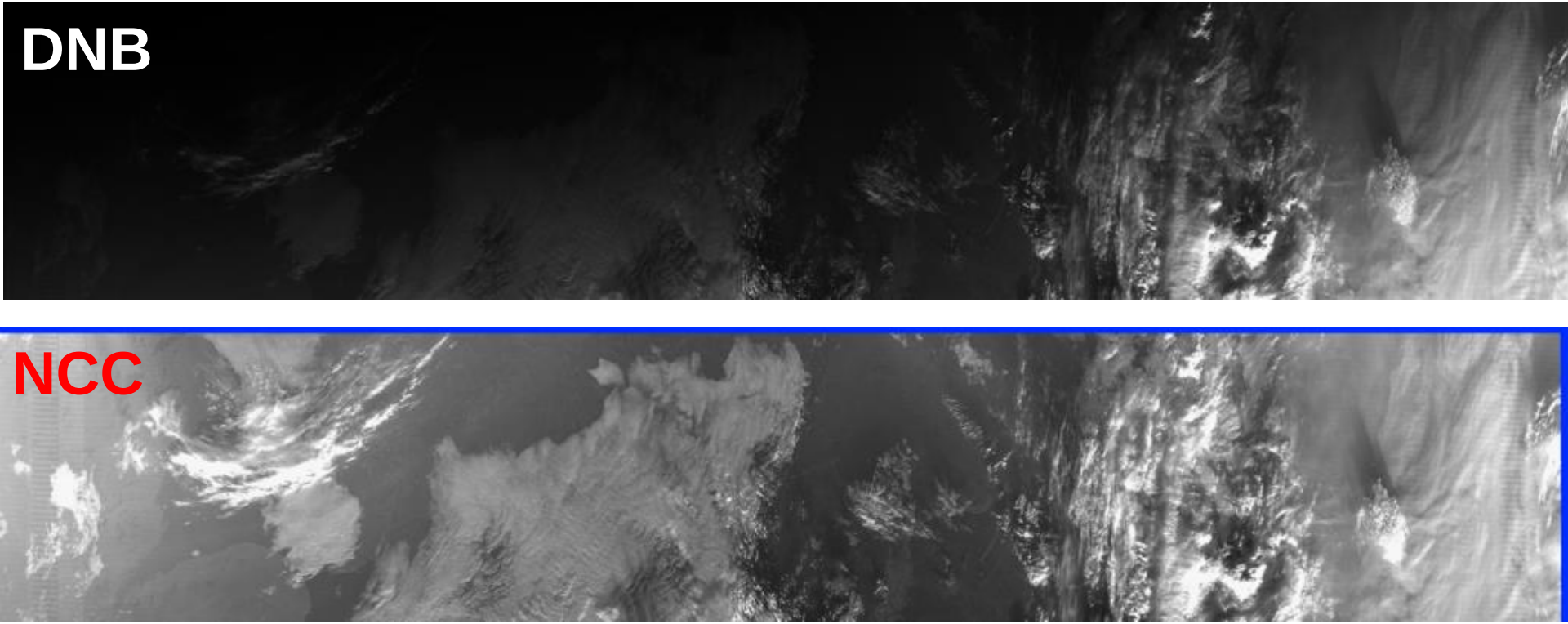
VIIRS SDR vs. EDR





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.



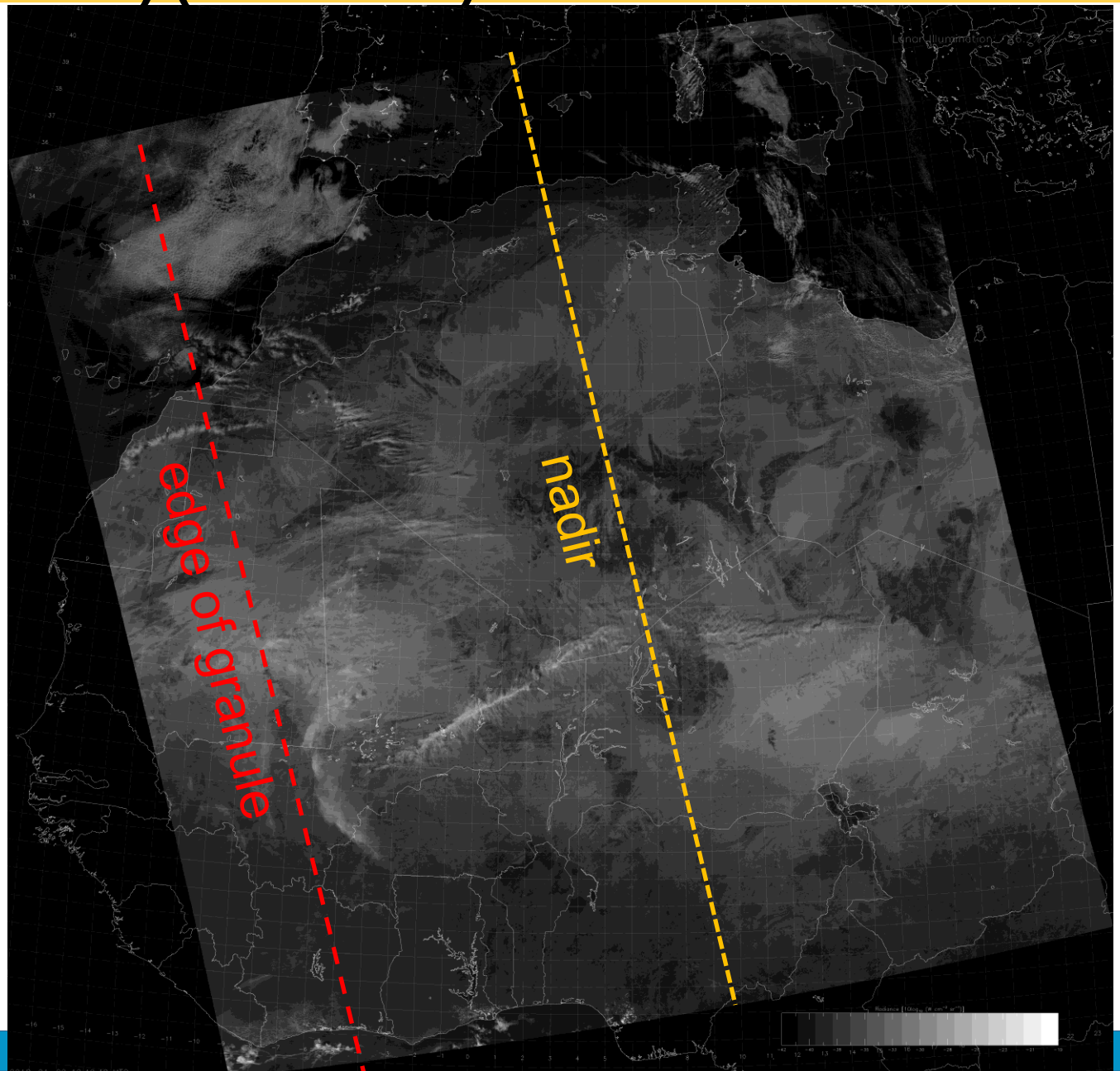
Curtis Seaman, CIRA

Findings/Issues at Validation Reviews

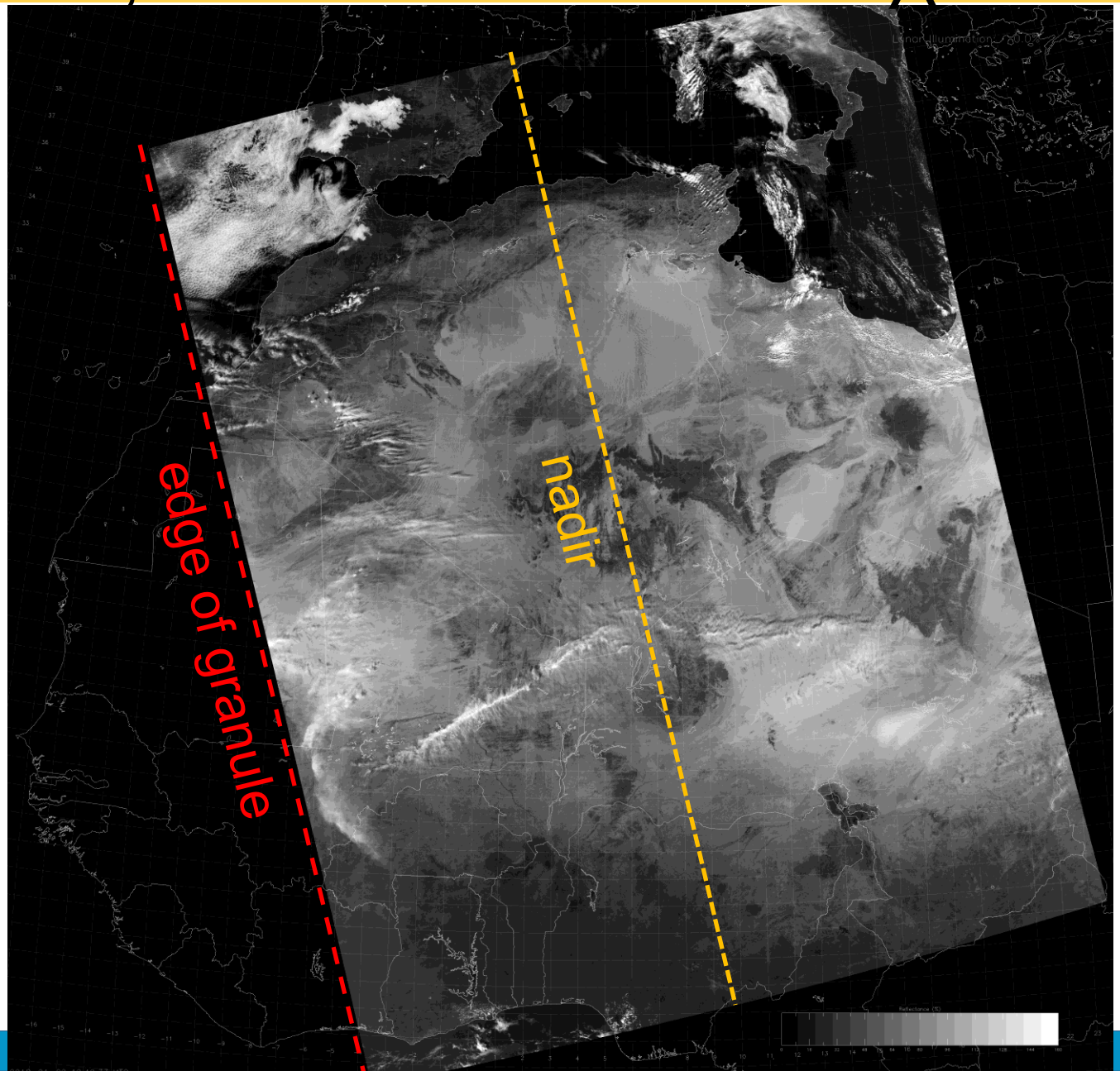
- VIIRS **M-bands** (all good) – vis/IR bands
- VIIRS **I-bands i**ssues at **Beta** that were resolved,
  - **I3 bad detector**
  - **I4 and I5 fill values**
- VIIRS **DNB/NCC** issues:
  - **Extended DNB granule processing** by NCC is working
  - **Geolocation issues** (resolved with LUT updates)
  - **Stray light (VIIRS SDR Team)**
- **Better together: NOAA-20 and SNPP** (50 min half-orbit separation examples)
- **NOAA-20 VIIRS Imagery display (I-bands, M-bands, and DNB/NCC)**
  - **http://rammb.cira.colostate.edu/ramsdis/online/noaa-20_viirs.asp**

NOAA-20 DNB extended granule

DNB (extended granule on left and nadir not at center) (2018-01-22)

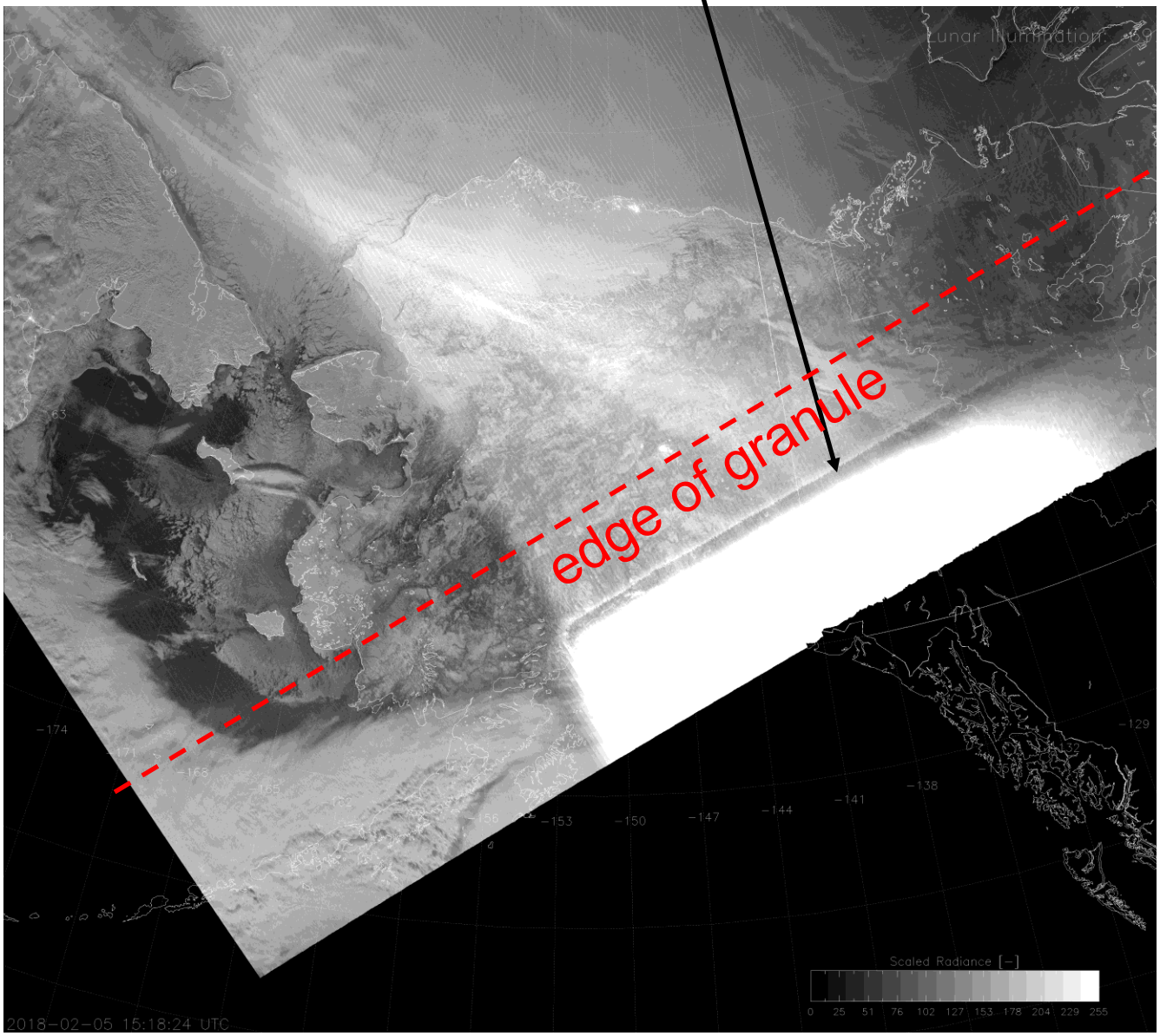


NCC (extended granule not included, and nadir at center, and better contrast than DNB) (2018-01-22)

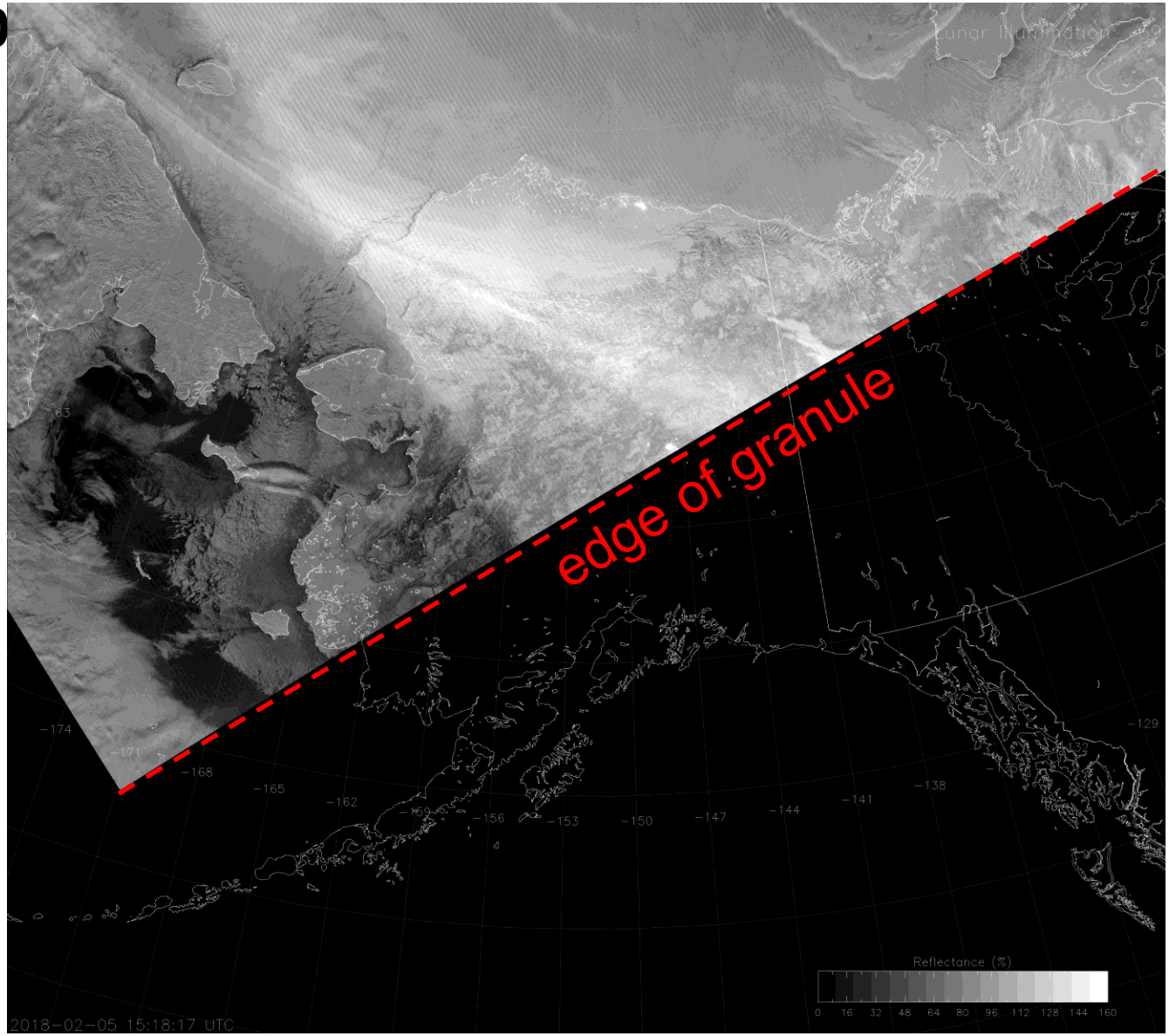


NOAA-20 DNB stray light

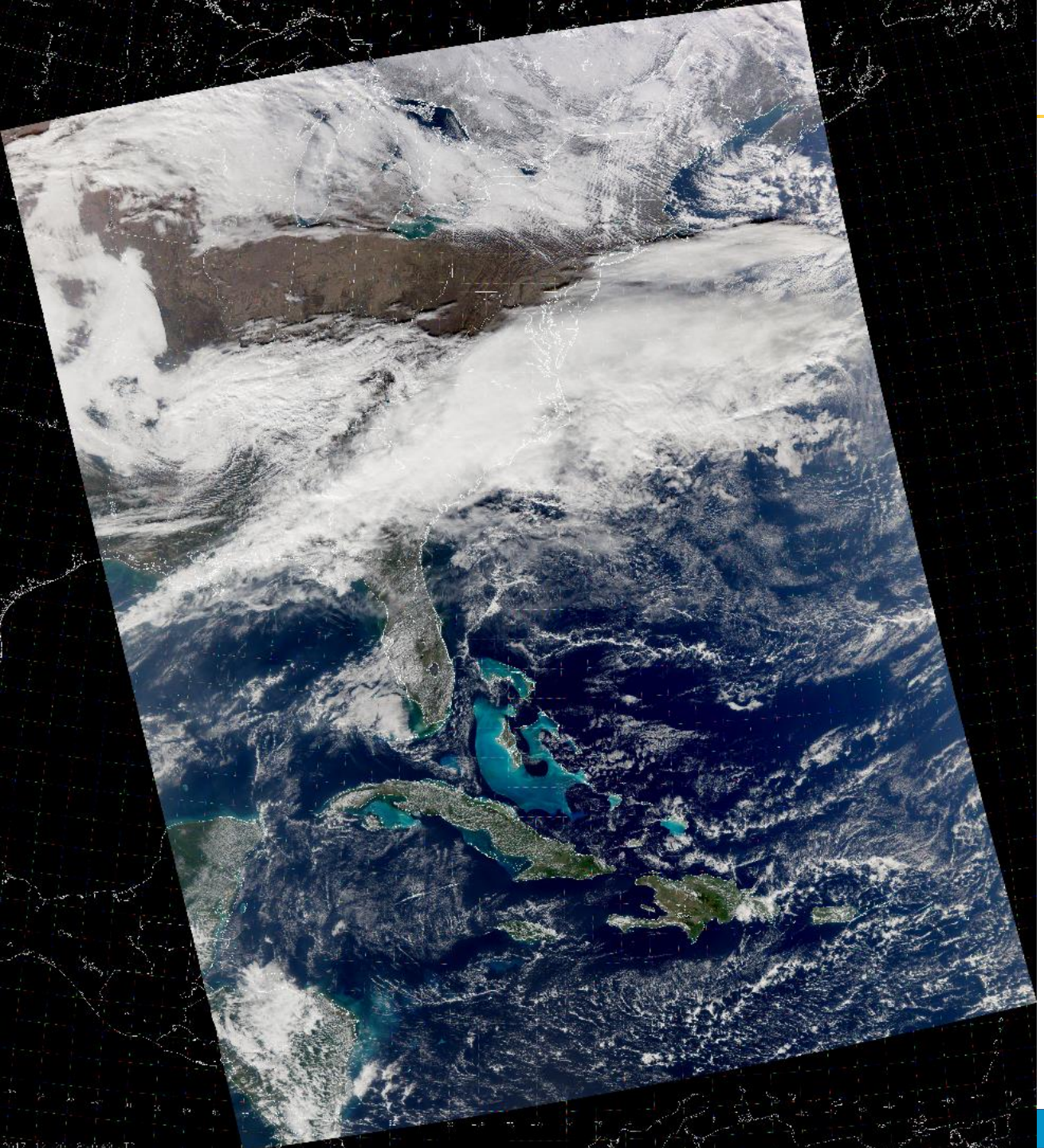
Extra strong patch of stray light in extended DNB granule (2018-02-05)



Extra strong patch of stray light not in NCC granule which cuts off extended portion of DNB (2018-02-0



NOAA-20 M-bands visible/IR bands



VIIRS True Color

Eastern US (2017-12-20)

(C. Seaman, CIRA)

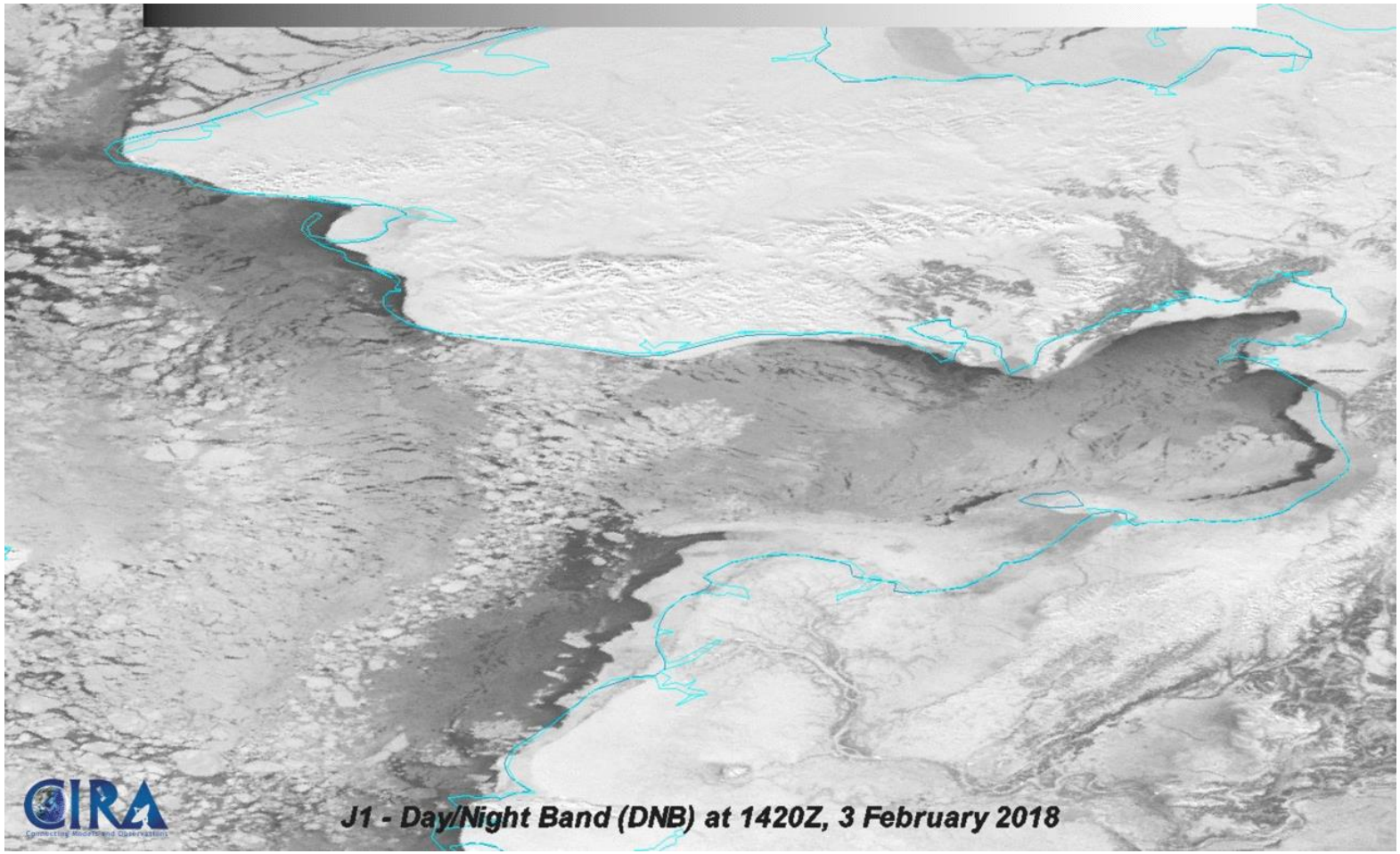
Day-Night-Band First Light CONUS (2017-12-14)

(S. Miller, CIRA; NOAA Facebook)

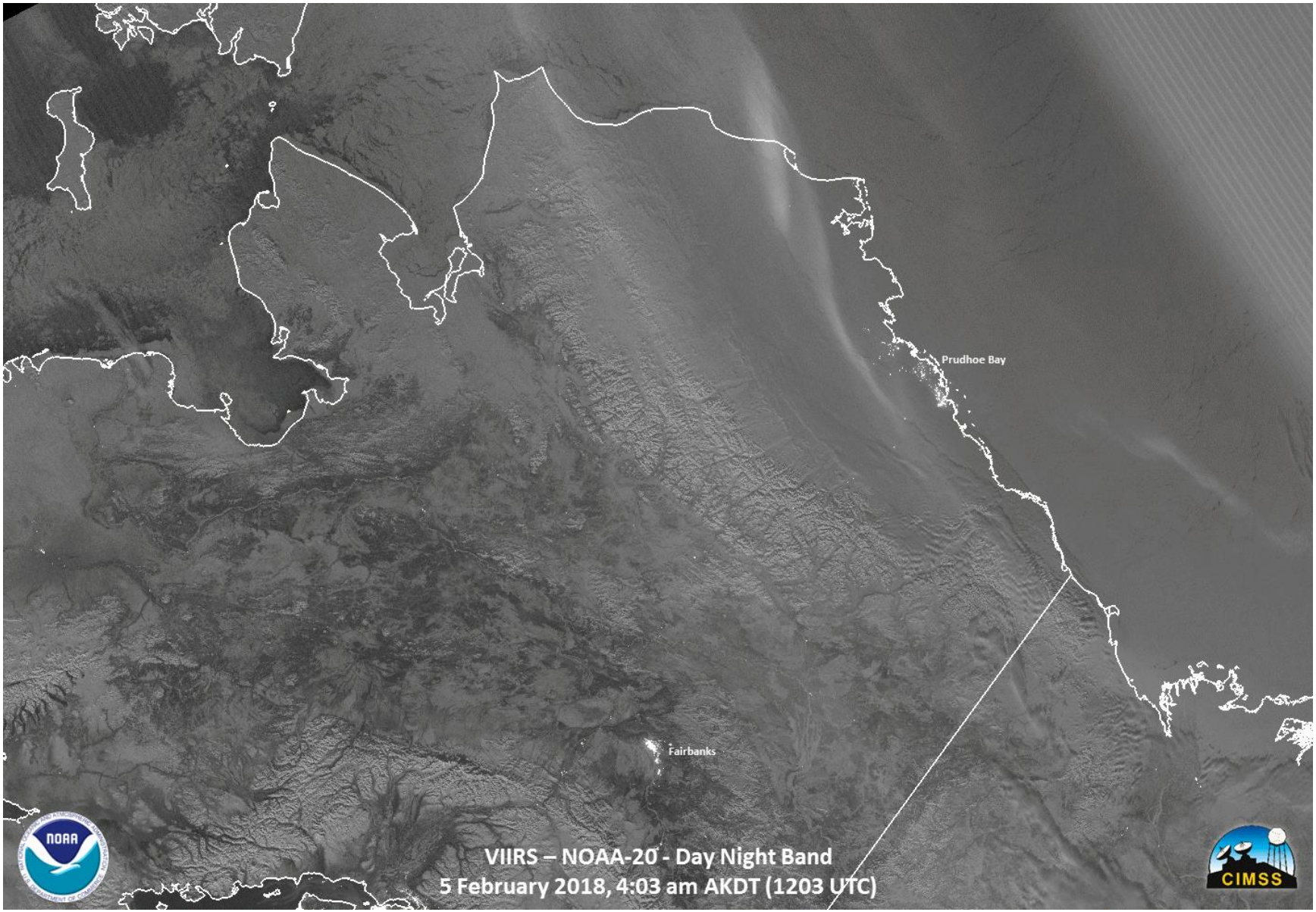


SNPP and NOAA-20 DNB comparisons (~50 minutes separation)

NOAA-20 DNB animation shows NW Alaska (near Nome, AK) of snow-covered areas, sea-ice edges and sea-ice motion over a period of 3 days: 3-5 February 2018. (J. Torres, CIRA)

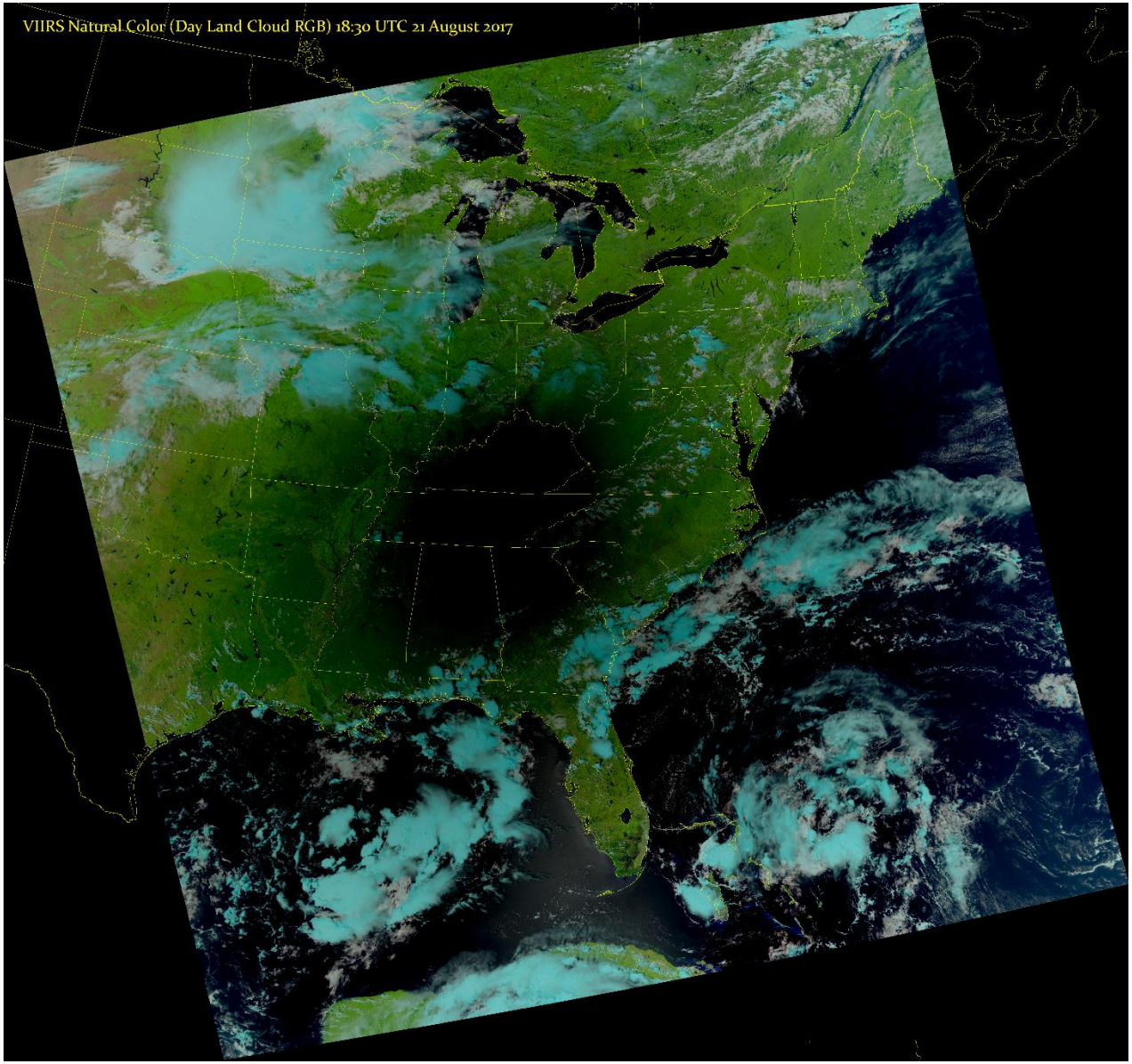


NOAA-20/SNPP DNB animation of aurora – note how quickly the light show changes! (W. Straka, CIMSS/SSEC)

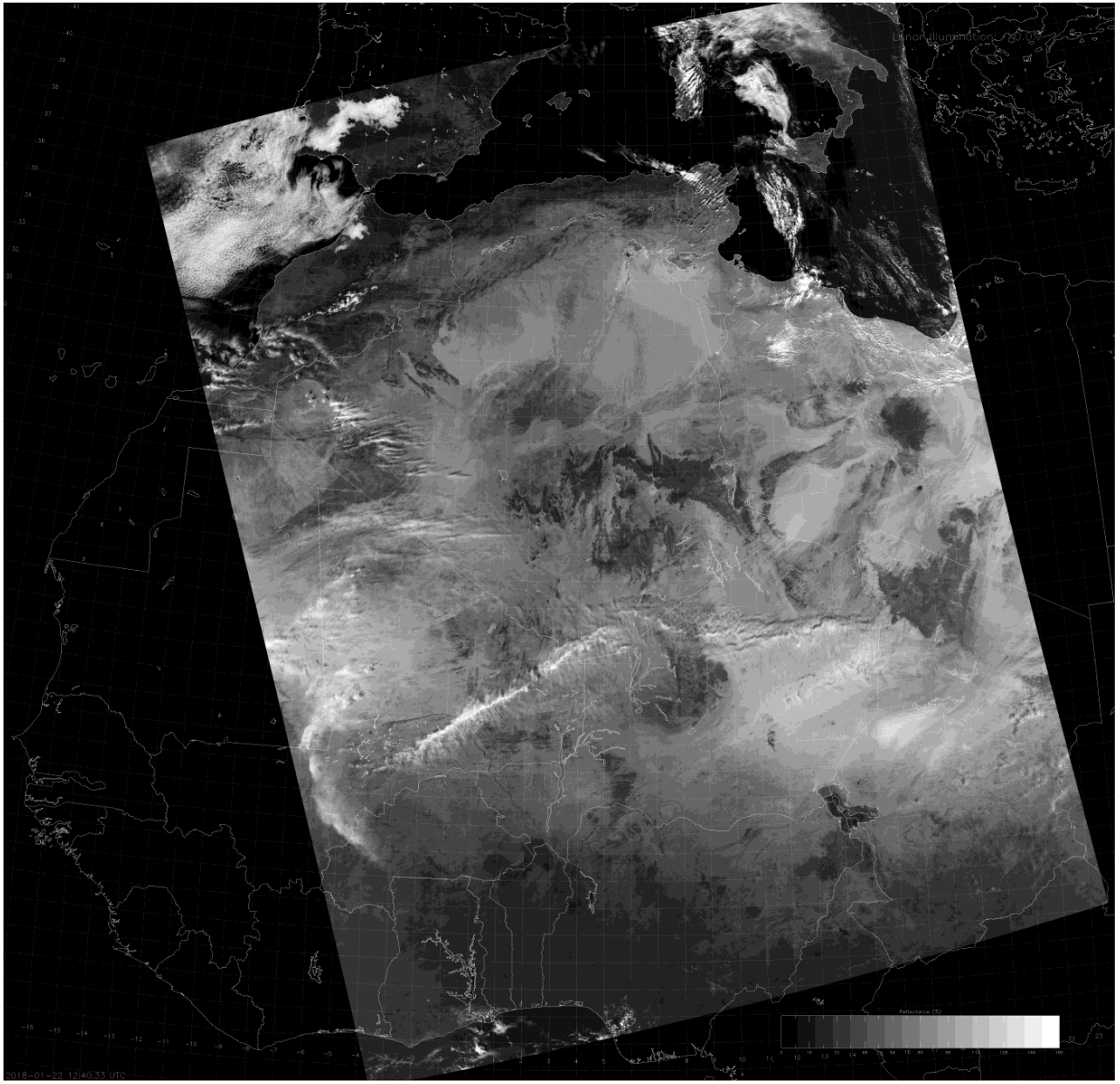


More examples

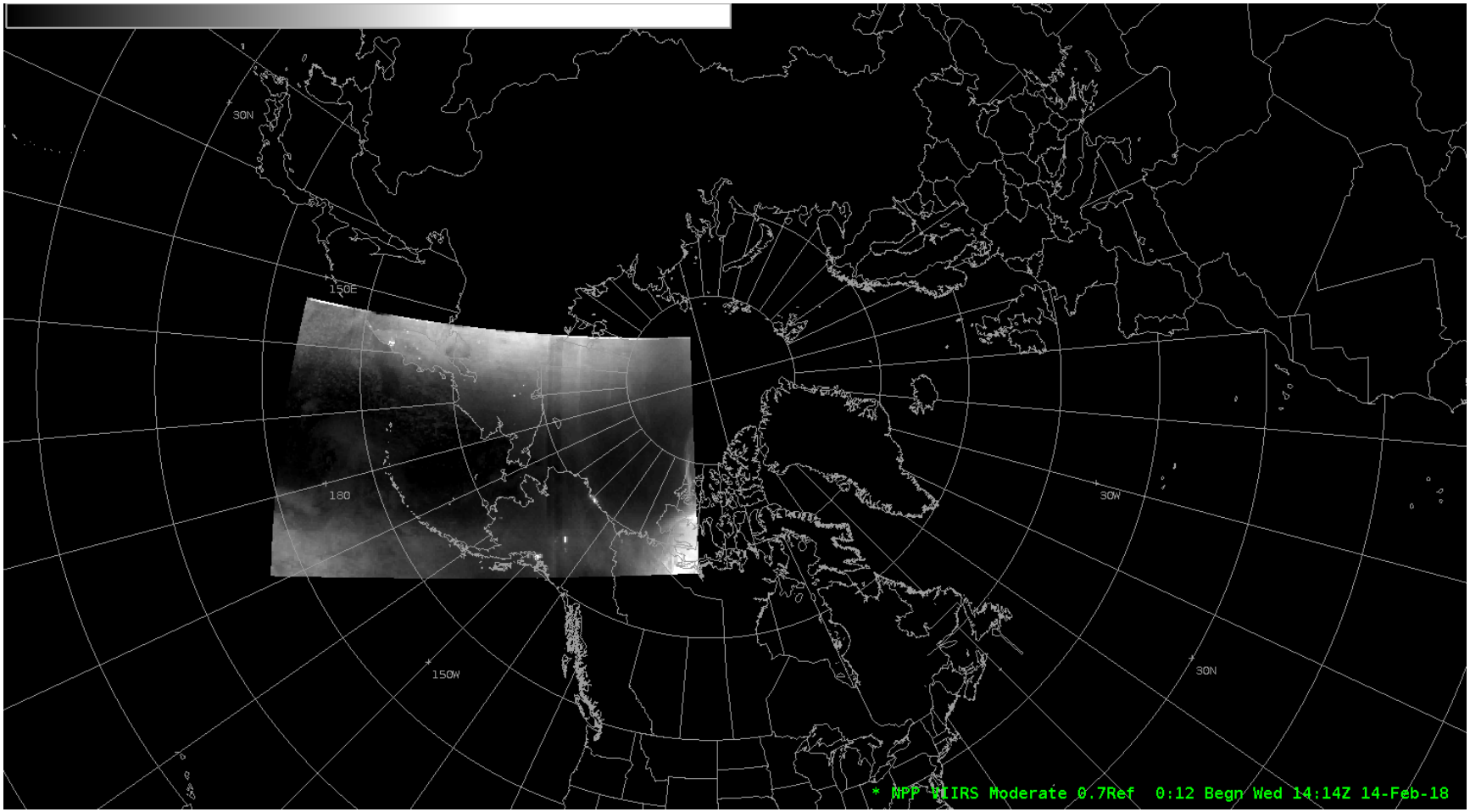
Total Eclipse – 2017-08-21 @ 1827 UTC (C. Seaman)



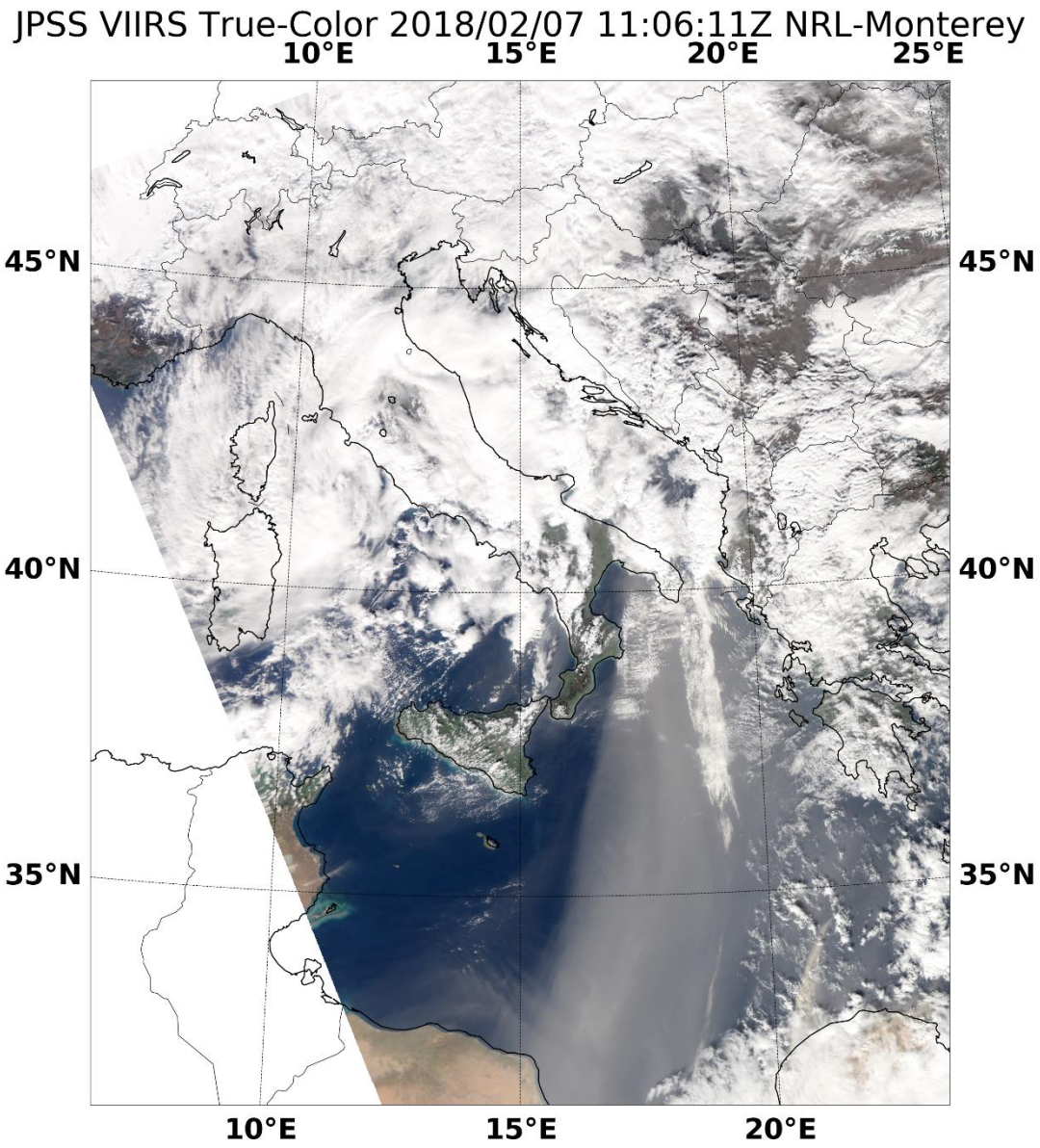
NCC 2018-01-22 @ 1240 UTC



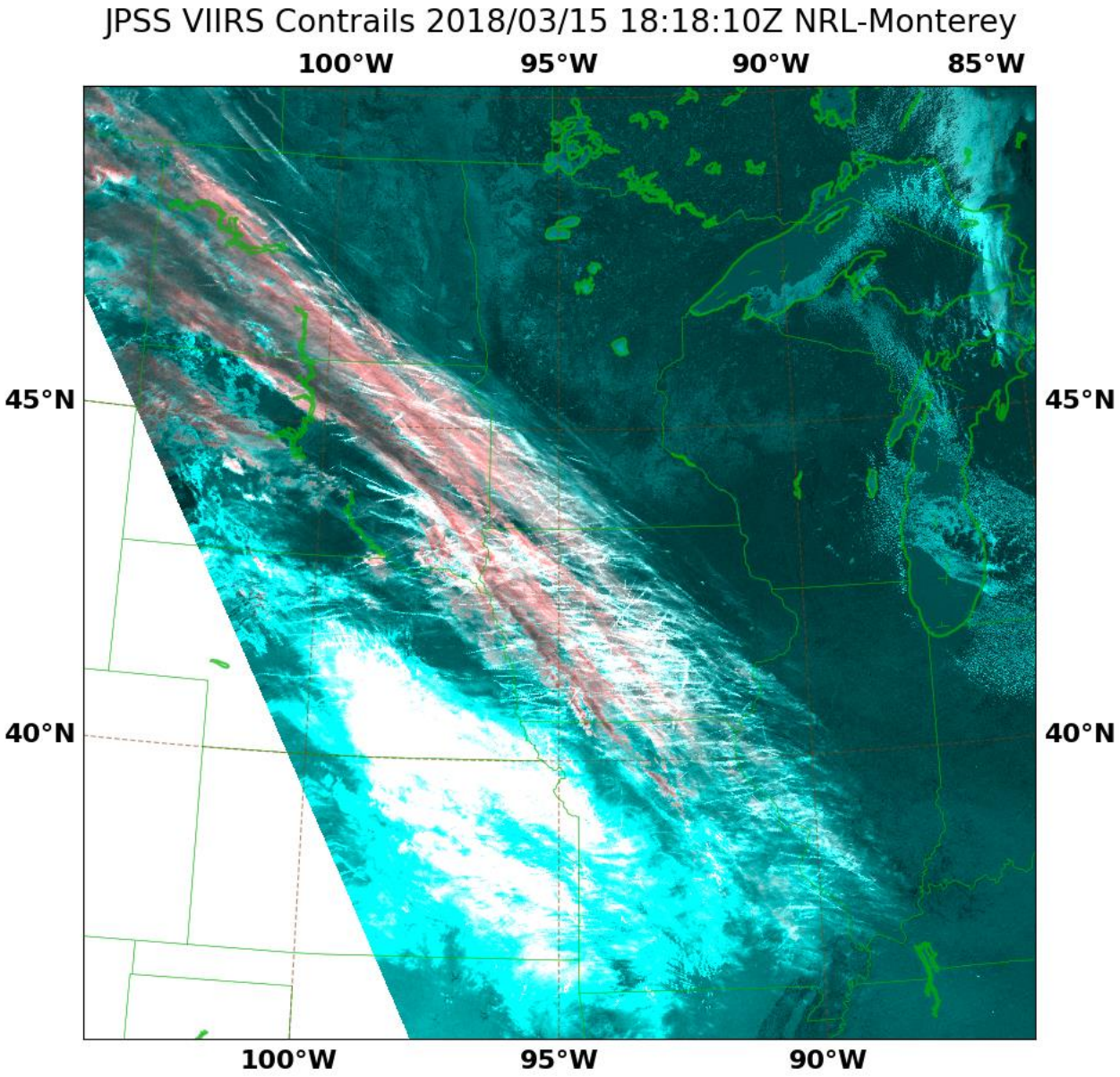
Alaska Direct-Broadcast loop



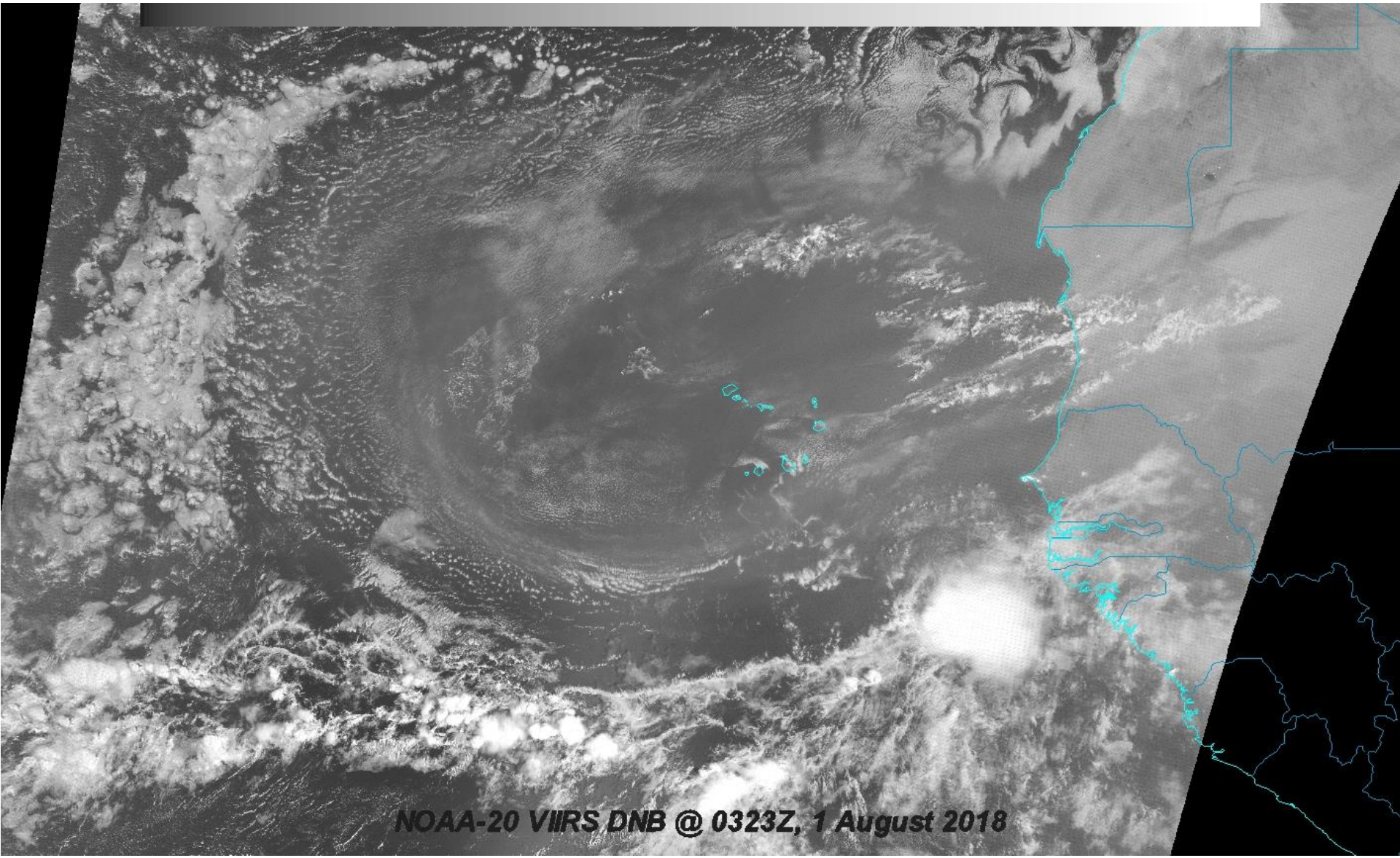
2018-02-07 @ 1106 UTC – Dust across Med (NRL)



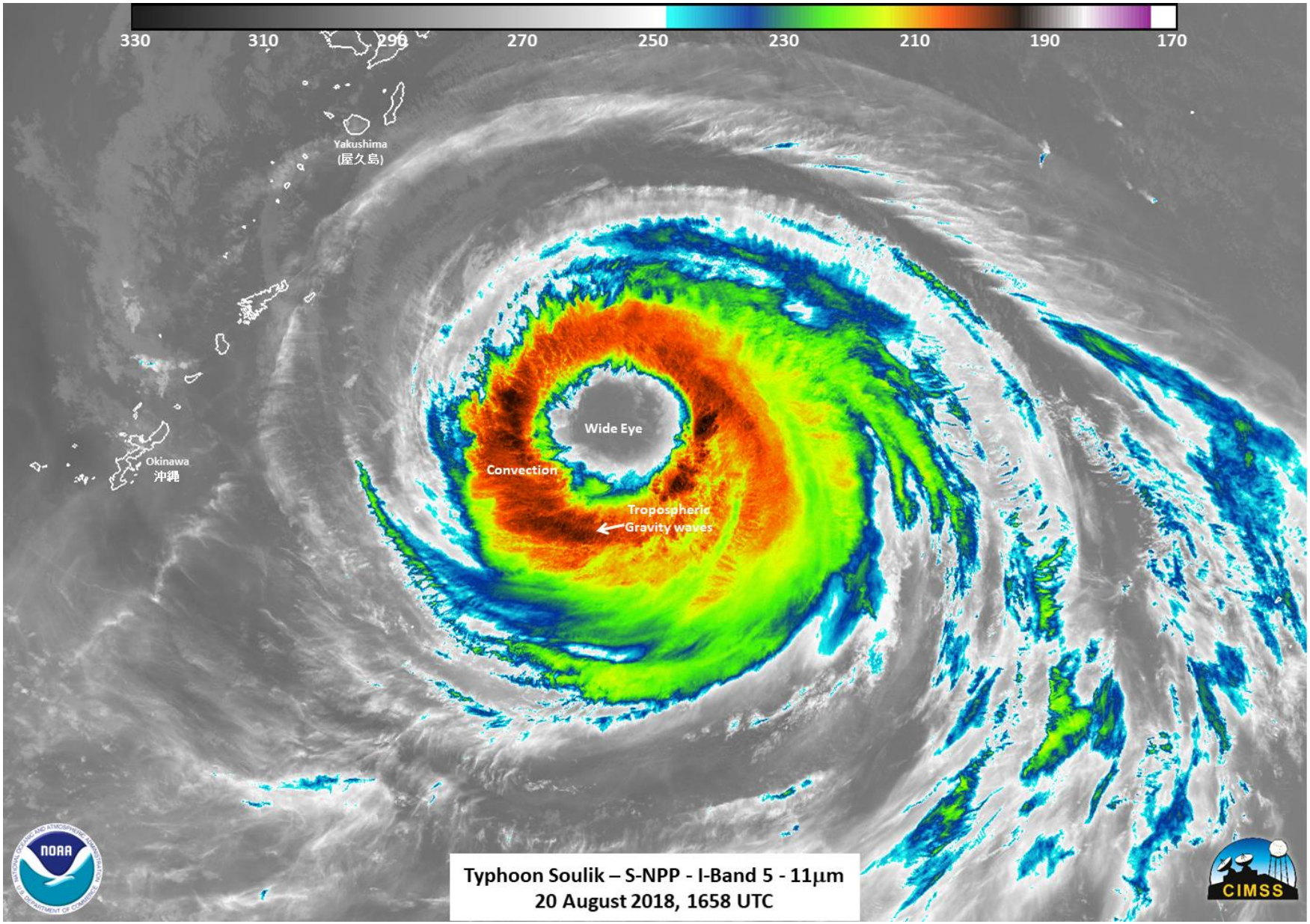
2018-03-15 @1818 UTC – contrails (NRL Monterey)



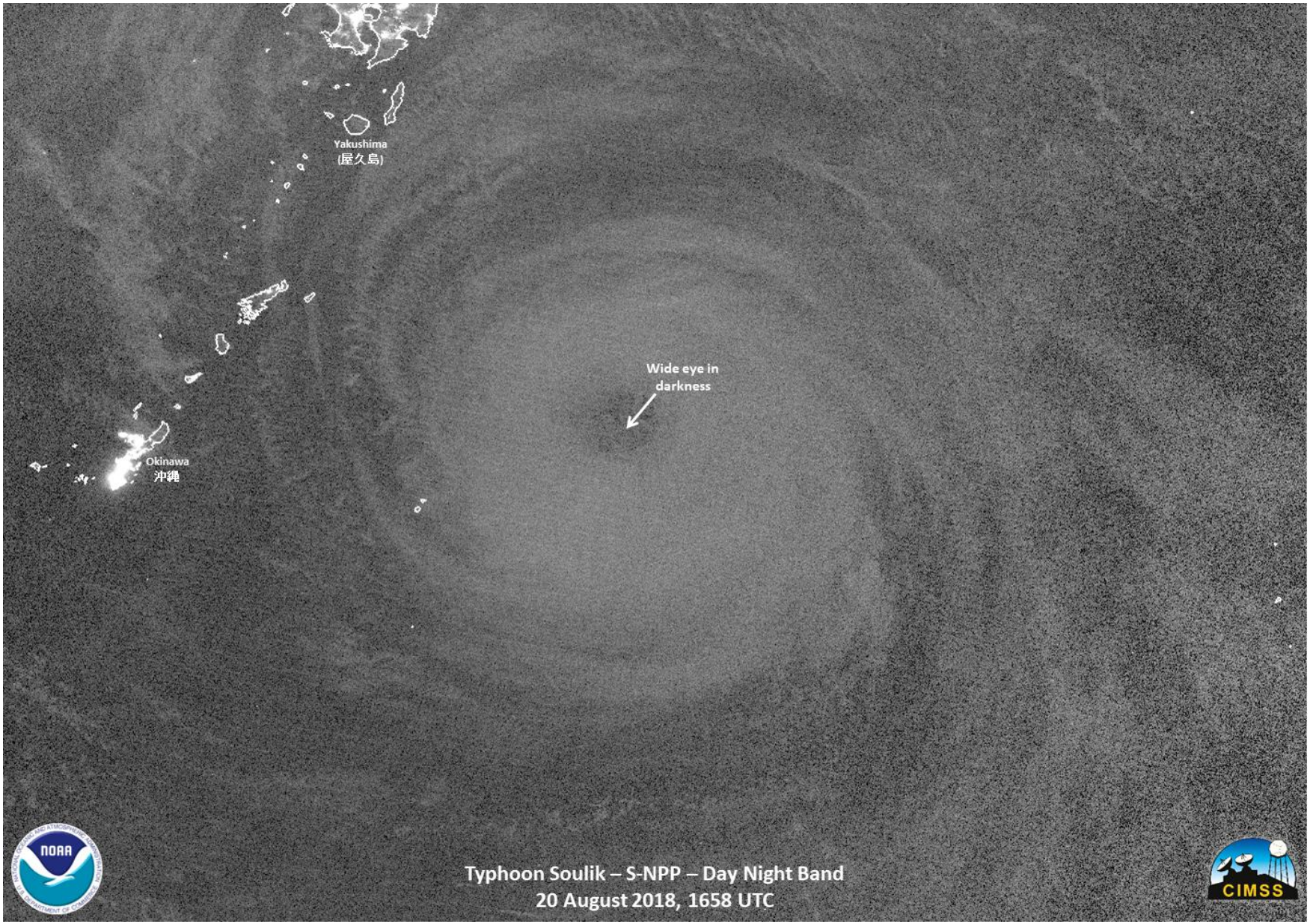
2018-08-01 @ 0323 UTC – NCC dust off Africa (J. Torres)



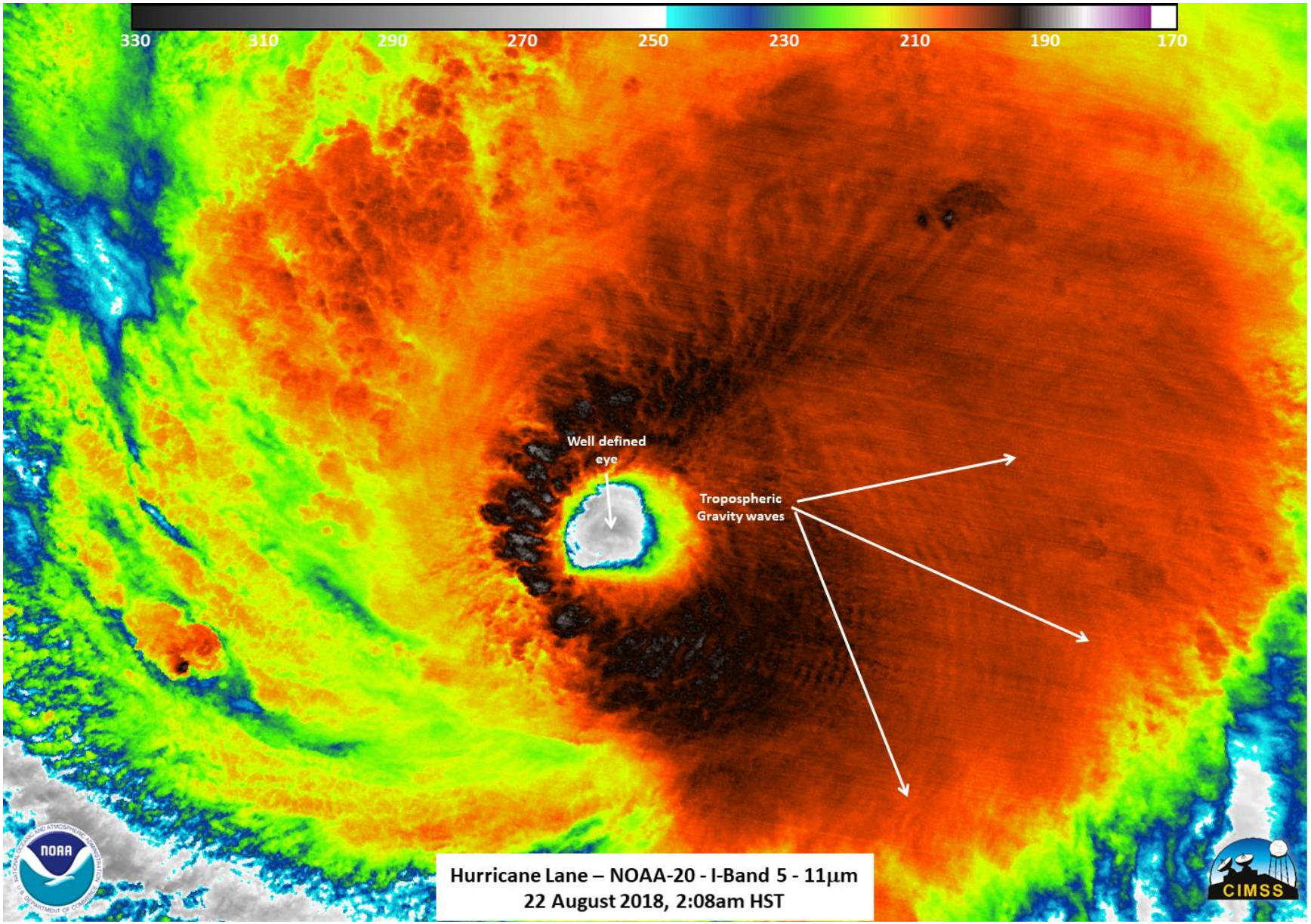
2018-08-20 @1658 UTC – Typhoon Soulik (W. Straka)



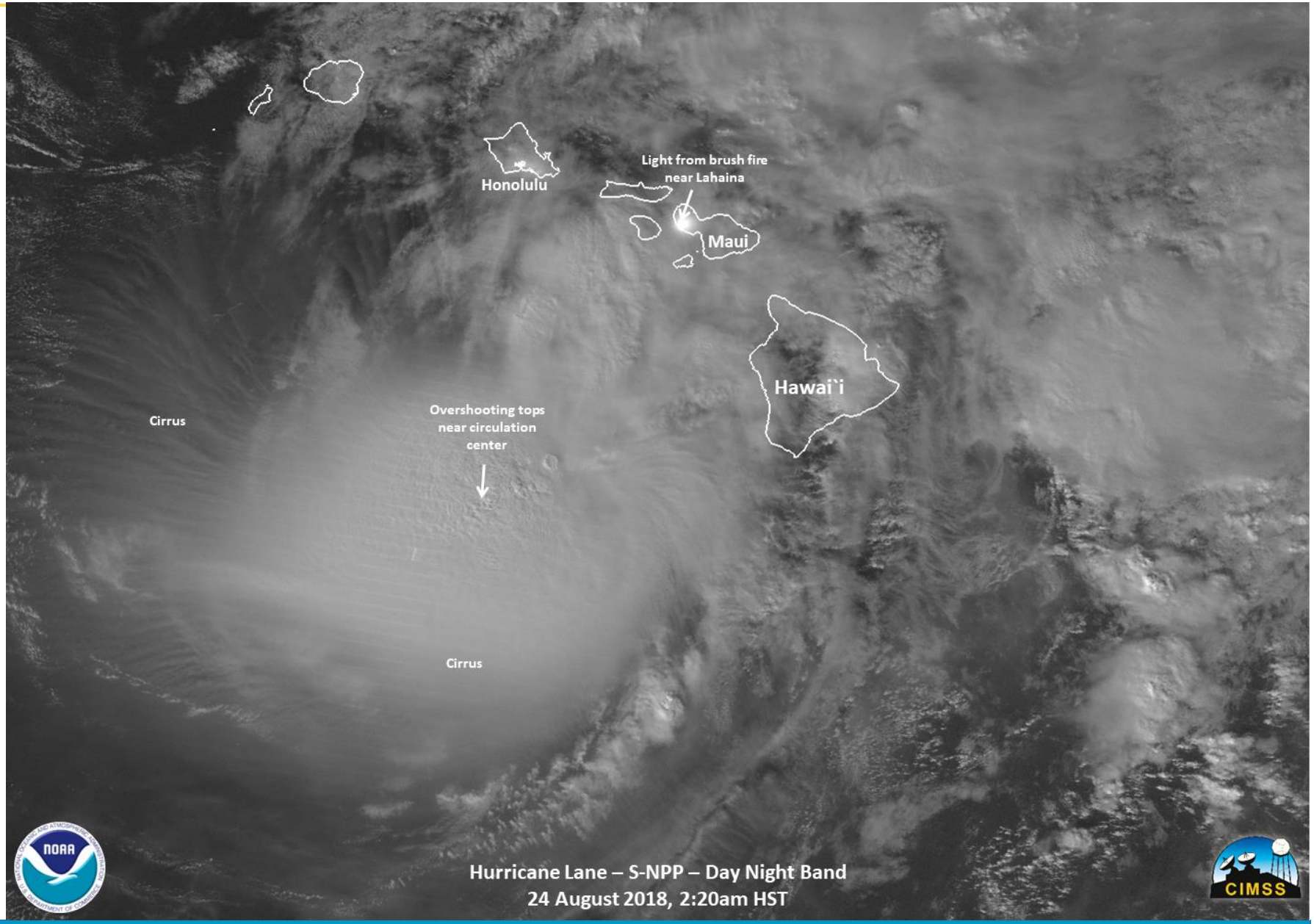
2018-08-20 @1658 UTC – Typhoon Soulik (W. Straka)



2018-08-22 @ night – Hurricane Lane (W. Straka)



2018-08-24 @ night – Hurricane Lane (W. Straka)



Path Forward

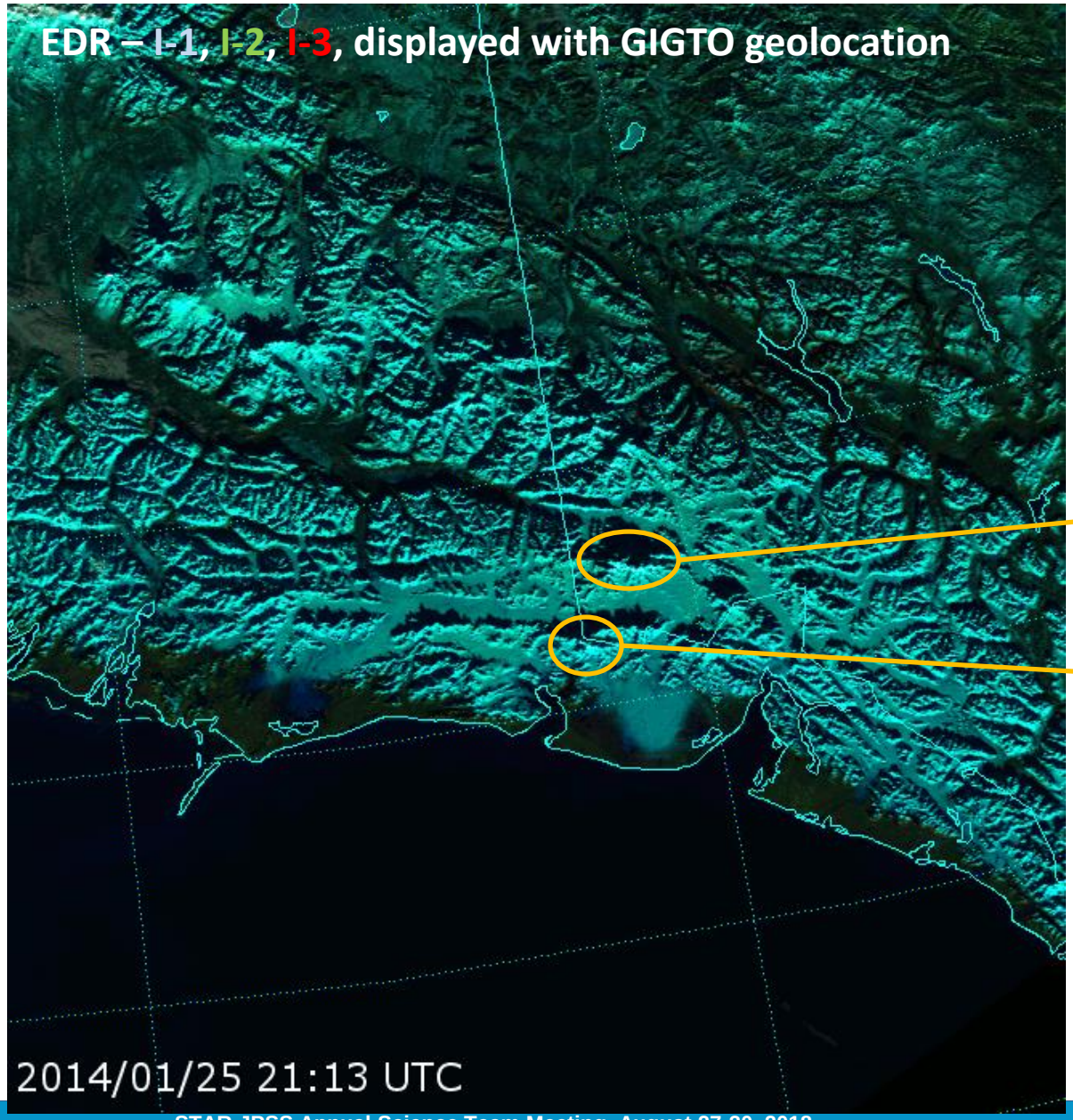
Path Forward (NCC LUT update)

- NCC LUT “Goosey” Table Update:
  - **No** indication that an update is **needed**
  - Will update once for **JPSS-1** (for each satellite)
  - Update **tool/software** has been located, but is currently not installed on **GRAVITE**.
    - **Restore LUT update tool onto GRAVITE**
    - **GVVSSE/”Goosey” LUT update** (March 2019, enabled, but may not be needed)

Path Forward (Terrain Correction for EDRs)

- Terrain Correction for EDR Imagery:
  - Terrain Correction **not** currently available for **VIIRS Imagery EDRs**.
  - **Requested** by VIIRS EDR Imagery users in **Alaska** (in particular)
  - Terrain Correction **required for MX3** (JPSS-2)
  - **Imagery Team** and VIIRS **Geo Team** are working together to address TC implementation
    - ADL testing via Imagery/Geo Team/AIT collaborations
    - Testing finds M-bands are TC “ready” (capable)
    - Need to create necessary GRC_TC file for I-bands and NCC (never part of the processing to date)
    - **Terrain Corrected Imagery EDR code delivery** (Sep 2019)

Imagery **EDRs** are **not** Terrain Corrected!

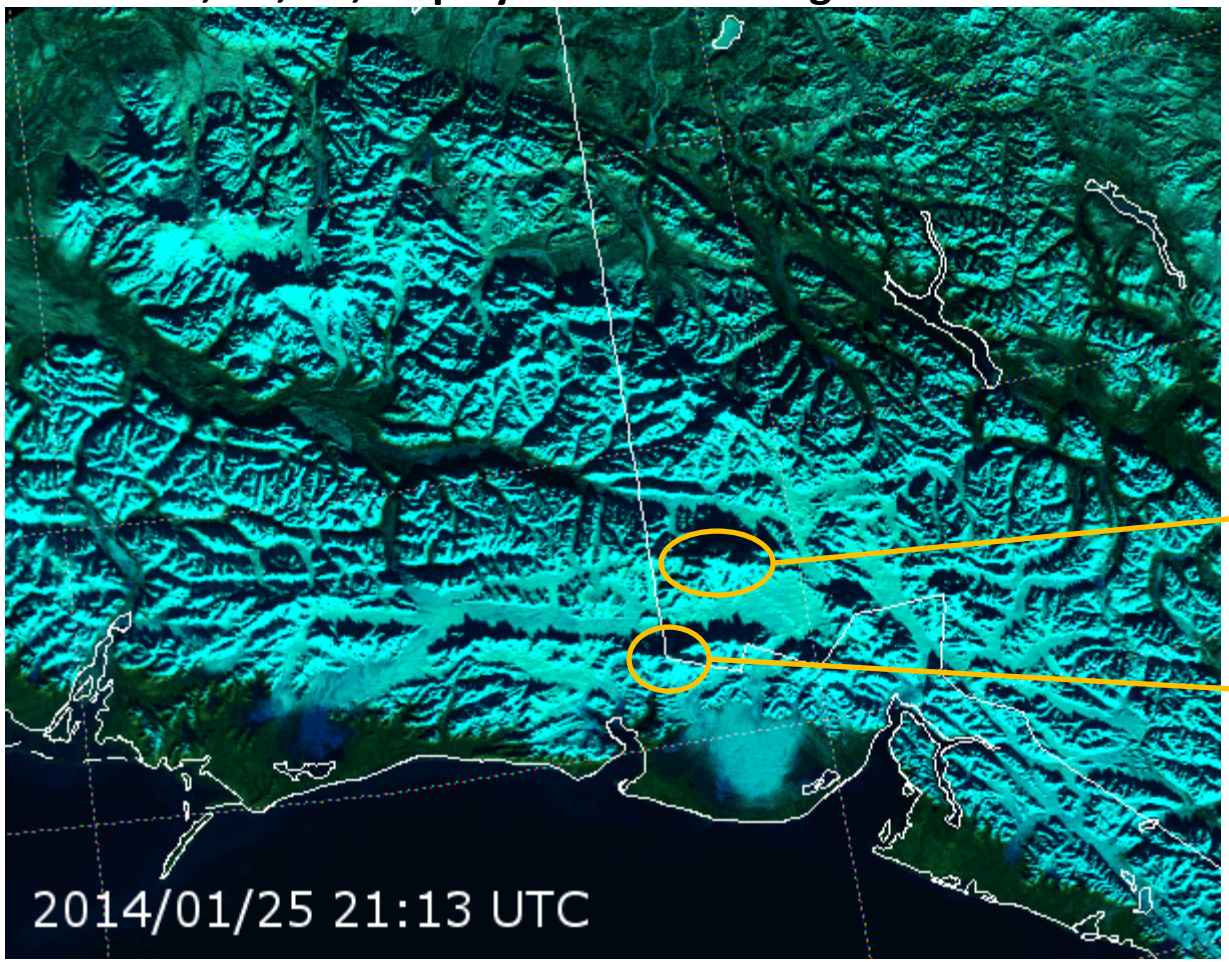


Mt. Logan
(6050 m MSL)

Mt. St. Elias
(5489 m MSL)

Terrain Correction Works for **SDRs**!

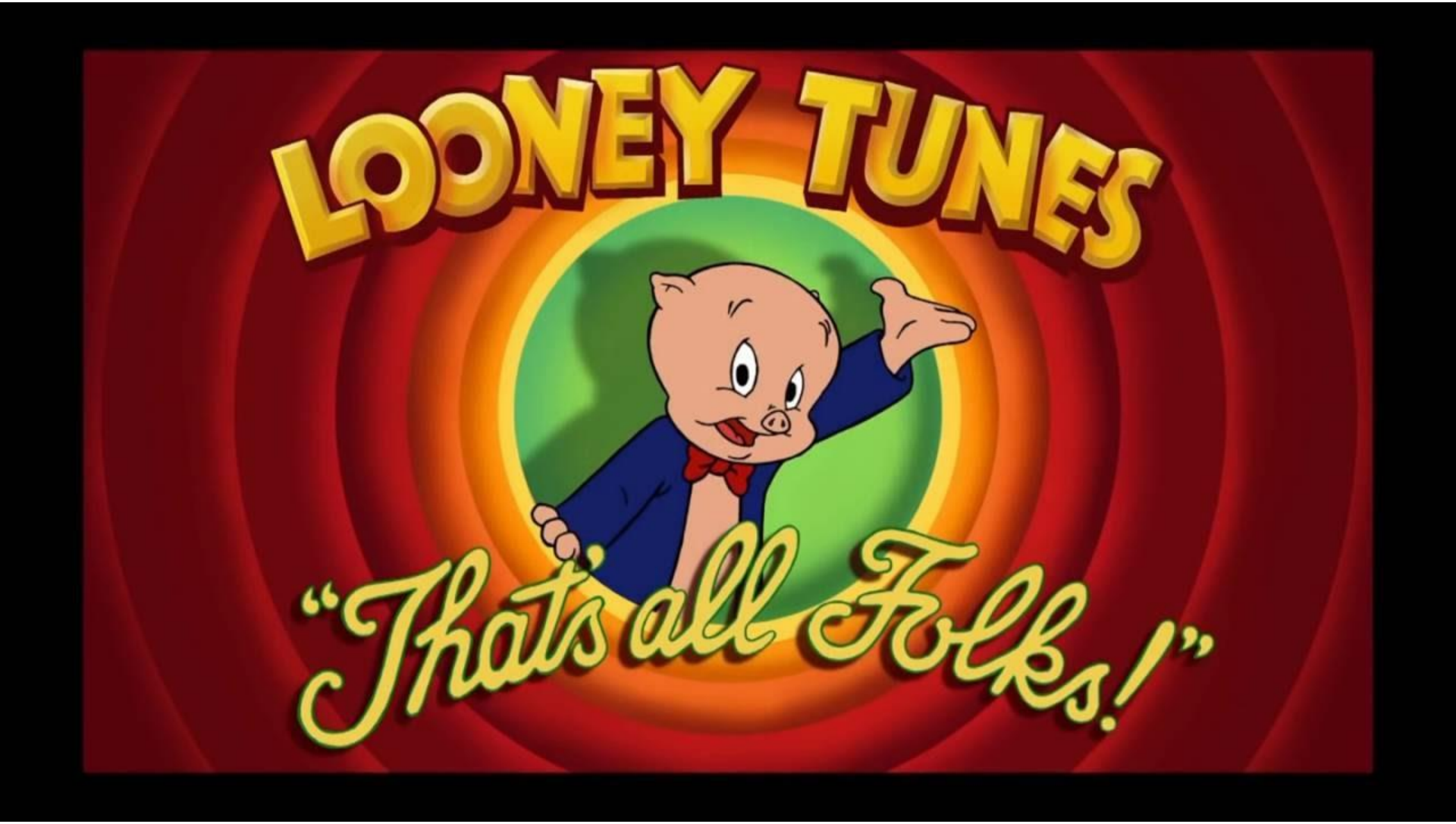
SDR – I-1, I-2, I-3, displayed with GITCO geolocation



Mt. Logan
(6050 m MSL)

Mt. St. Elias
(5489 m MSL)

Alaska Users' Presentation
(part of Imagery Validation Review)


LOONEY TUNES
"That's all Folks!"

Global VIIRS Imagery



Curtis Seaman

Steve Finley

Kevin Micke

With Contributions from Jorel Torres, Steve Miller, and Don Hillger*

CIRA

Colorado State University & *NOAA/NESDIS/STAR

STAR JPSS Annual Science Meeting
27-30 August 2018
College Park, MD

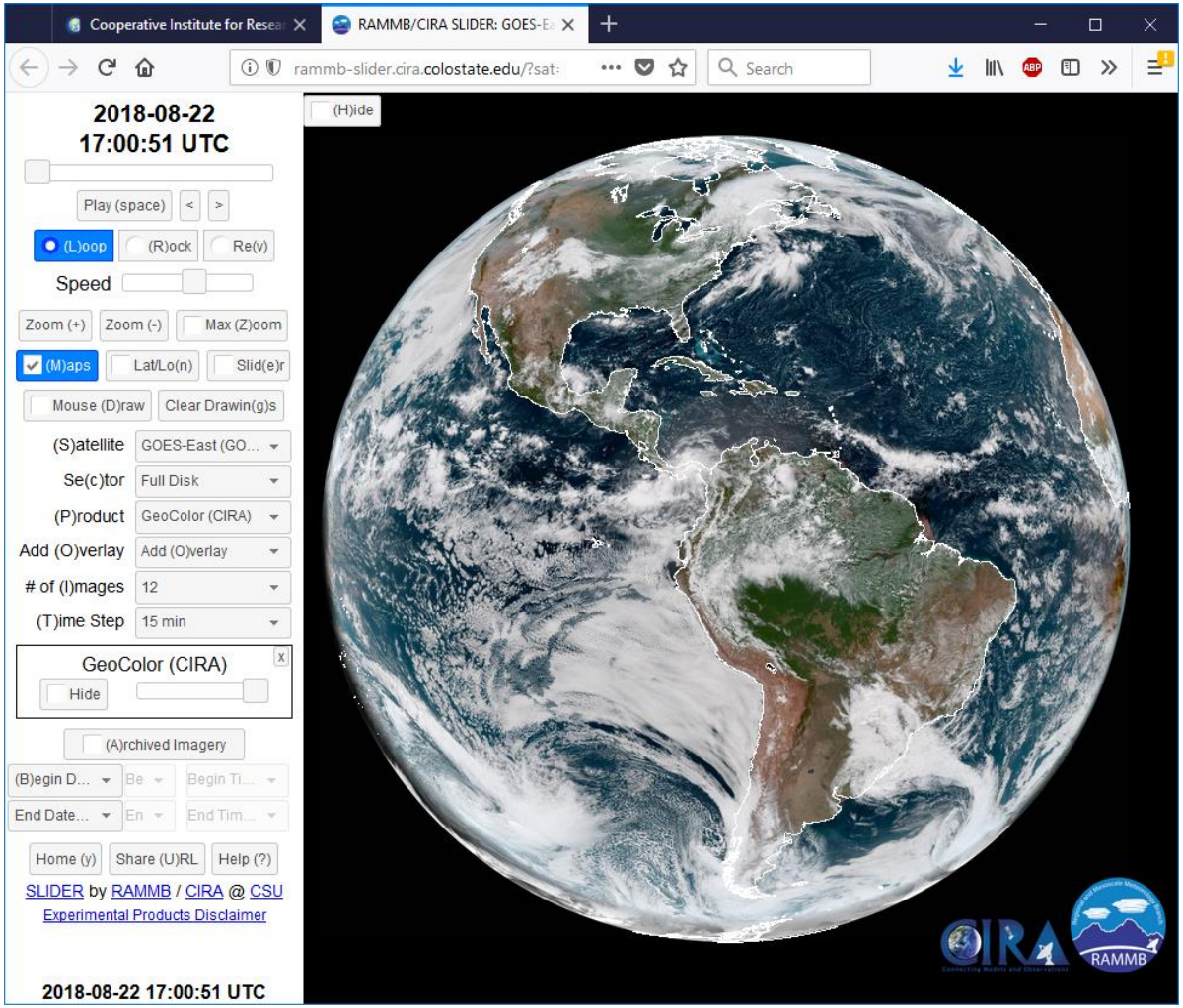
CIRA's SLIDER Website

22 June 2017: CIRA launched SLIDER to the public

SLIDER: Satellite Loop Interactive Data Explorer in Realtime

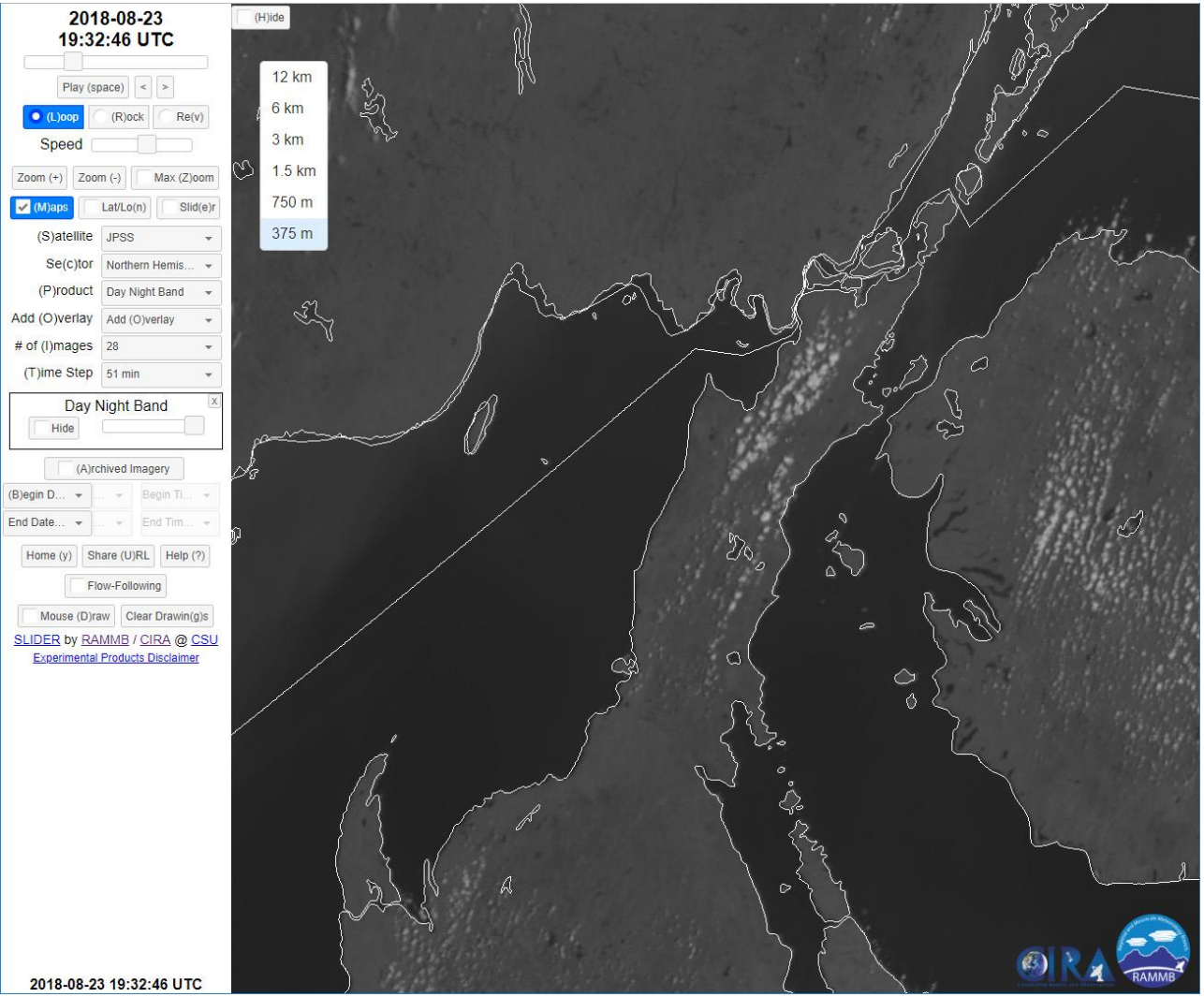
This website was designed to loop GOES-R (16/17) and Himawari-8 images in realtime

Imagery is displayed at varying zoom levels from the full view of the full disk (16 km), down to the full resolution of the visible channels (500 m)



http://rammb-slider.cira.colostate.edu

Introducing Polar SLIDER

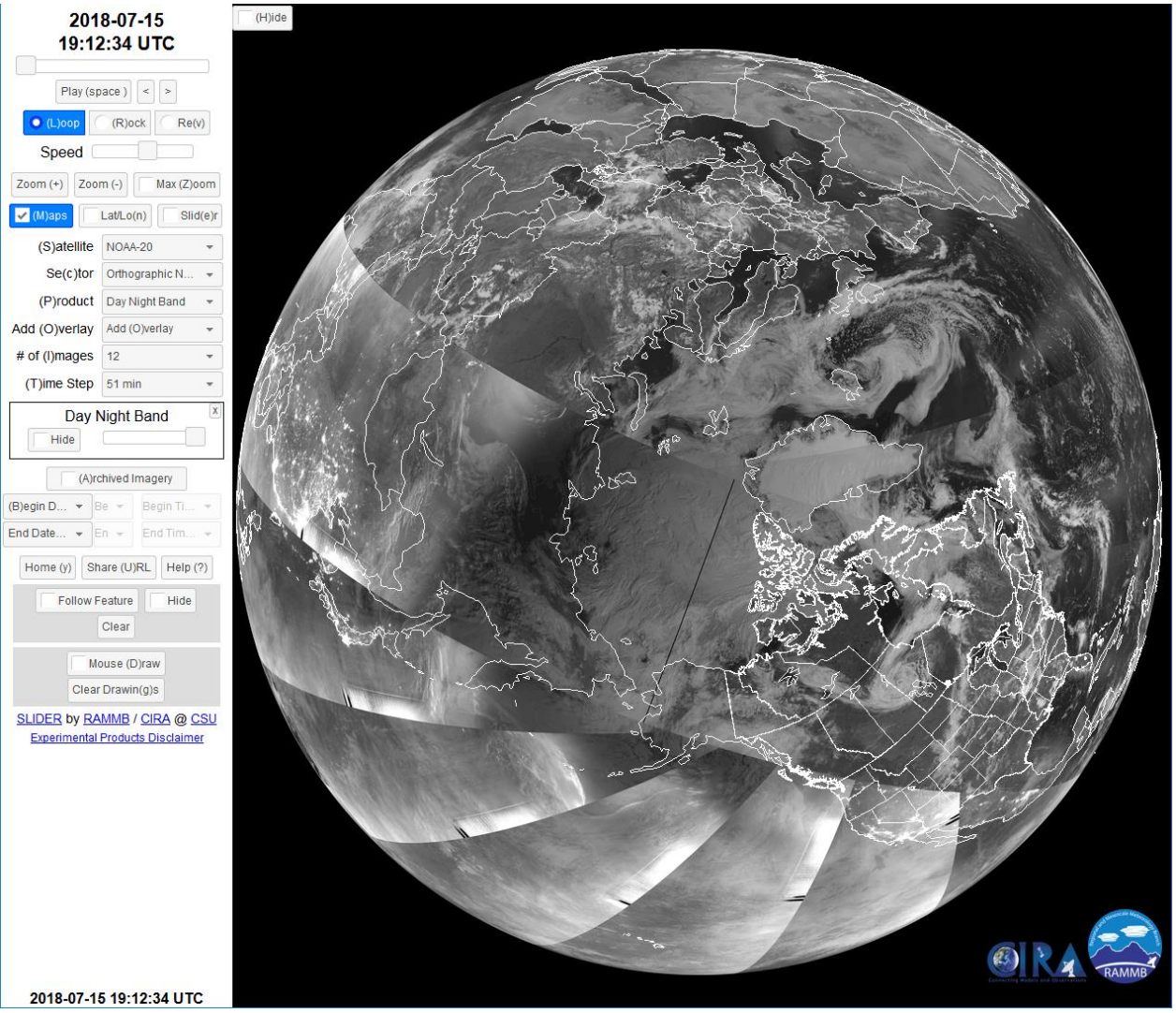


CIRA is nearing the launch of a new version of SLIDER designed to show polar satellite data in near-realtime.

Polar SLIDER shows satellite data for the entire globe at 6 zoom levels ranging from 12 km to 375 m, the resolution of the VIIRS Imagery bands (I-bands).

Click through to see the 6 zoom levels on a sample VIIRS Day/Night Band image composite of the Northern Hemisphere.

Introducing Polar SLIDER



The goal of Polar SLIDER is to show the most recent VIIRS data (all 22 bands) for each location on Earth at all times - with low-enough latency to be useful for forecasters.

This is the Northern Hemisphere view, showing one day of NOAA-20 Day/Night Band imagery.

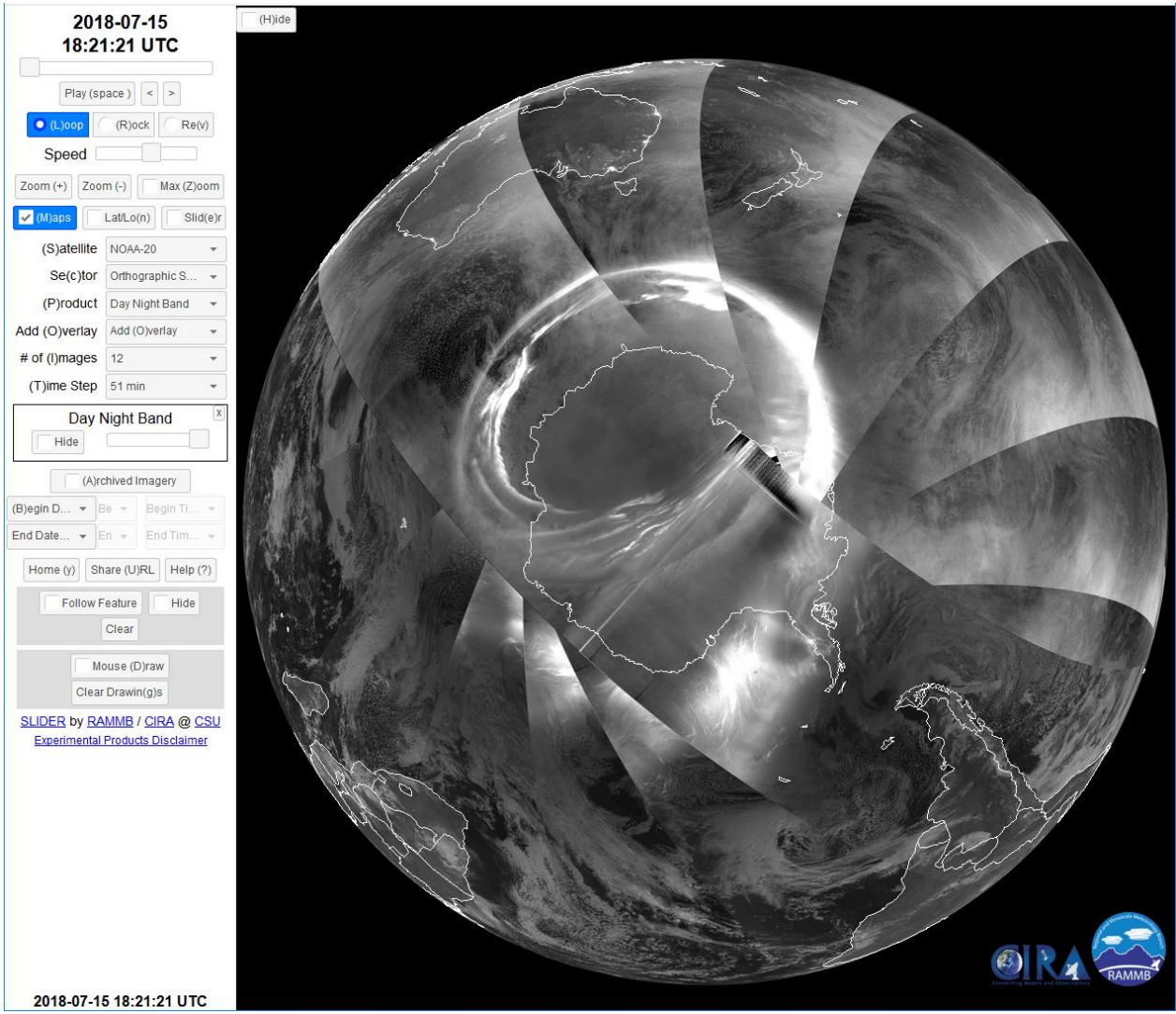
Animated GIF

Southern Hemisphere View

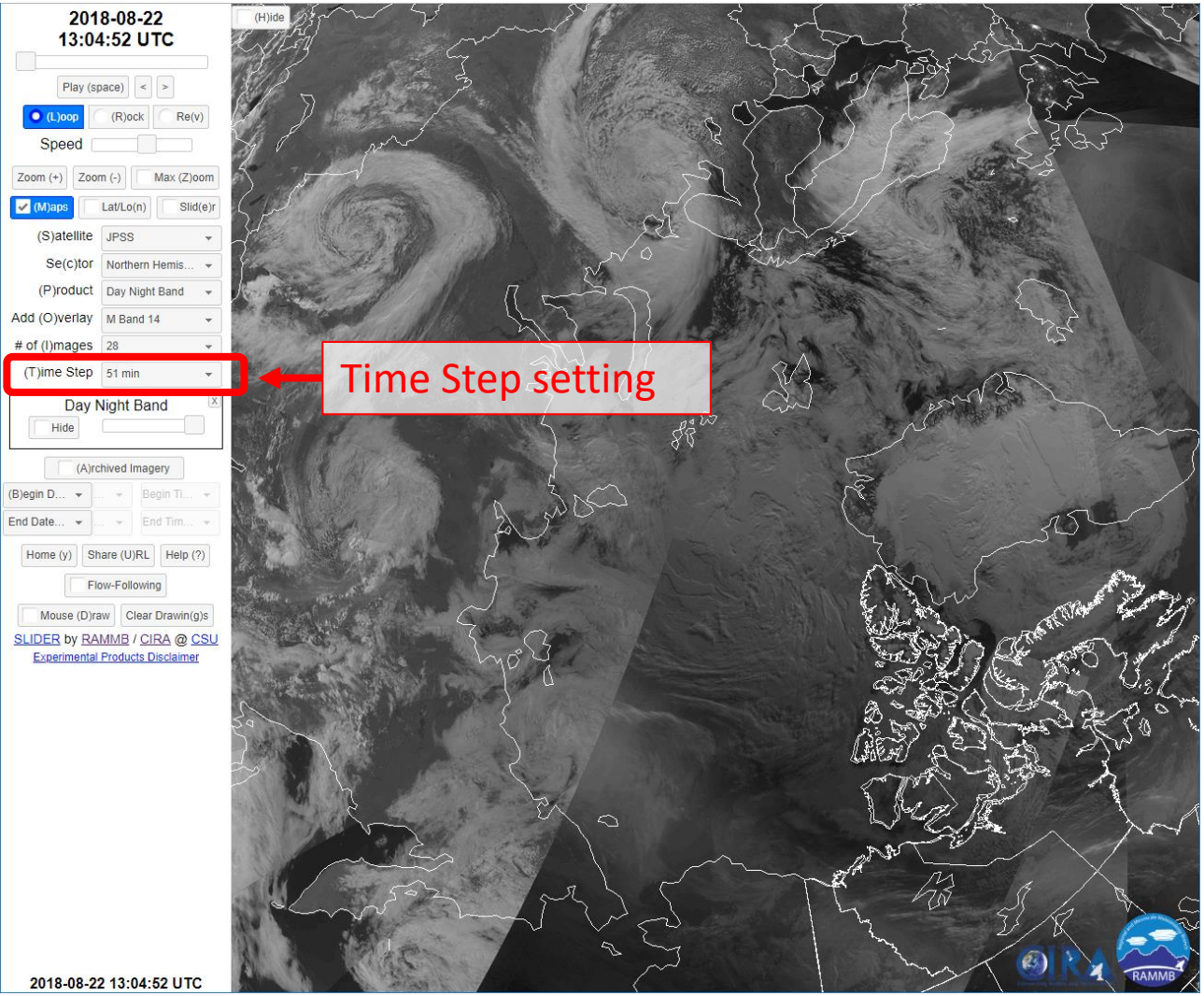
Here is the Southern Hemisphere view of Polar SLIDER.

Since it is winter and perpetual night in this example (15-16 July 2018) over Antarctica, the aurora is present in nearly every VIIRS overpass.

Animated GIF



Twice the VIIRS



By default, Polar SLIDER shows both VIIRS (S-NPP and NOAA-20). This is like having a geostationary satellite hovering over each pole!

If you are a S-NPP snob (or NOAA-20 snob) you can choose to display only one satellite by changing the loop time step from 51 min. to 102 min.

Animated GIF

All Your Favorite Features

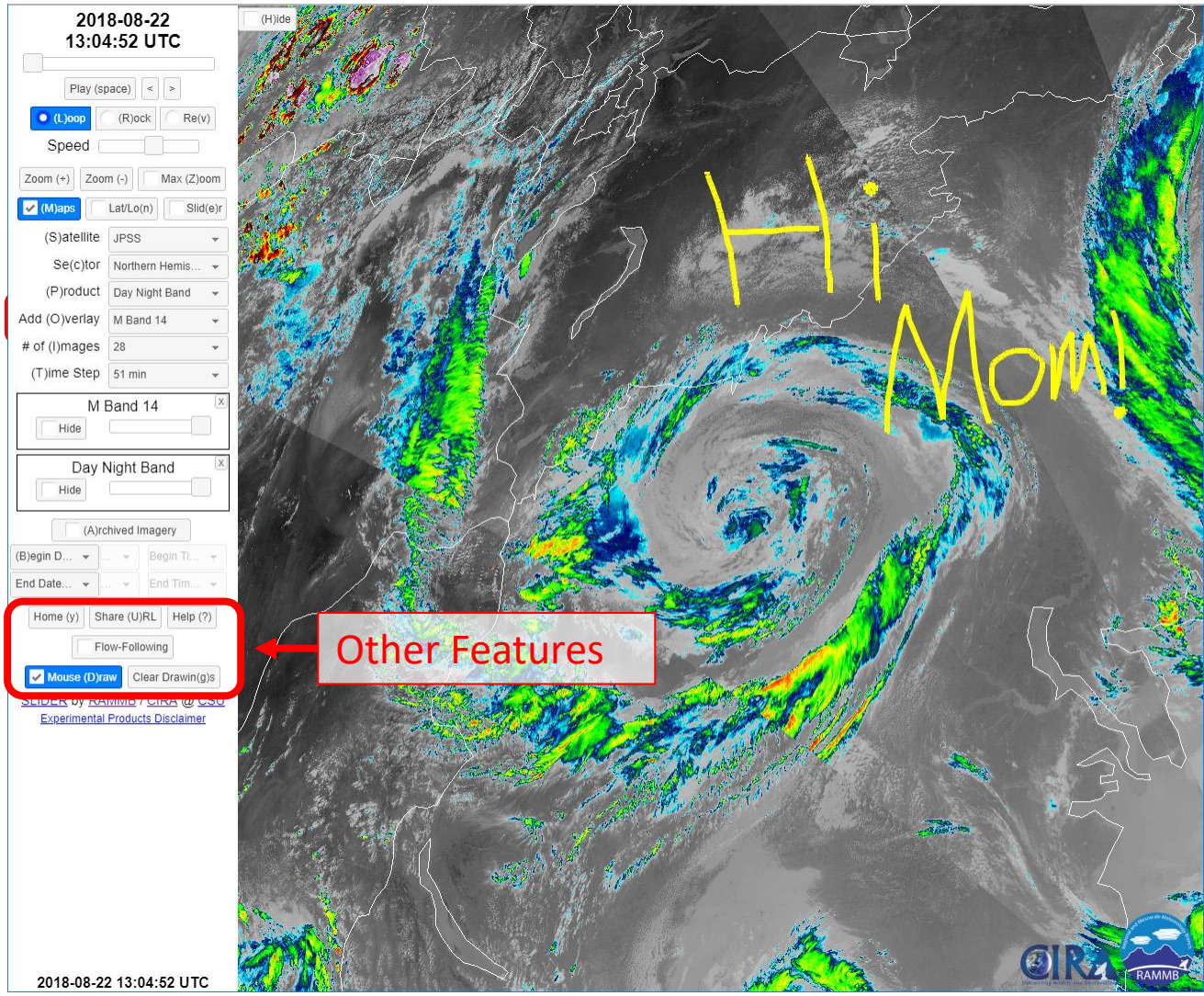
The “Add Overlay” feature allows you to compare two spectral bands or blend them together.

One popular use is the “Sandwich Product” which blends longwave IR imagery with visible imagery to provide unique detail of the cloud top structure.

Since we have the Day/Night Band, we can extend the utility of the Sandwich Product to nighttime as well!

The “Slider” bar with overlay turned on lets you easily compare two spectral bands.

Other features include: “Flow-Following” for feature tracking, “Mouse Draw” for annotations, and “Share URL” for easy sharing.



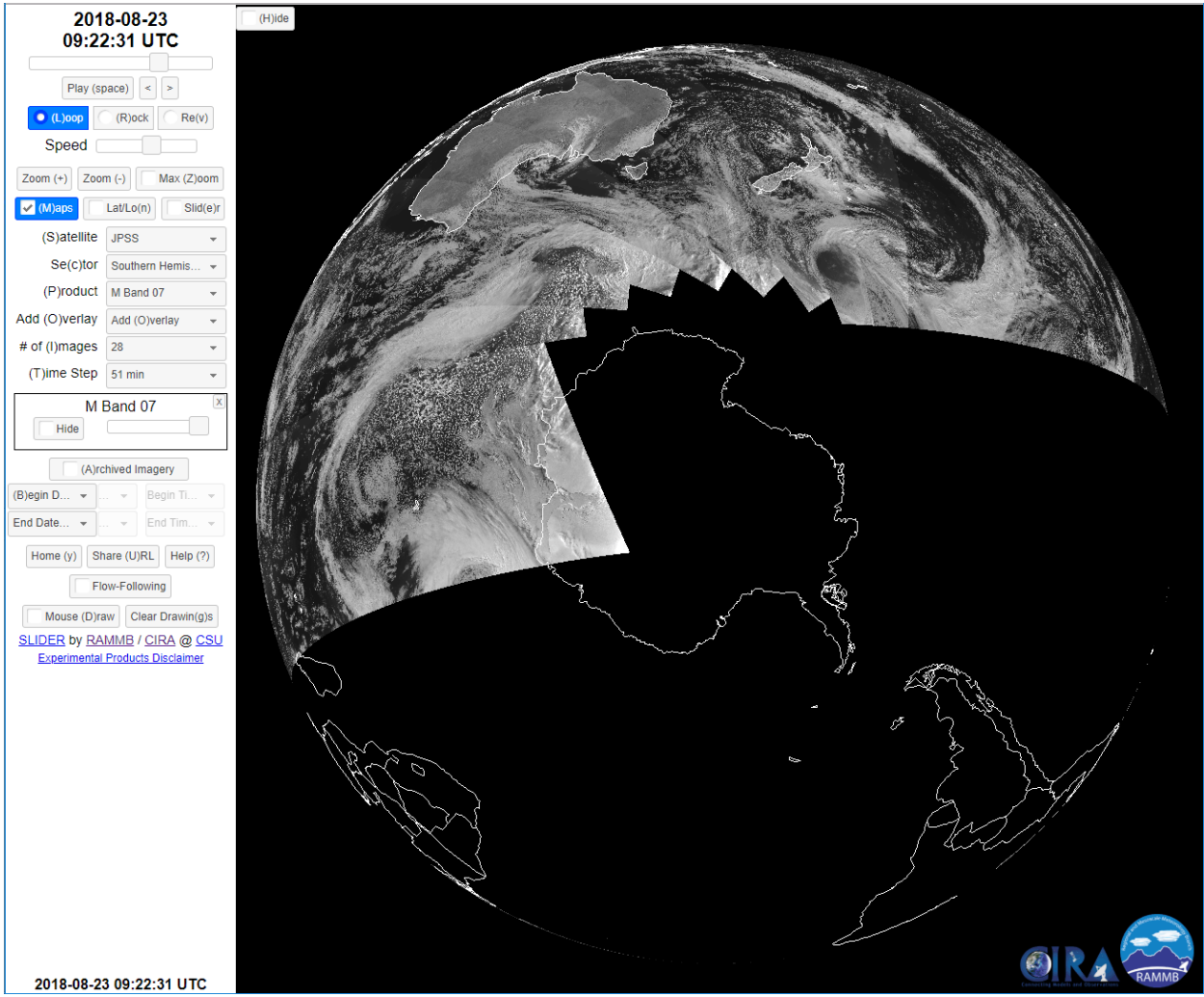
Cautionary Tales

Full resolution images are 16,000 x 16,000 (M-bands, DNB) and 32,000 x 32,000 pixels (I-bands), increasing the load on your browser compared to ABI

For the Solar Reflective Bands (M1-M11, I1-I3) in the summer months, more than half the image will be illuminated. In the winter months, more than half the image will be black, and you lose information over the poles. (But you still have the DNB and IR bands.)

The more VIS/NIR data there is in the Northern Hemisphere, the less there is in the Southern Hemisphere (and vice versa).

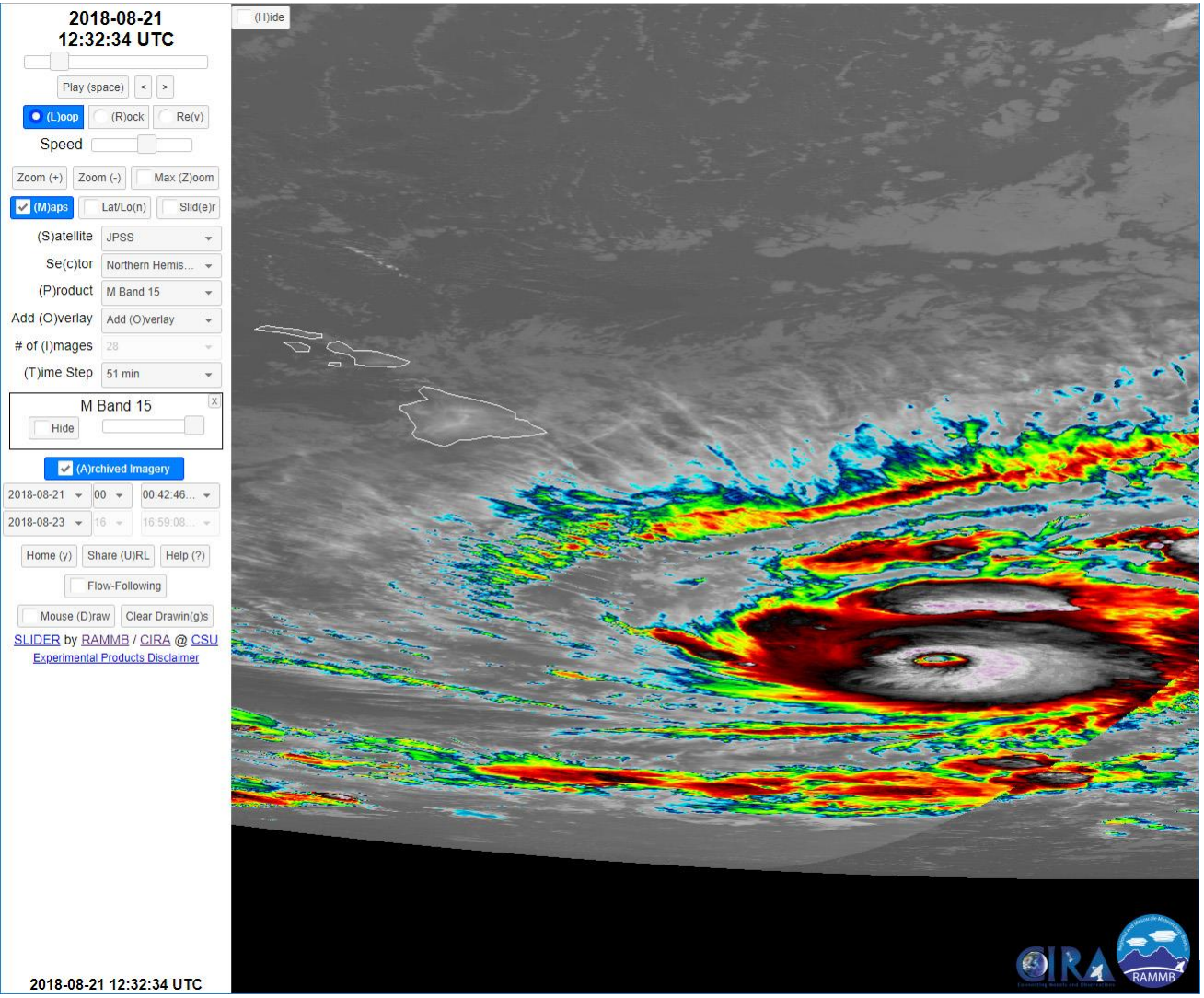
It should also go without saying that, the closer you are to the pole, the more overpasses you get, improving apparent motions and the feature tracking ("Flow-Following") utility.



Animated GIF

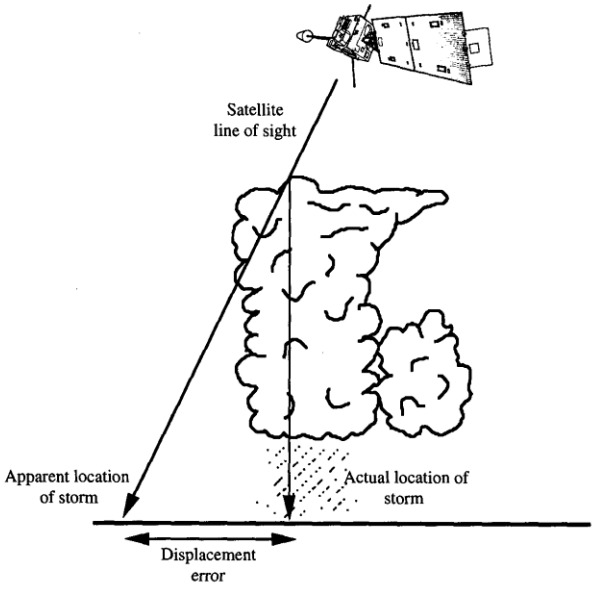
Some of the data in each image is up to 12 hours old!

Hurricane Lane



Parallax effects may be significant for objects near the edge of scan, leading to apparent motion that is not actually occurring.

Hurricane Lane did not move back to the east during this time period.

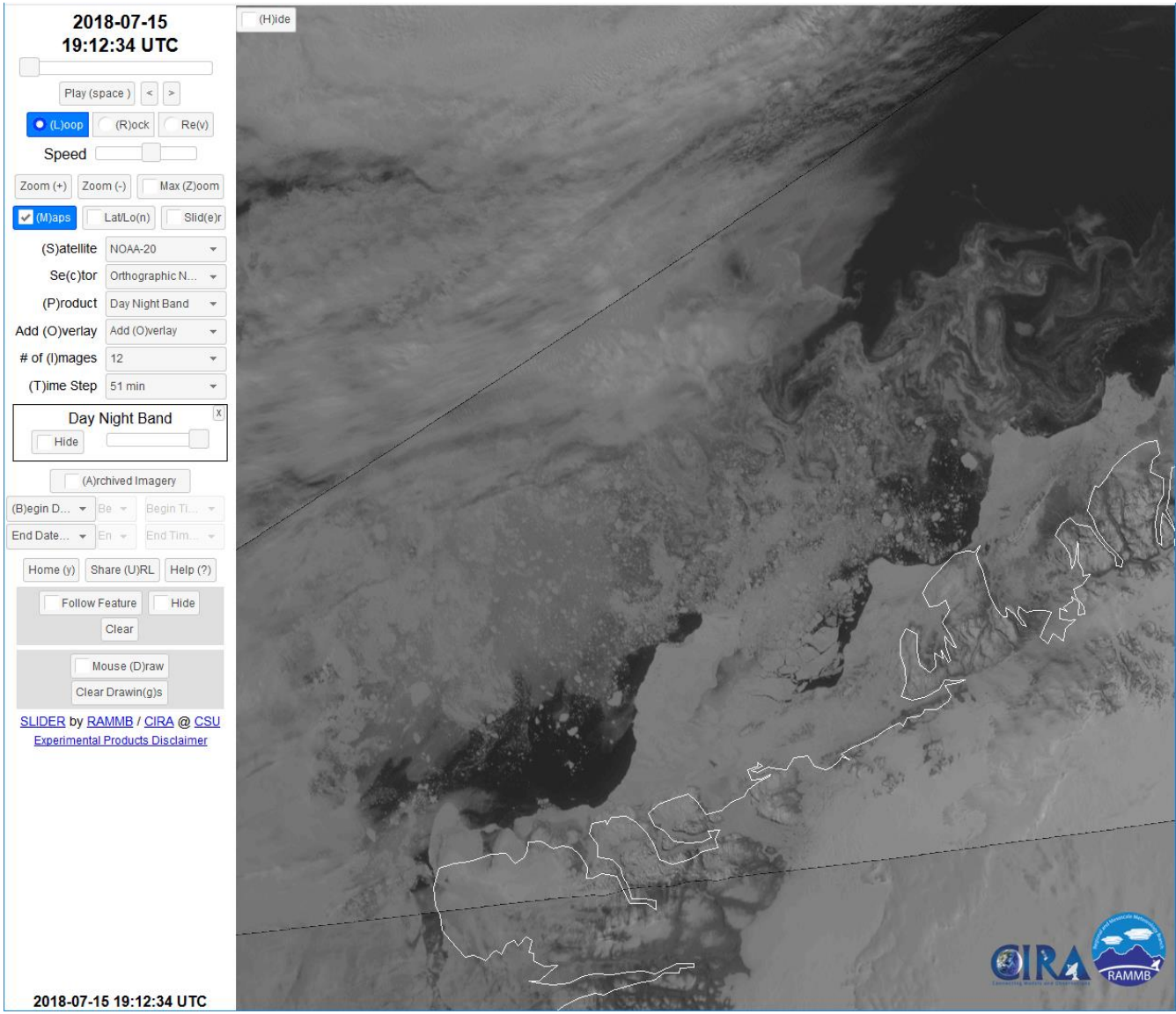


Ice, Ice, Baby

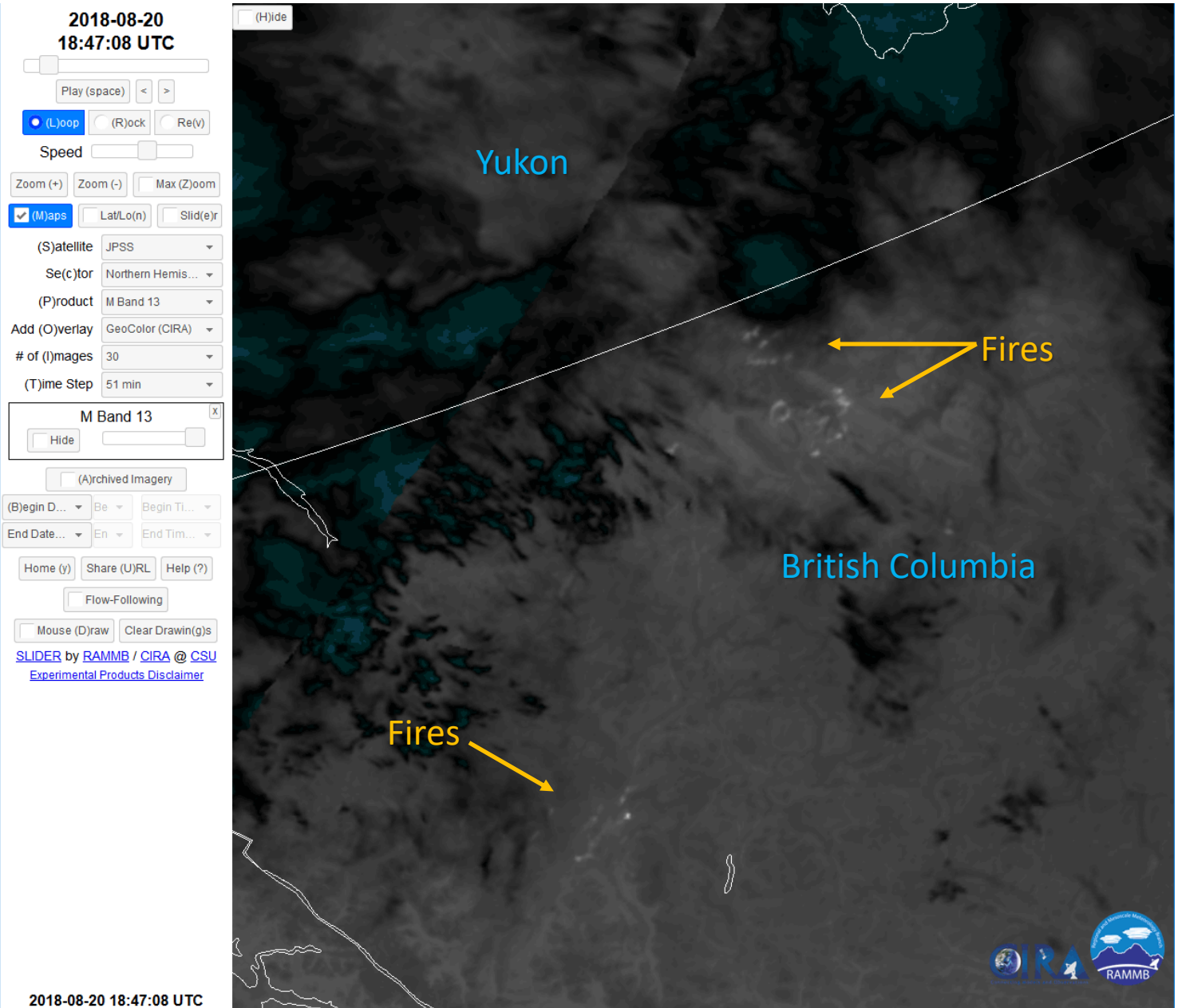
Ice off the east coast of Greenland in the Day/ Night Band (15-16 July 2018).

Note the complicated motions due to a combination of currents and tidal flows.

Animated GIF



British Columbia Fires

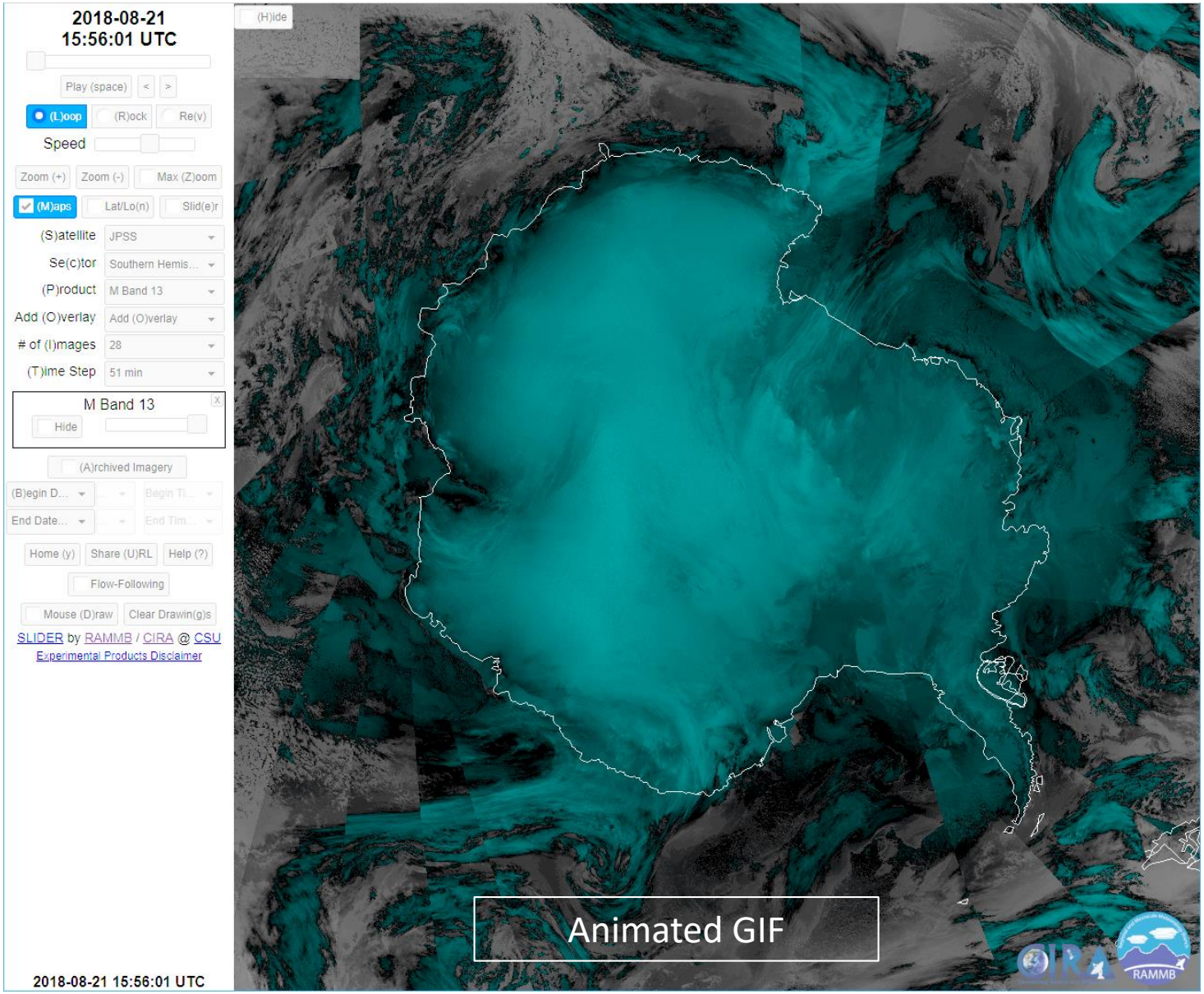


S-NPP and NOAA-20 combine to give this region 6 consecutive overpasses, each 51 min. apart, between 18:47 UTC and 22:10 UTC (21 August 2018).

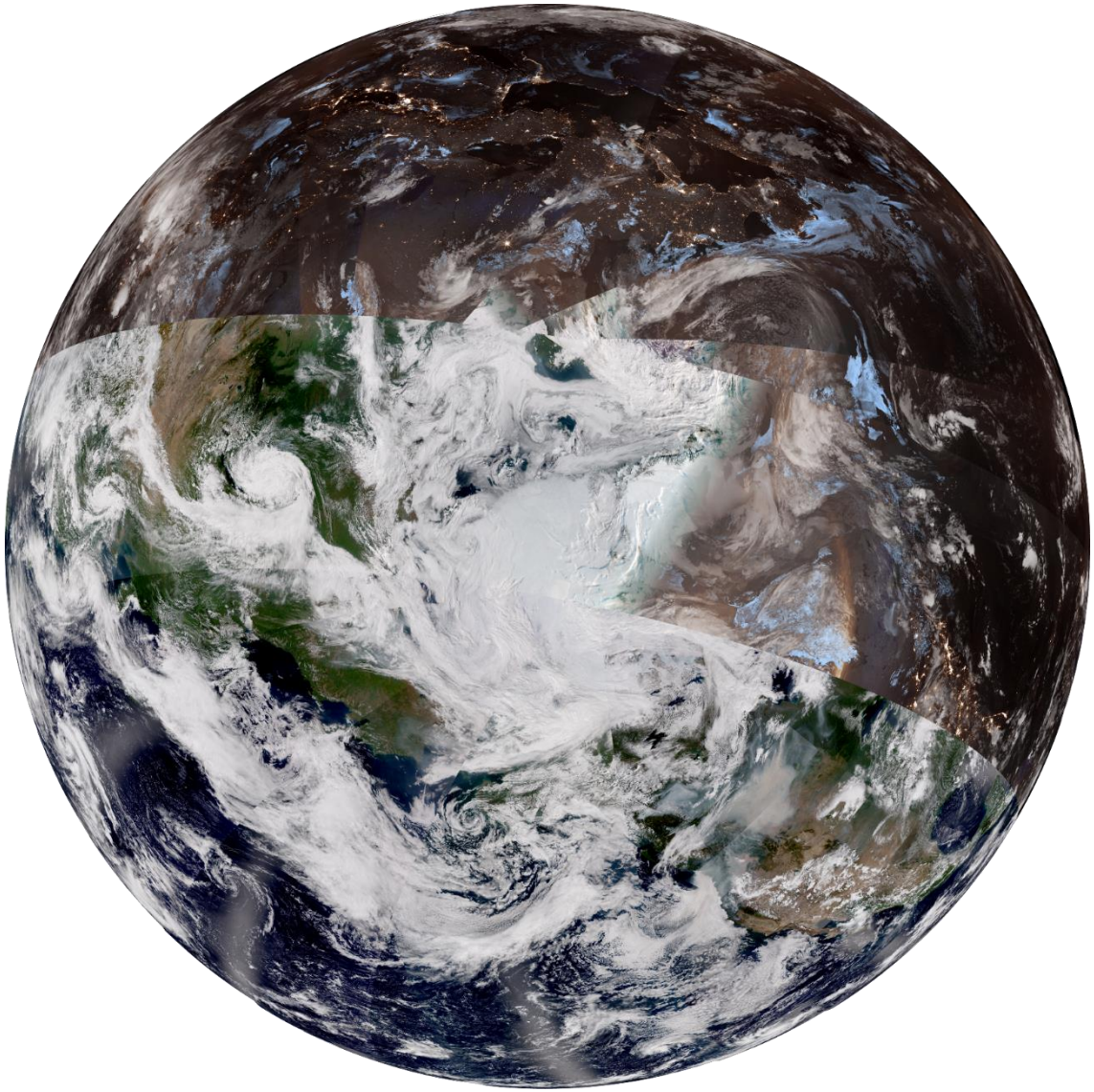
The typical afternoon flare-up of wildfires in British Columbia is evident during this time period in band M-13 (4.0 μm).

Pixels warmer than 60 C (333 K) are highlighted in red.

Antarctica in M-13 (4.0 µm)



New for SLIDER: VIIRS GeoColor



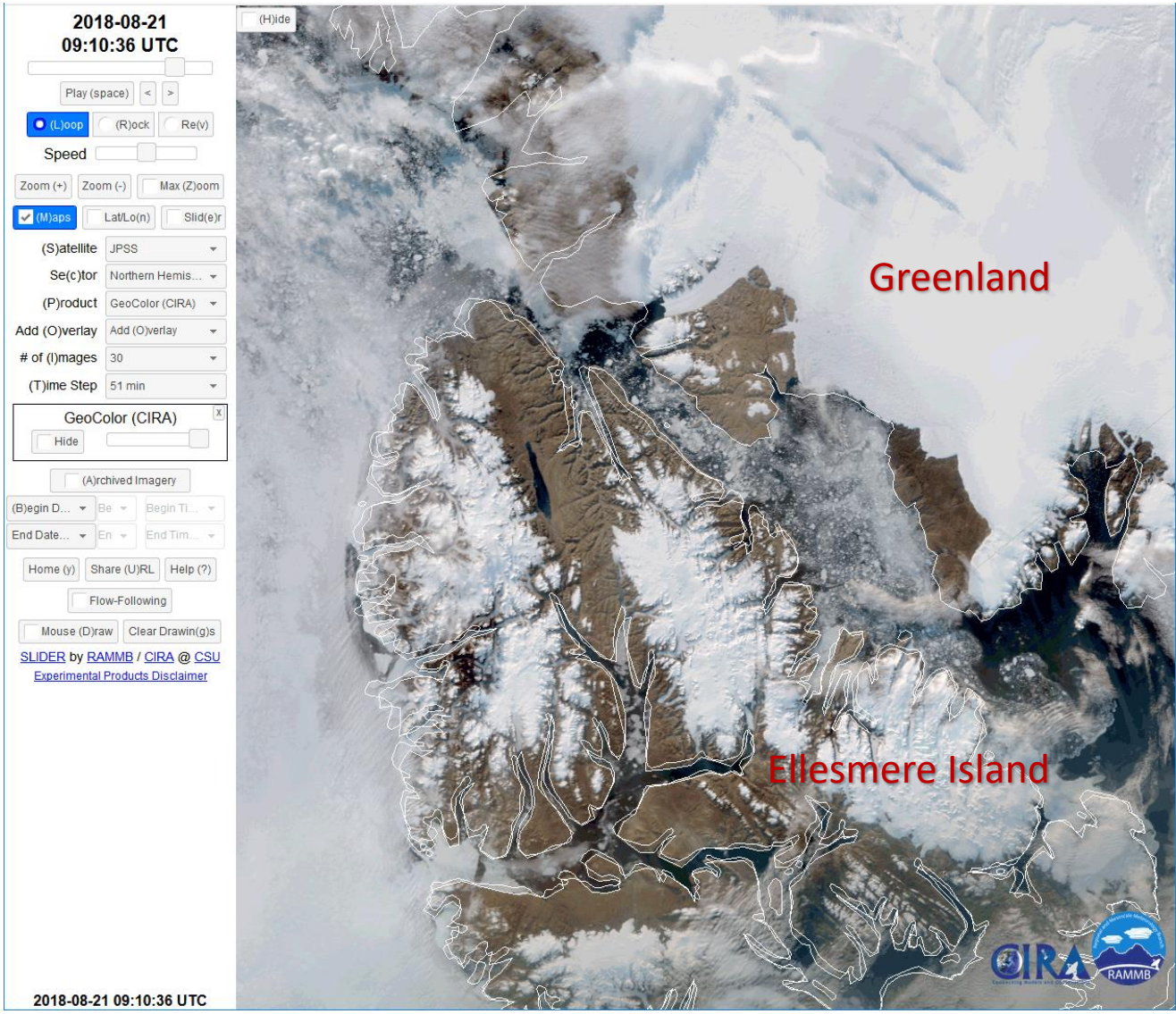
VIIRS GeoColor combines True Color imagery during the day with a low cloud detection algorithm at night. Because it uses the DNB, it will also show auroras, ship lights and even fires at night. This is a change from geostationary versions of GeoColor, which simply use a static DNB city lights database.

True Color in the Arctic

During the summer months, GeoColor may be used to view the Arctic in true color.

This example shows ice in the Nares Strait between Greenland and Ellesmere Island, Canada.

Animated GIF



GeoColor for Antarctica

This example shows the coast of Antarctica in GeoColor during the long polar night. You can expect something similar in the Arctic during the winter.

Blowing Snow?

Animated GIF

Lots To Do

Currently working for 11 of 16 M-bands + DNB
- Once all bands are running in real time, the images will be sent to the public server

Imperfections in GeoColor
- Low cloud detection at night
- Auroras appear yellow, instead of green

All your favorite RGBs to follow:
- Natural Color/Day Land Cloud RGB at 375 m resolution!

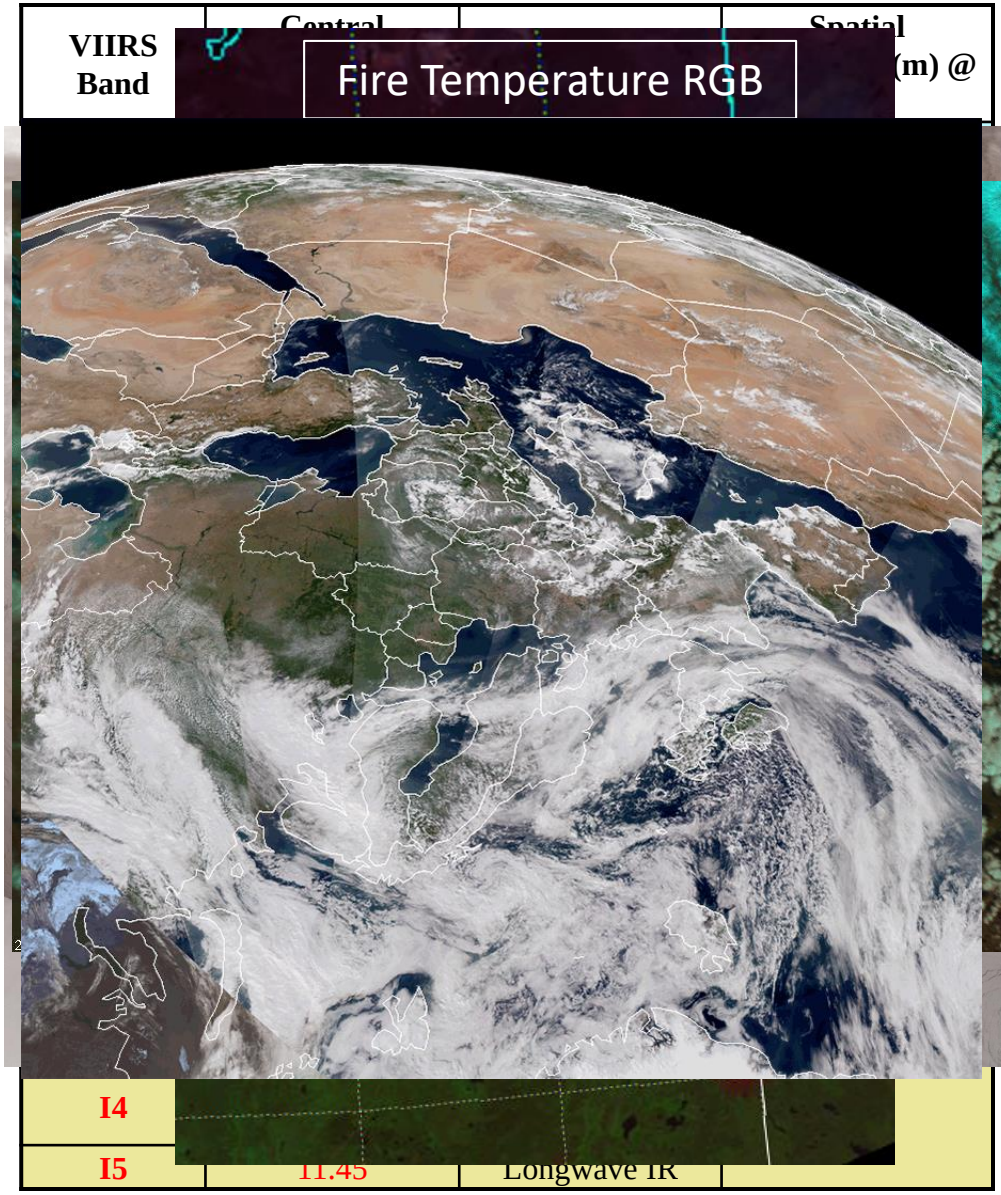
- Fire Temperature and Natural Fire Color/Day Land Cloud Fire RGB

- Day/Night Snow/Cloud Discriminator
… and many more!

Extend Polar SLIDER to additional JPSS products
- Cold Air Aloft (shown here)
- Cloud and other EDR products
- Microwave, Blended TPW/LPW …

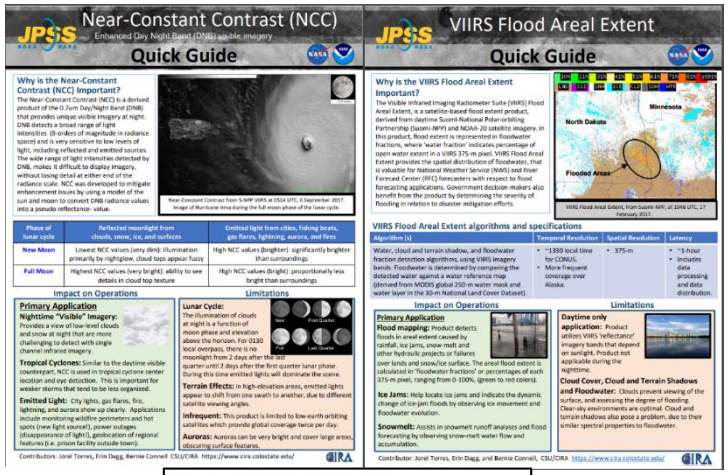
Coming soon: Rotate feature in SLIDER!

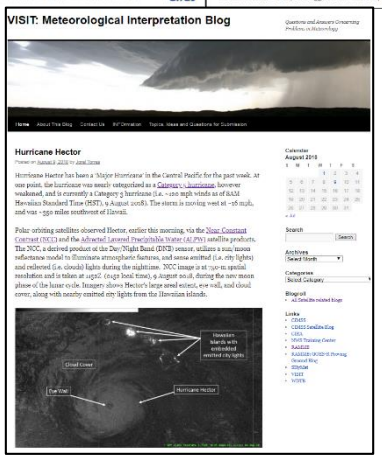
Polar SLIDER will become available to the public at http://rammb-slider.cira.colostate.edu
(Under the satellite menu, choose "JPSS")



JPSS Training

- Satellite Foundational Course for JPSS (SatFC-J)
  - Consists of JPSS training modules. Course duration: 3-4 hours.
  - Available FALL 2018 for NWS forecasters and non-AWIPS users.
- In complement to SatFC-J, JPSS Product and Application Reference Materials are currently in development.
  - Quick Guides (1-2 page documents), Quick Briefs (3-5 minute videos) and Job Aides (Product Exercises).
  - JPSS/GOES Quick Guide and Quick Brief web-links via CIRA/VISIT and STOR within NOAA Vlab.
    - http://rammb.cira.colostate.edu/training/visit/quick_guides/
    - http://rammb.cira.colostate.edu/training/visit/quick_briefs/
    - https://vlab.ncep.noaa.gov/web/stor/polar2
- More JPSS Products will be available in AWIPS via SBN in CY 2018, and CY 2019 (e.g. CONUS Sector, NOAA-20 NCC and NUCAPS, tentative date: Dec 2018).
- Satellite Blogs:
  - VISIT Meteorological Interpretation Blog: http://rammb.cira.colostate.edu/training/visit/blog/
  - Seeing the Light: VIIRS in the Arctic Blog: http://rammb.cira.colostate.edu/projects/alaska/blog/
- Upcoming JPSS Training Workshop at AMS 99th Annual Meeting in Phoenix, AZ. For more information contact Jorel Torres (CIRA): jorel.torres@colostate.edu





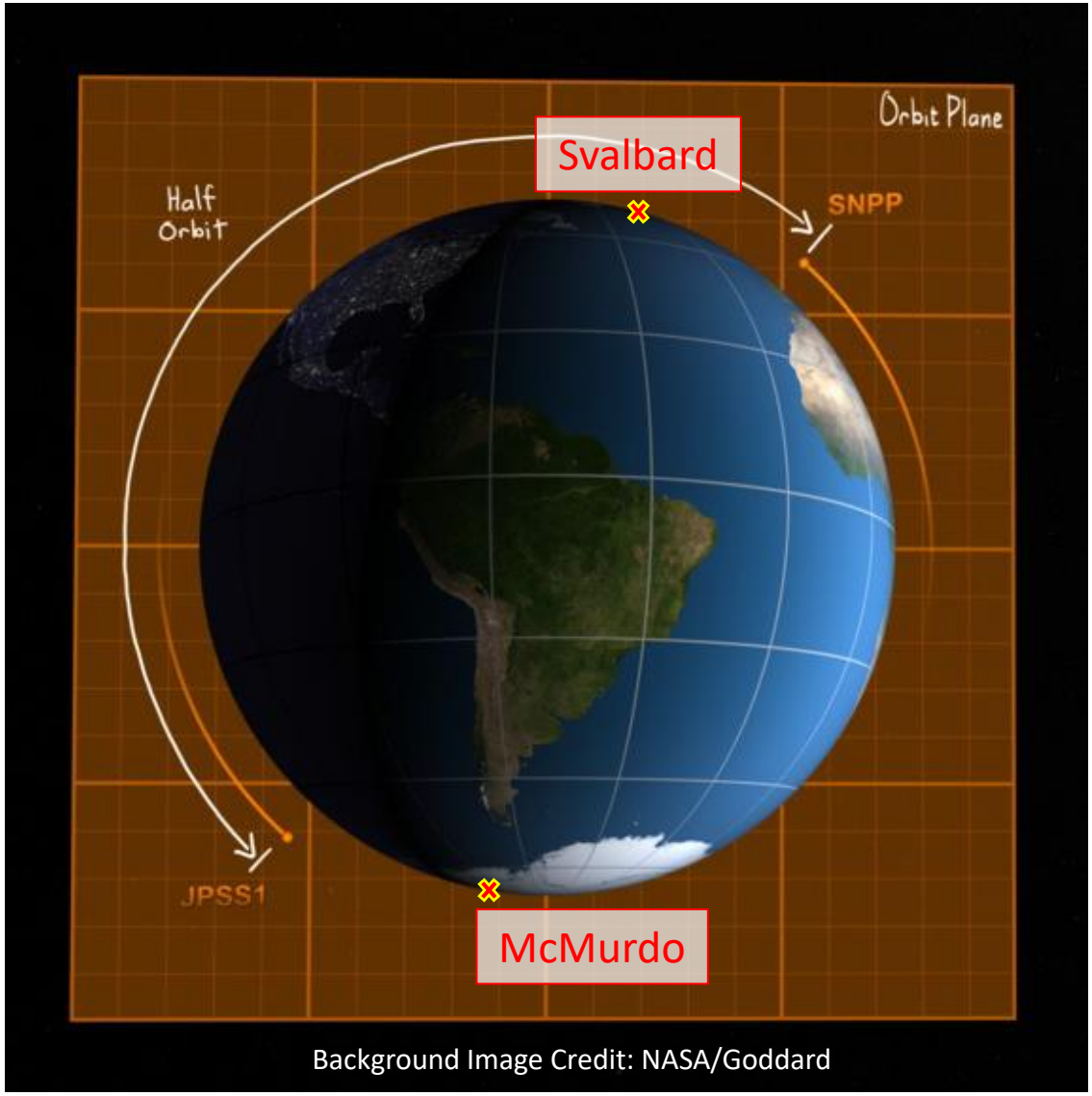
Cautionary Tales

Full resolution images are 16,000 x 16,000 pixels (M-bands & DNB), 32,000 x 32,000 (I-bands), which puts more strain on your web browser than GOES-R ABI.

Each individual orbit image contains ~51 min. of data. Image time stamps are set to match the last VIIRS granule to cross the Equator in each hemisphere. At this time, we lack the ability to go back and reprocess missing granules.

S-NPP data is only downlinked from Svalbard. NOAA-20 data is downlinked from both Svalbard and McMurdo. This means more recent NOAA-20 data may arrive before older S-NPP data. The final images are sent to SLIDER after S-NPP processing is complete.

With current computing power, it takes ~50 minutes to process the ~100 min. of data from each orbit (M-bands).



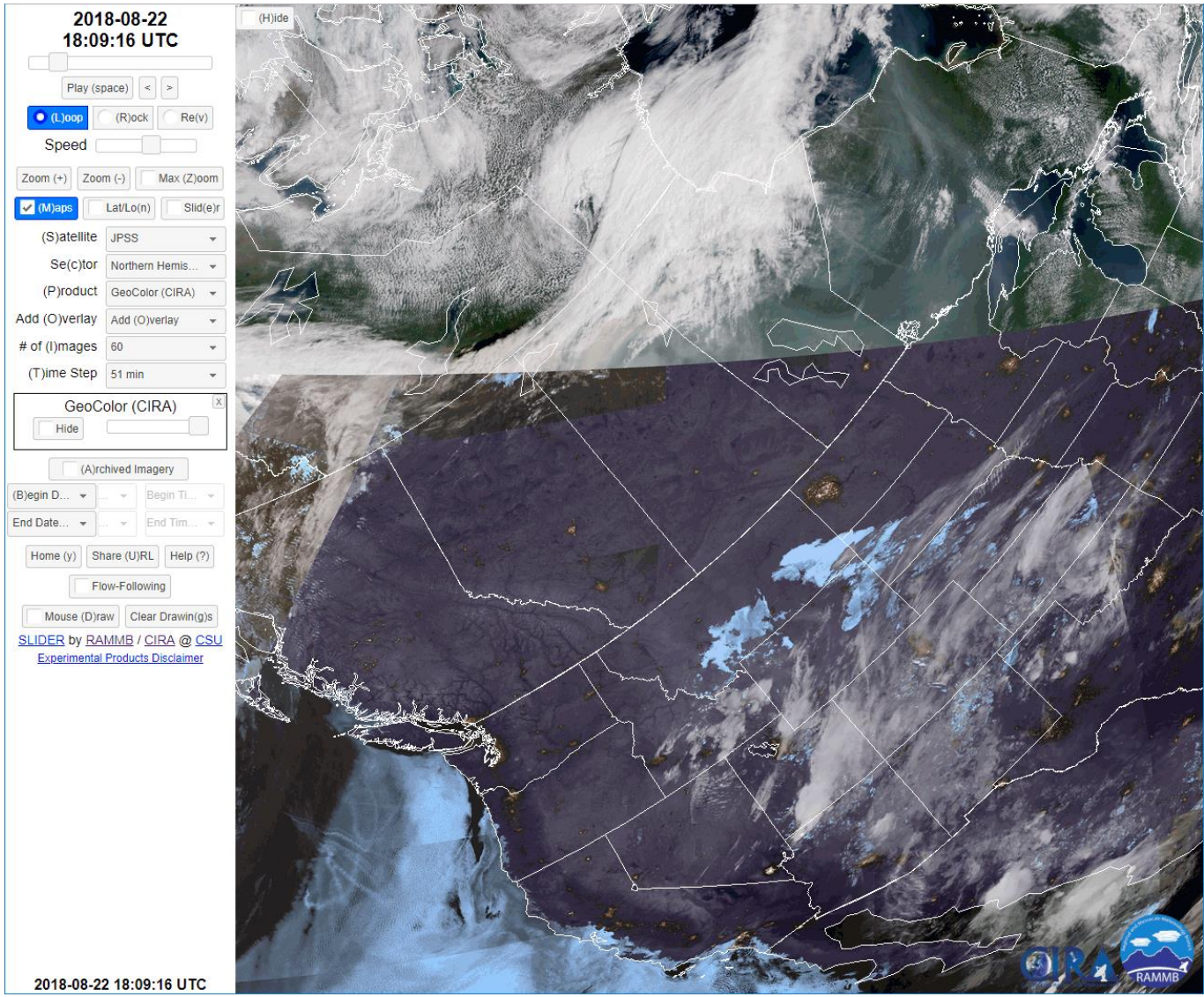
Background Image Credit: NASA/Goddard

Smoke Transport

Smoke from fires in the Pacific Northwest advects all the way to the U.S. Midwest, Great Lakes and Hudson Bay.

Smoke plumes are also visible near the Ontario-Manitoba border.

Animated GIF



CIMSS support of Imagery EDR team and Other JPSS Activities

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

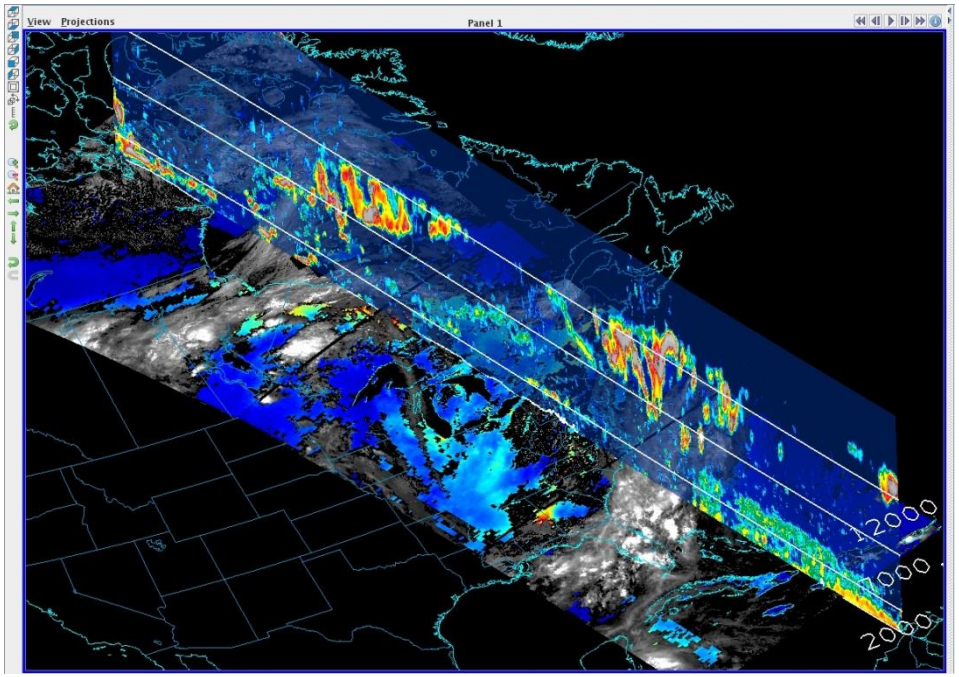
Outline

- 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**



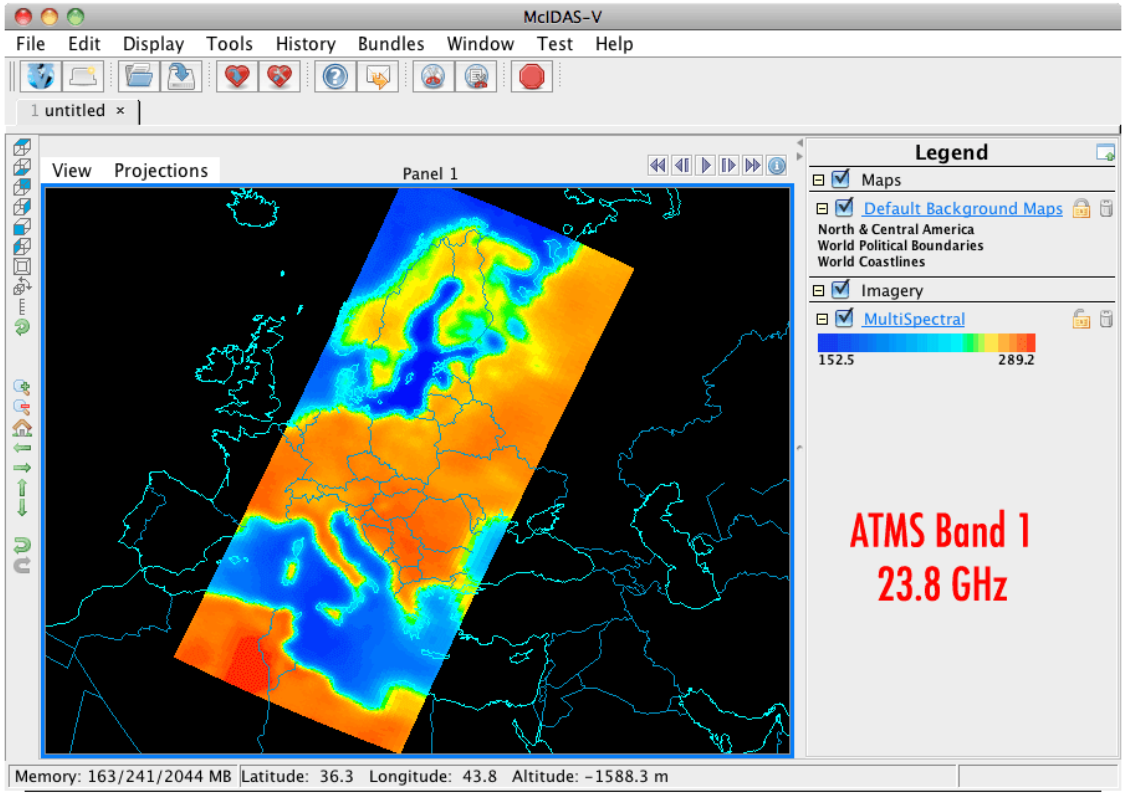
Key Aspects of McIDAS-V

- **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**

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

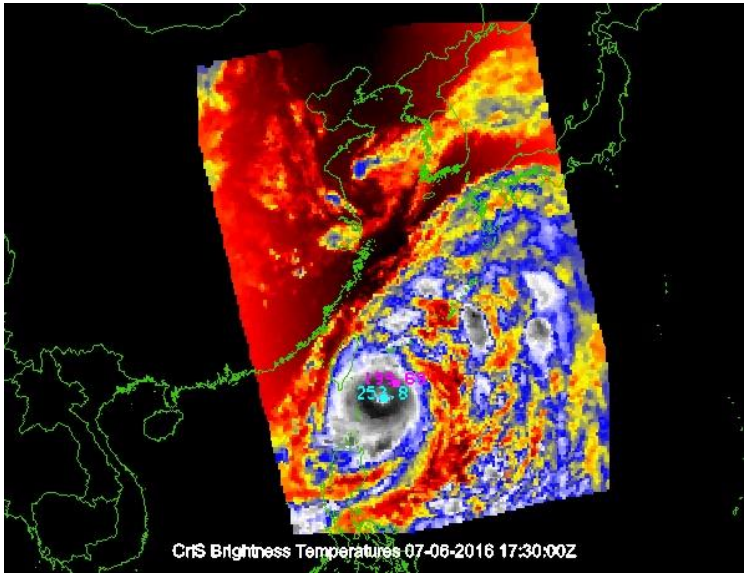
Advanced Technology Microwave Sounder (ATMS)

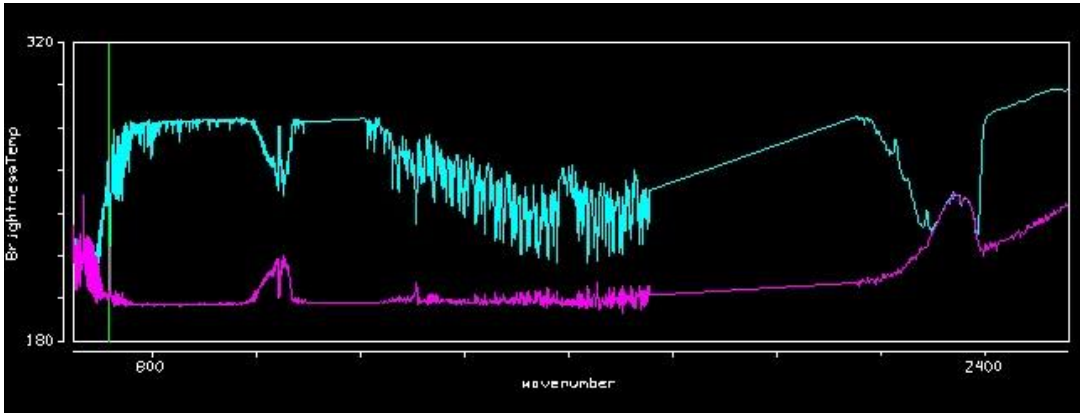
- 22 microwave channels, combining all the channels of the preceding AMSU-A1, AMSU-A2, and AMSU-B sensors into a single package
- Provides sounding observations needed to retrieve profiles of atmospheric temperature and moisture for forecasting models and continuity for climate monitoring purposes.



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.

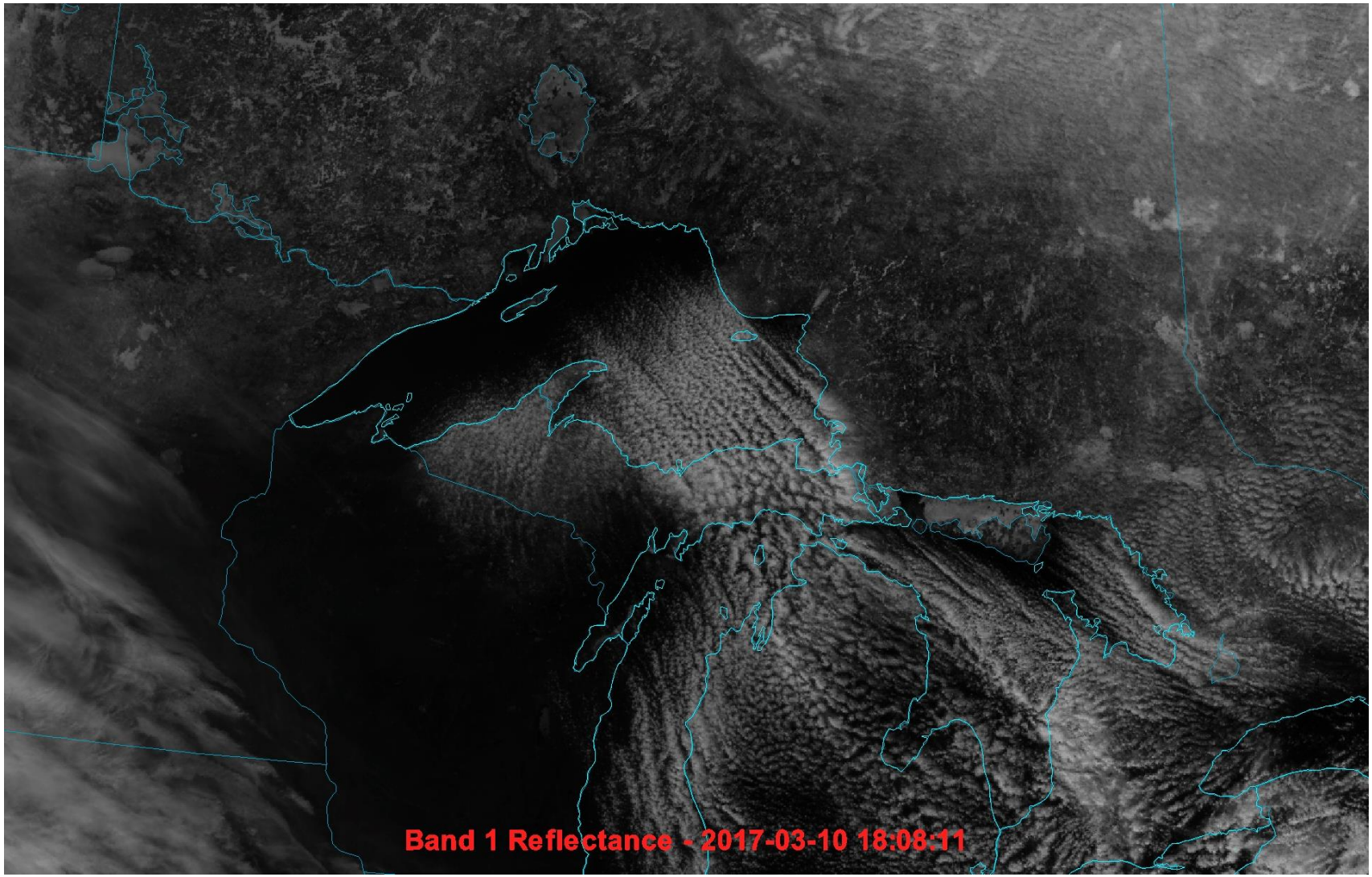




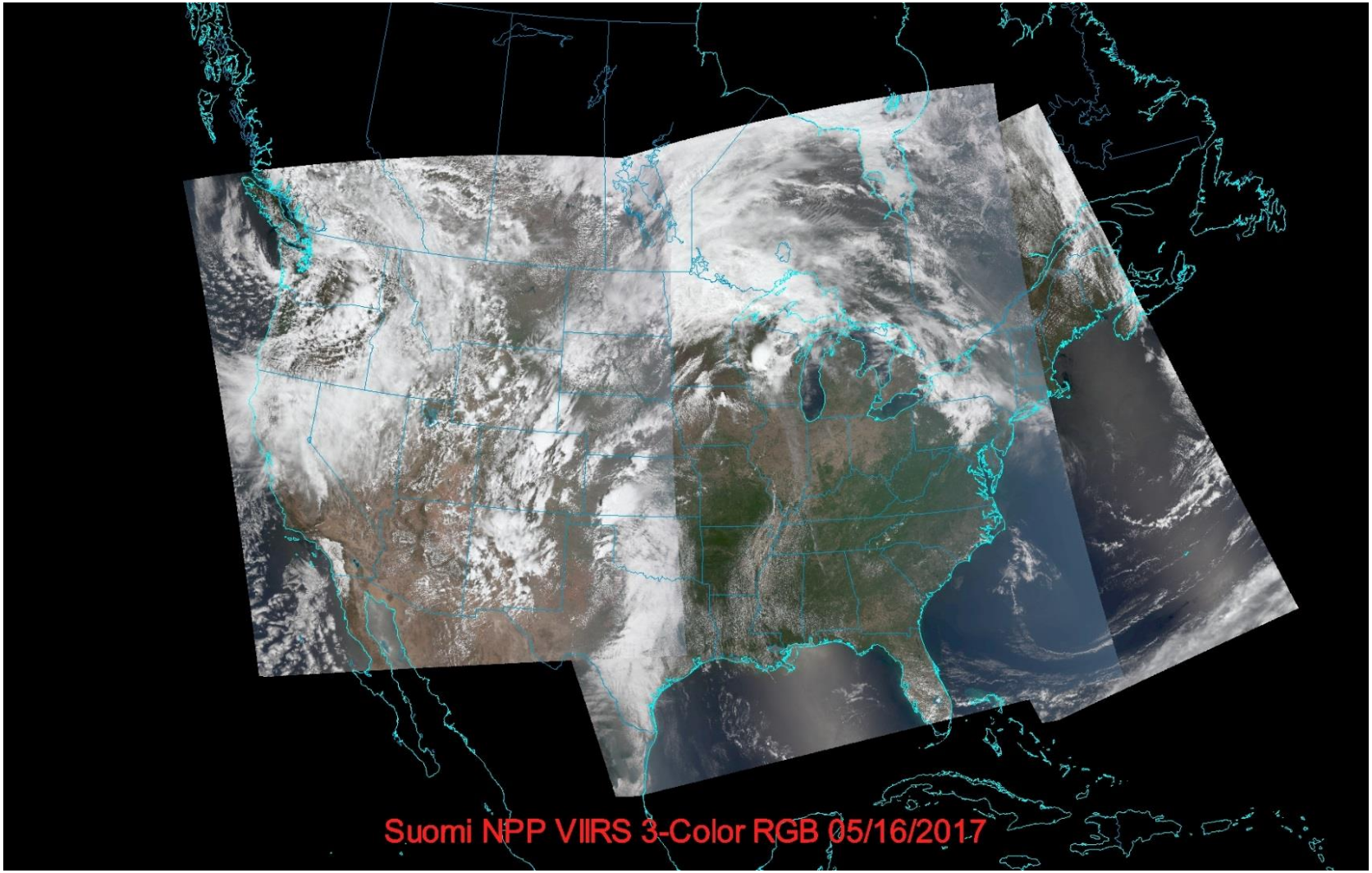
Visible Infrared Imaging Radiometer Suite (VIIRS)

- 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

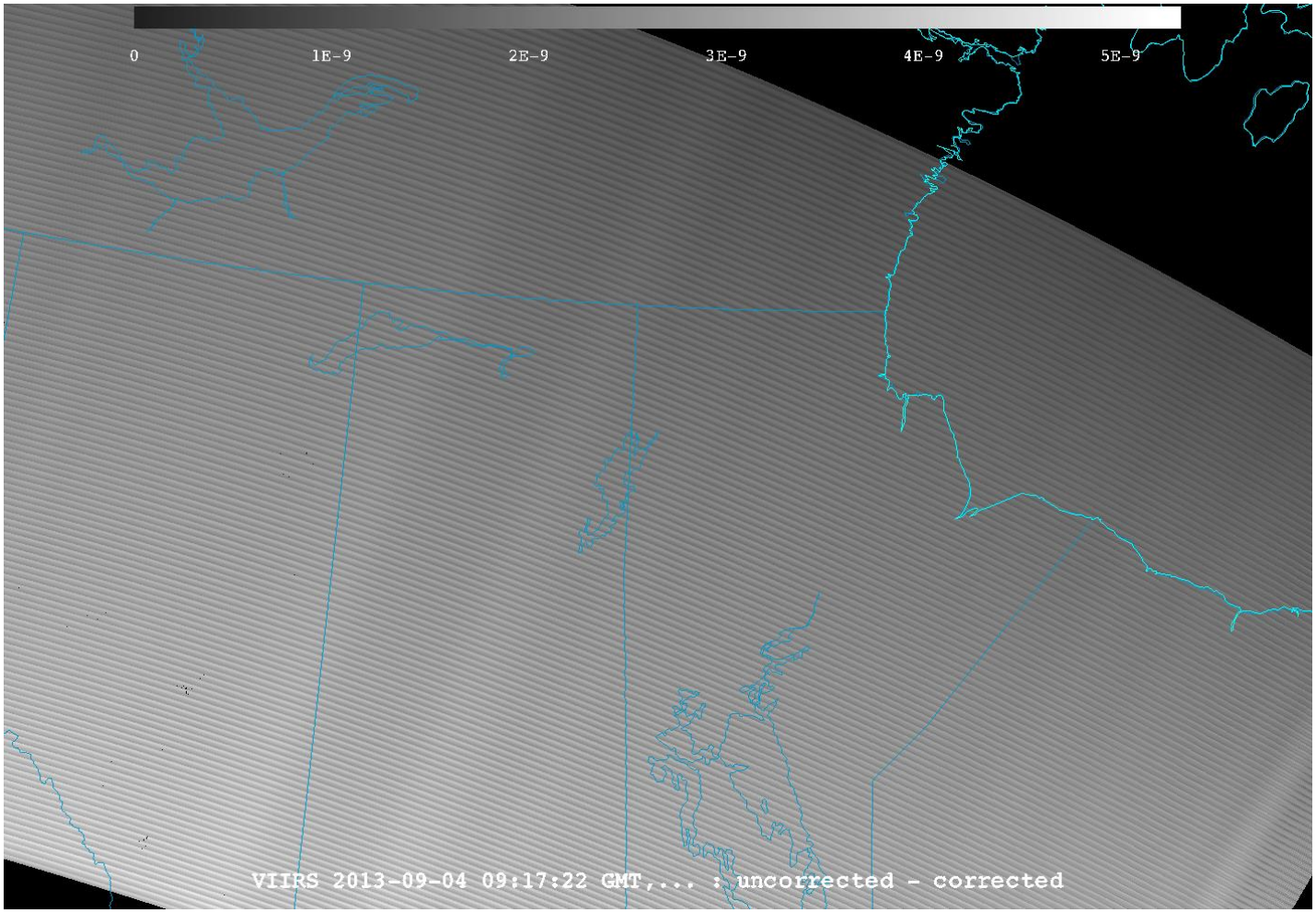
Multi-channel animation



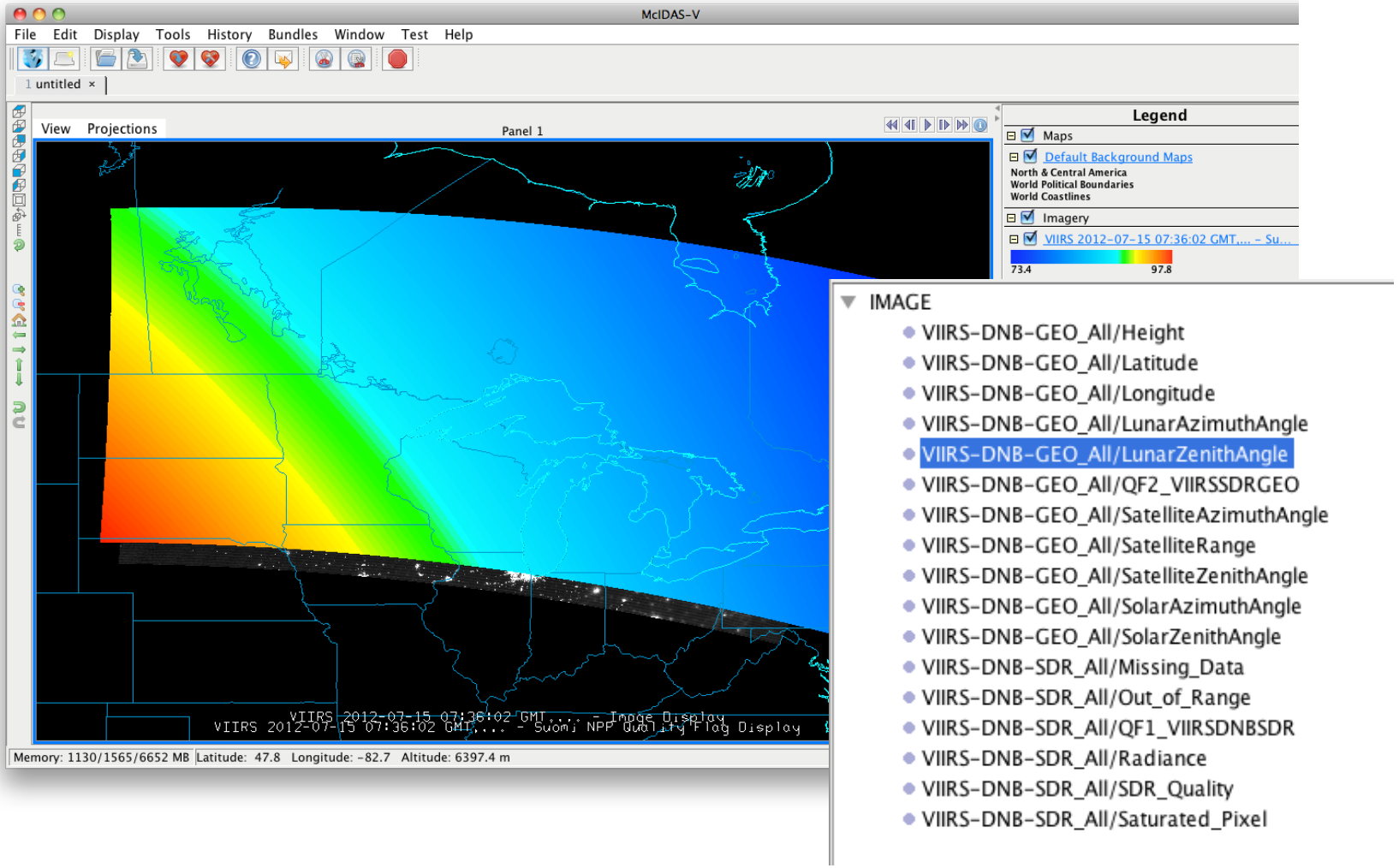
RGB composite



VIIRS Channel Differencing DNB Stray light example



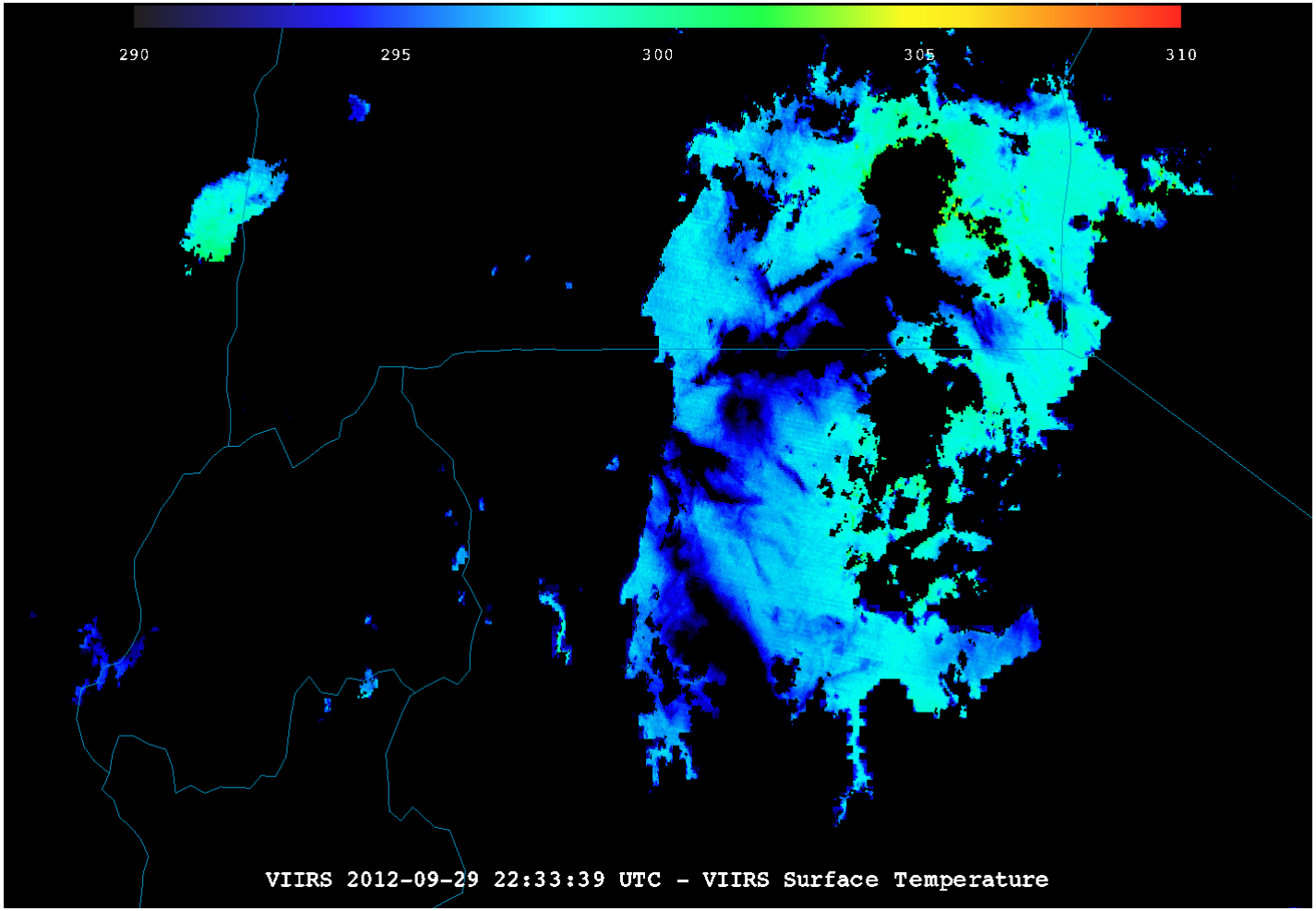
VIIRS SDR
Ancillary data



Visible Infrared Imaging Radiometer Suite (VIIRS) EDR

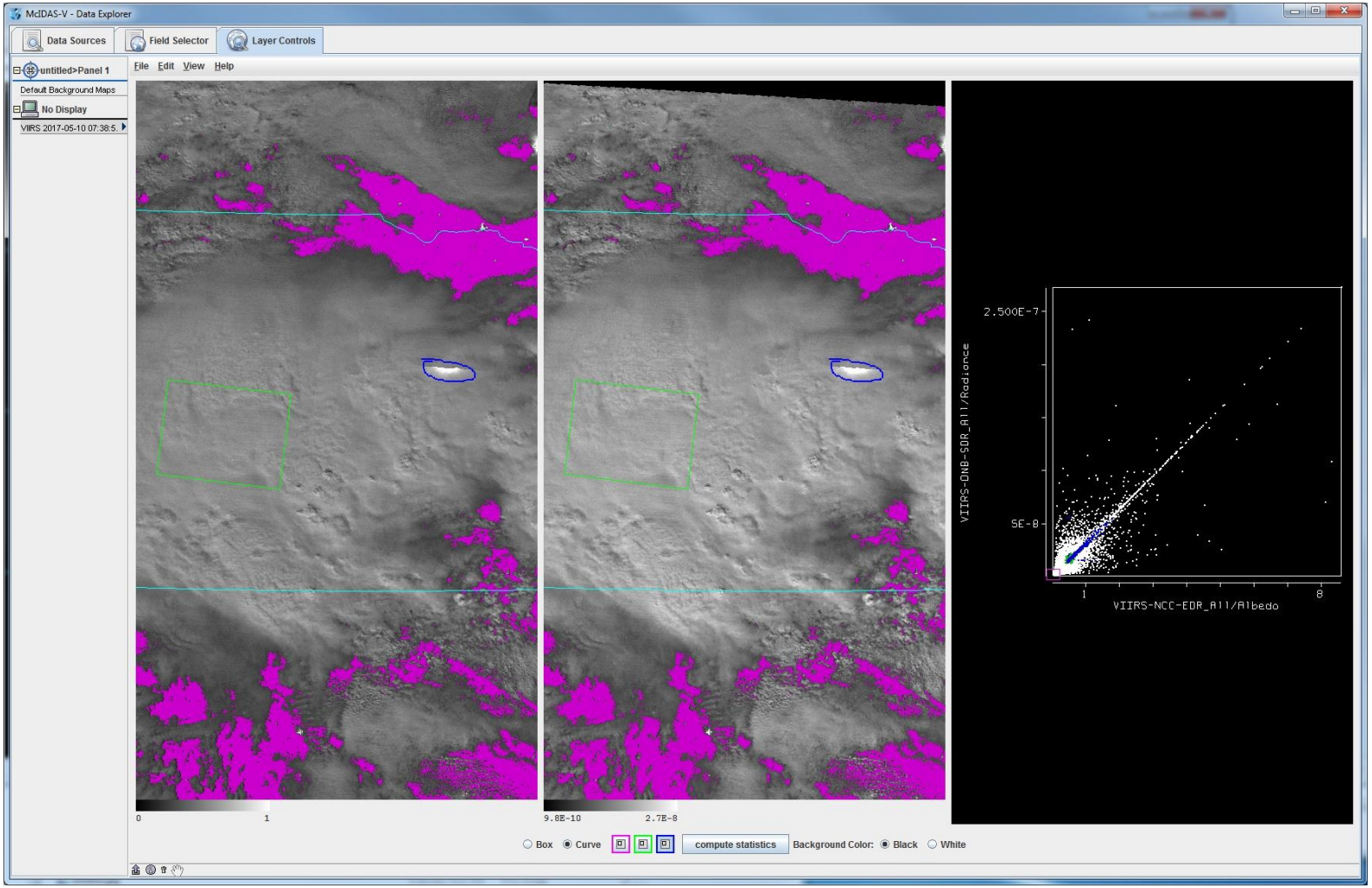
- There are a series of 20 Environmental Data Records (EDRs) produced from VIIRS from the IDPS
  - These algorithms are being migrated to the Enterprise algorithms
- McIDAS-V has been able to successfully ingest all EDRs including NDE Enterprise output
- McIDAS-V can unpack and display bit level data for IDPS data.
  - Ex. Displaying VCM test results
  - Will be working on unpacking bits for Enterprise algorithms

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

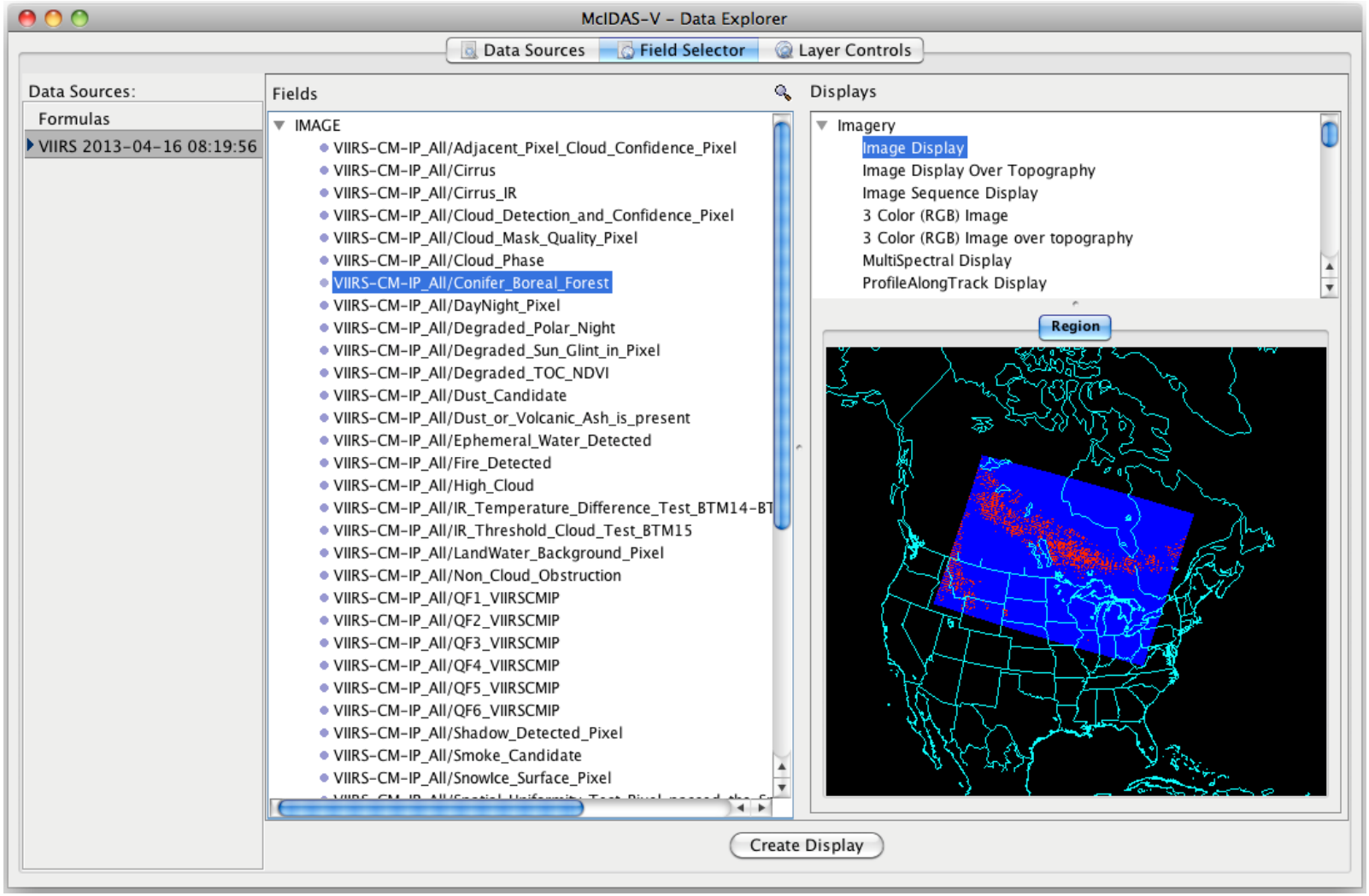


Lake Victoria

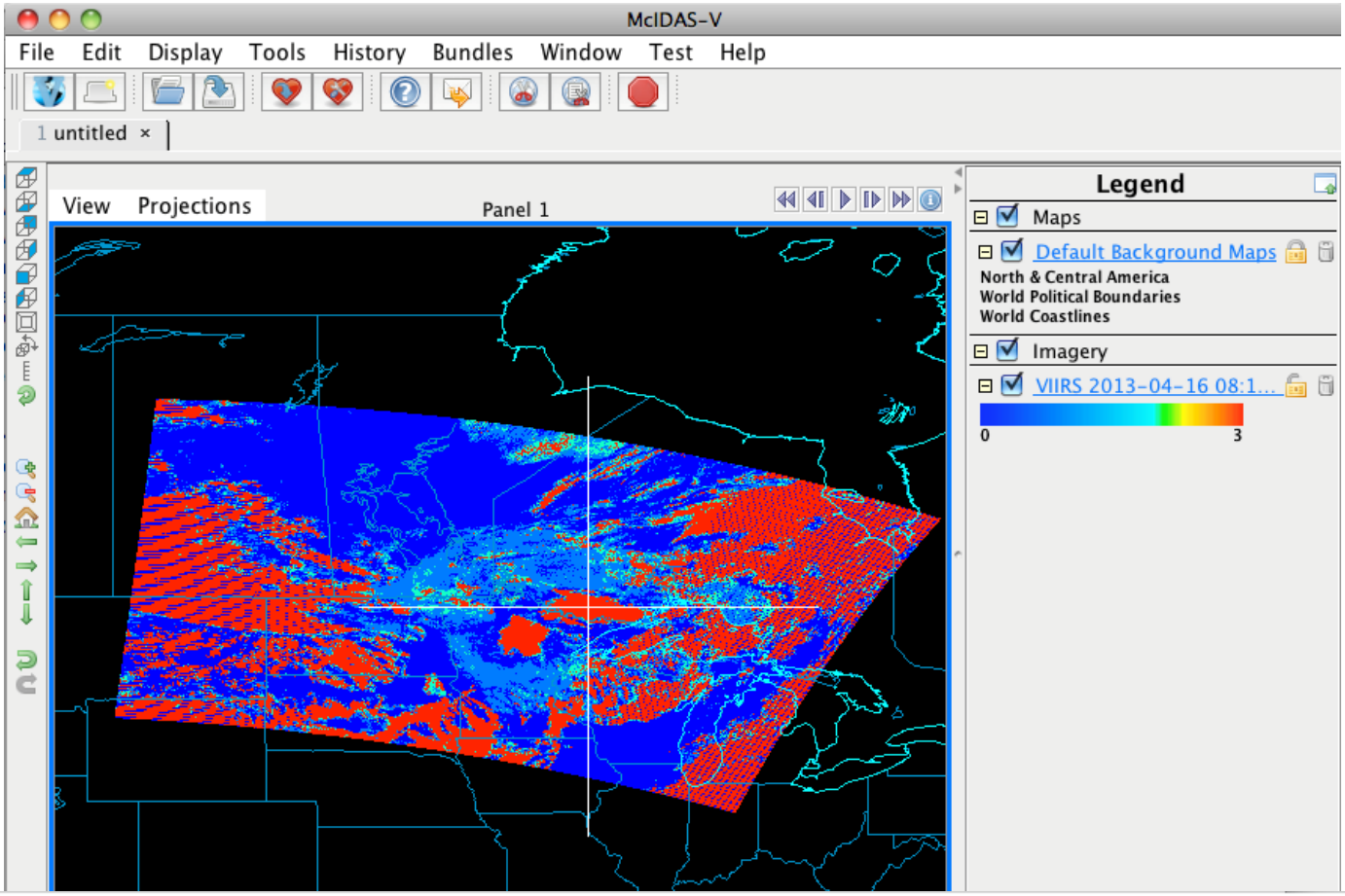
Imagery EDR example
Scatter analysis



Product EDR Variable selection



Product EDR Data Probe



S-NPP/NOAA-20 specific McIDAS-V 1.7 Updates

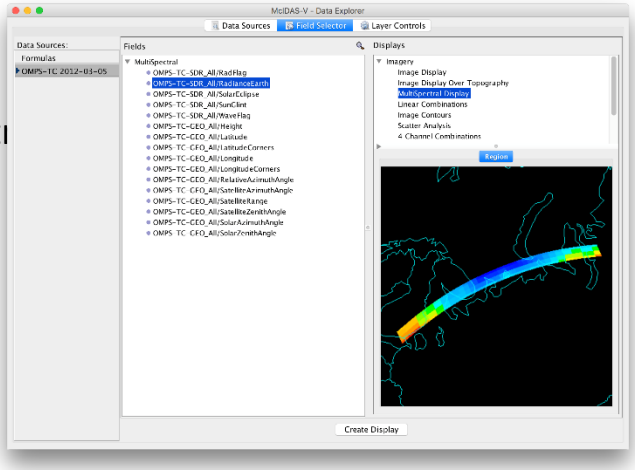
- Support for the VICMO cloud mask EDR (released March 2017) as well as backwards compatibility with IICMO data.
- Added a new "show variables" button to the Field Selector tab of the Data Explorer which can show the variable shortname or (if present) long name.
- VIIRS Formulas plugin that gives formulas to remove the bowtie deletion and create RGB displays without the bowtie
- Added several VIIRS specific Scripting functions to load and grab information and create RGBs from SNPP/J1 files.
  - Example – “True color” RGB function (http://mcidas.ssec.wisc.edu/forums/viewtopic.php?f=31&t=1912&sid=e0bc1d9c9ac28f776ab6669136d75e1c)

S-NPP/NOAA-20 Updates since McIDAS-V 1.7 in Nightly Build

- Support added for CrIS Full Spectrum data.
- Chooser rename to JPSS (it's not just for Suomi any more!)
- Reordering of fields provided now (e.g. M bands used to be listed out of order in multibanded VIIRS files)
- Better time formatting in scripting functions
- Generalization and renaming of scripting functions, with deprecation warnings provided

Needed features for JPSS activities

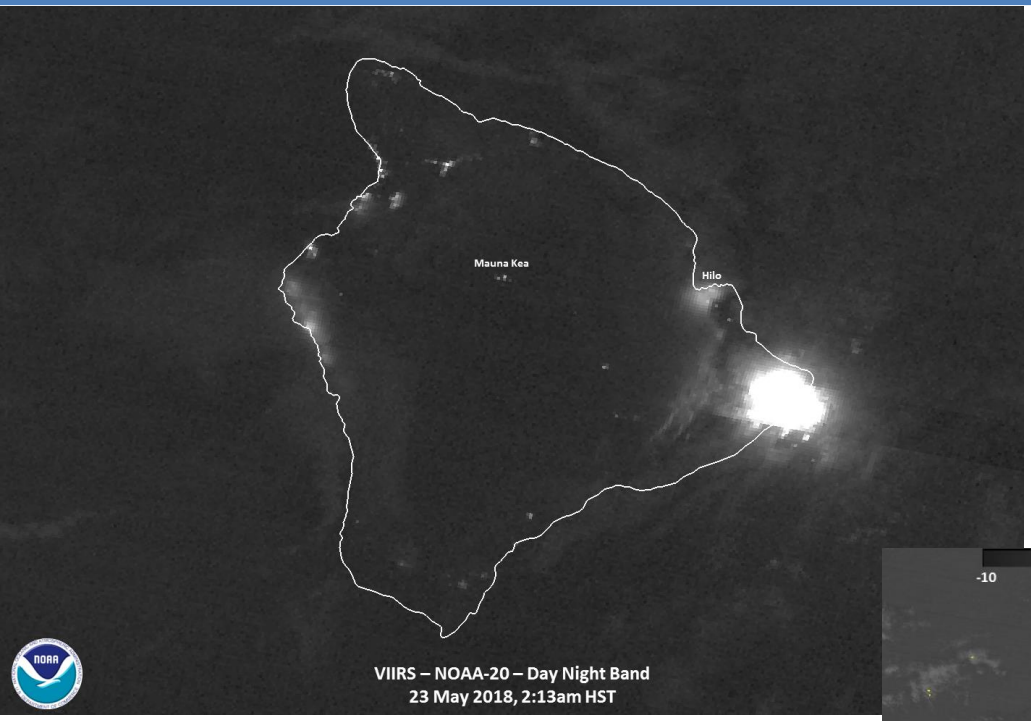
- Support for visualizing granules which straddle the dateline (note, this issue occurs with other polar and geo data)



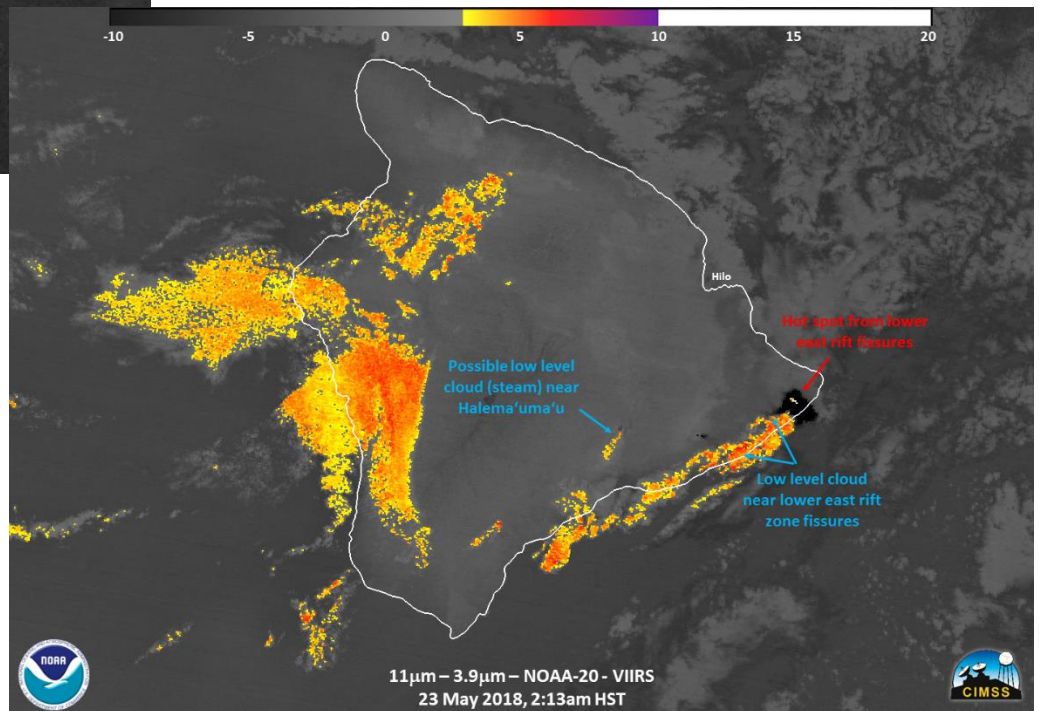
- Support for OMPS
  - Needed for comparisons and visualizations with other instr
  - Currently in testing
- Support for Active Fires products
- Support for NUCAPS
- Support for non-CF 3-D variables
- Output in other GIS-type formats (ex. geoTIF)
  - Google KML/KMZ files often either don't display properly in other GIS viewers other than Google Earth.
  - This is needed for comparisons and interactions with other groups, both in cal/val and other activities.

EXAMPLES OF MCIDAS-V USED FOR JPSS

NOAA-20
2018 lower Puna lava outbreaks

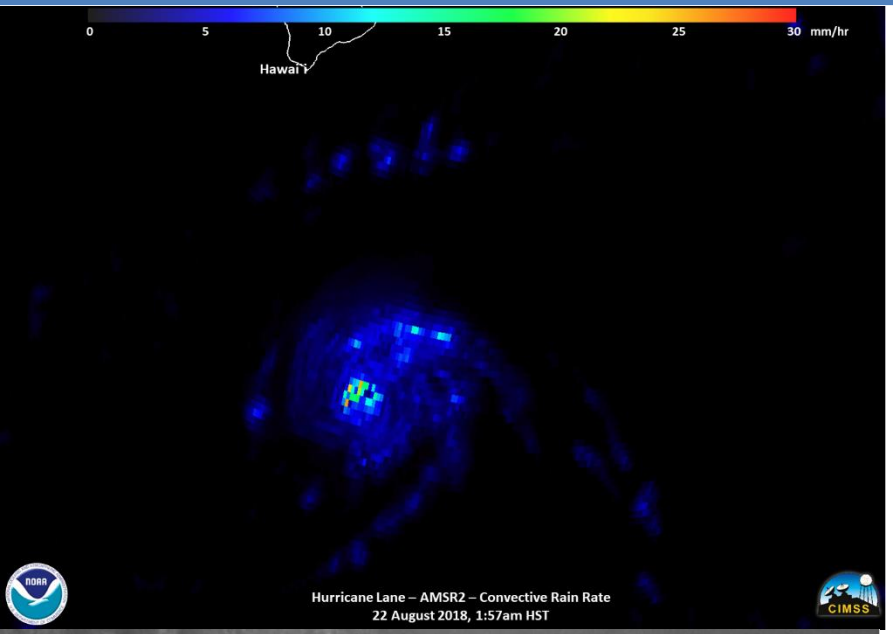


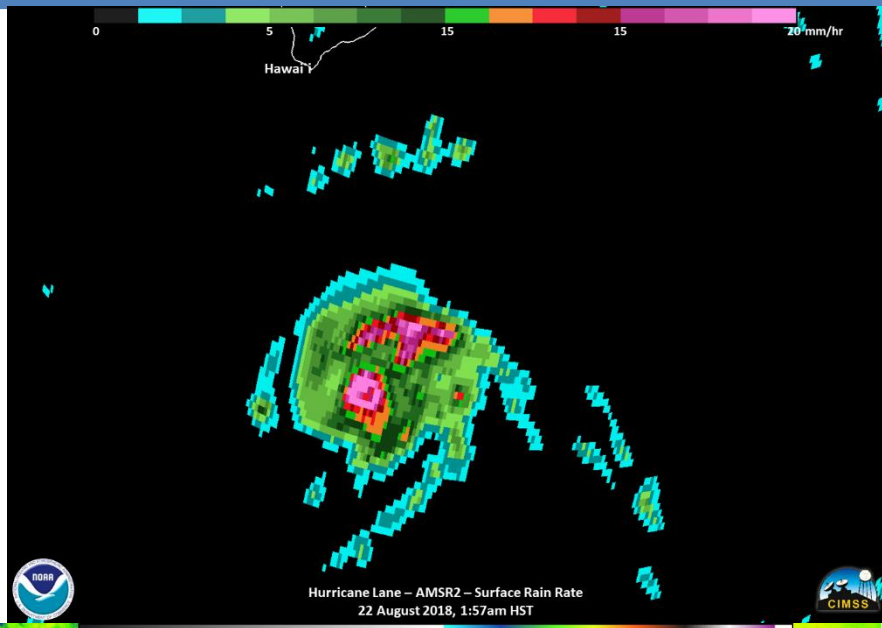
VIIRS – NOAA-20 – Day Night Band
23 May 2018, 2:13am HST

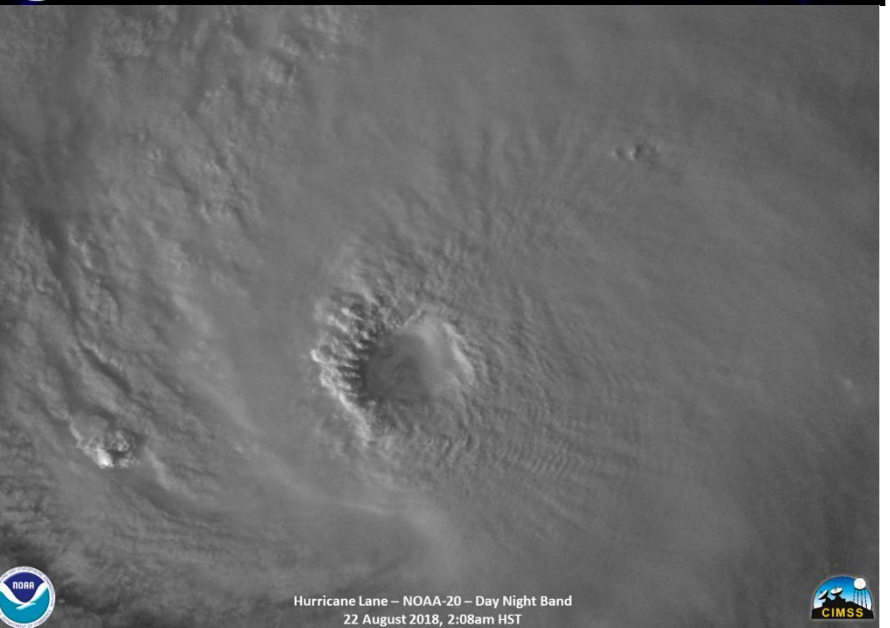


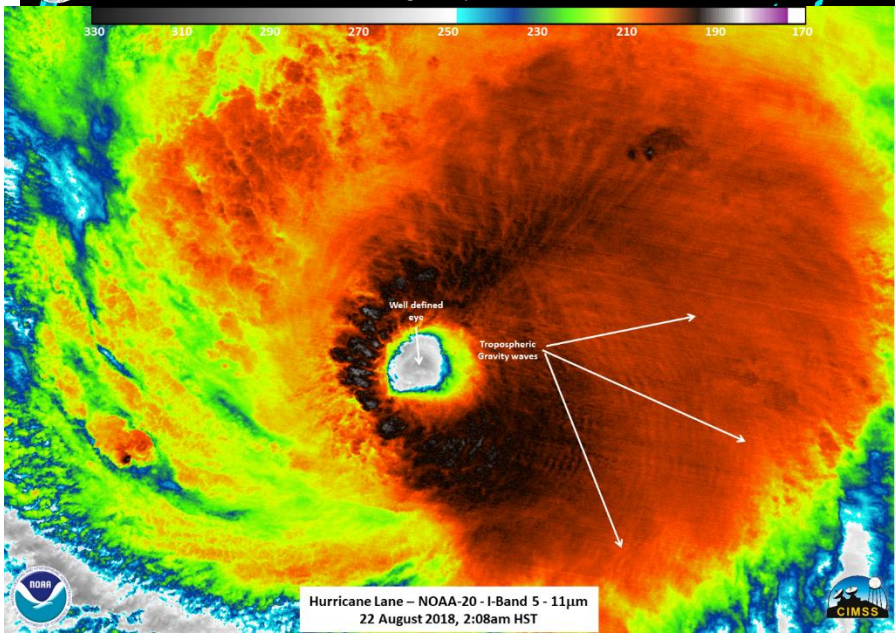
11μm – 3.9μm – NOAA-20 - VIIRS
23 May 2018, 2:13am HST

NOAA-20
Hurricane Lane

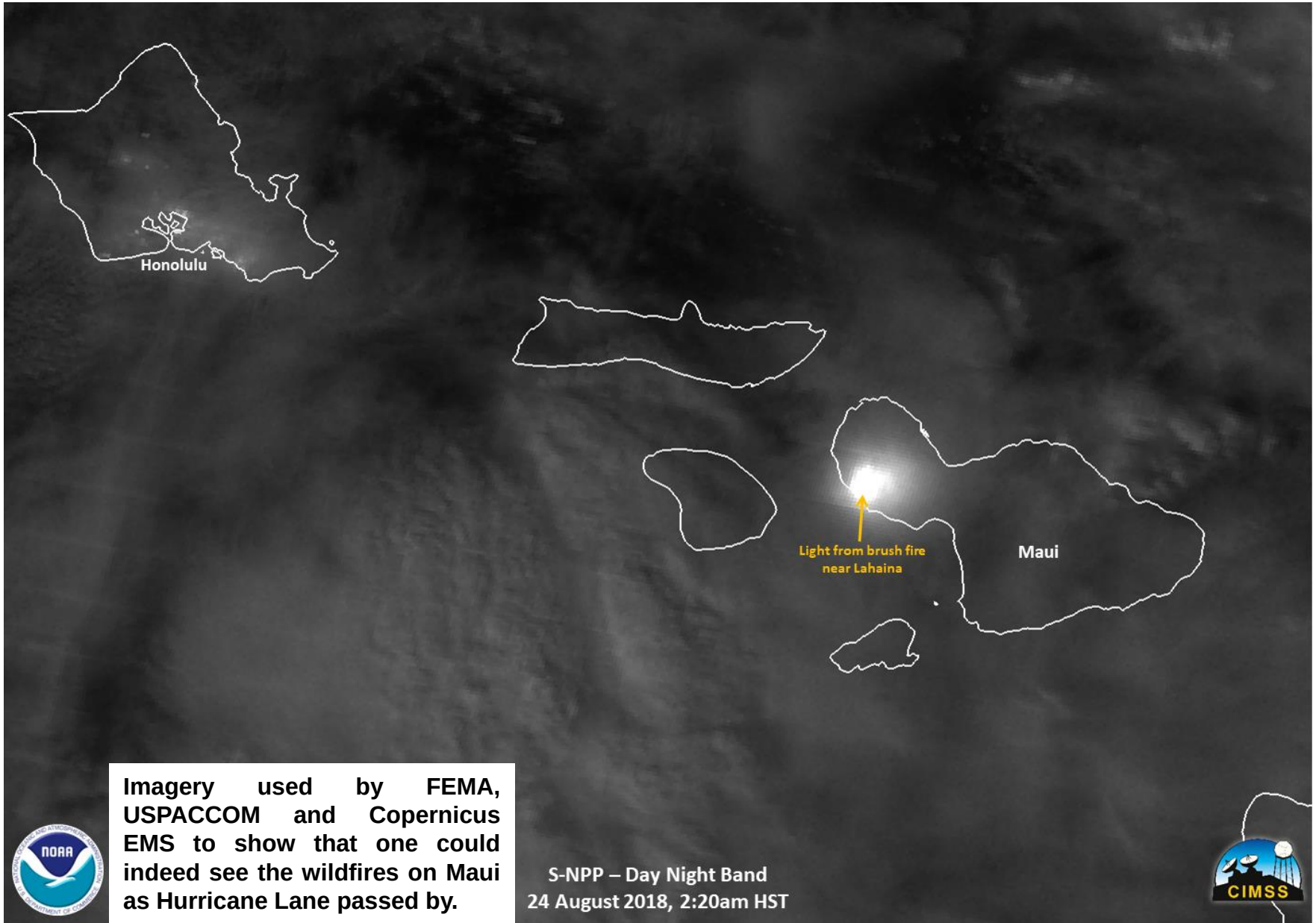








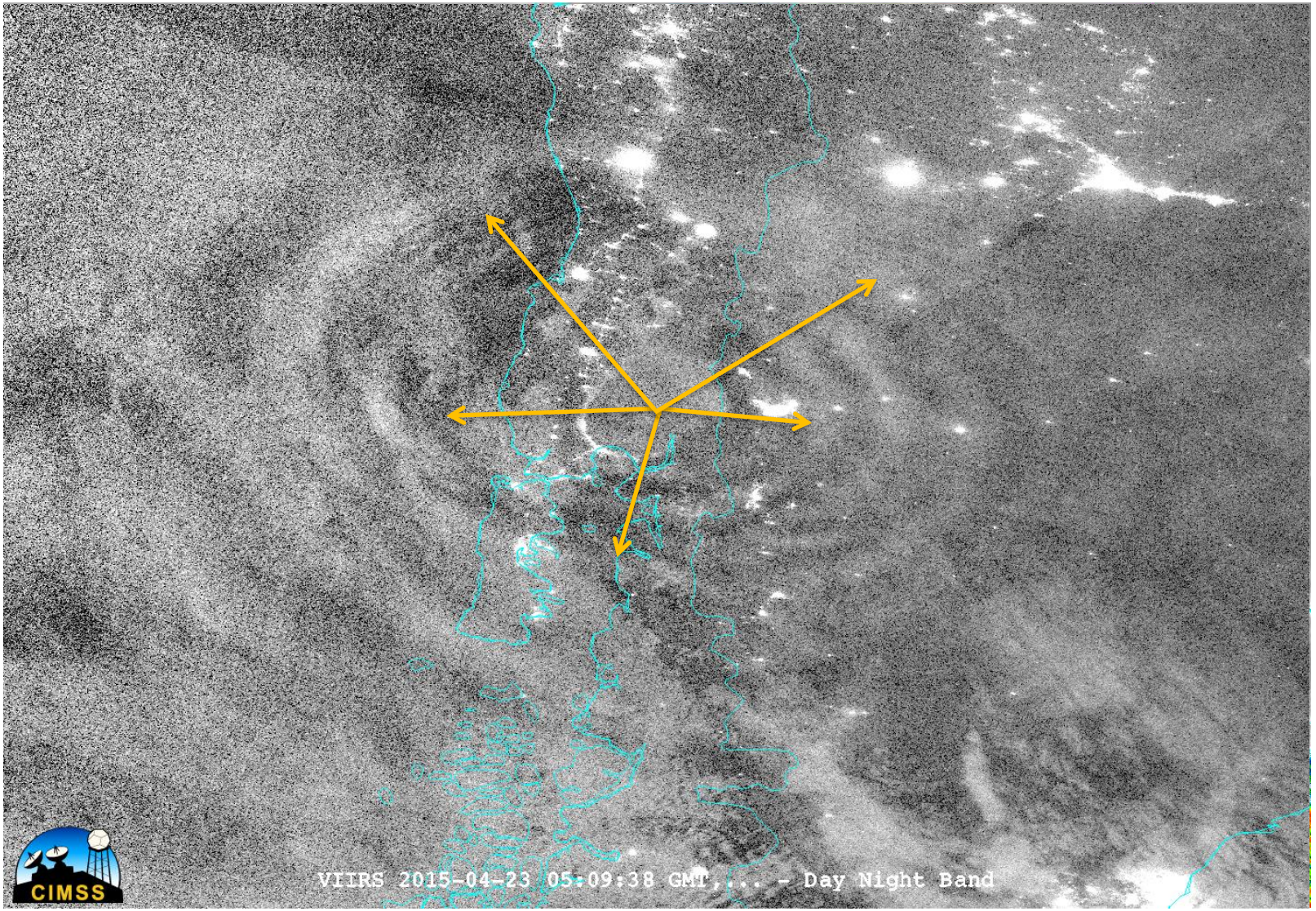
S-NPP
Hurricane Lane



Imagery used by FEMA, USPACCOM and Copernicus EMS to show that one could indeed see the wildfires on Maui as Hurricane Lane passed by.

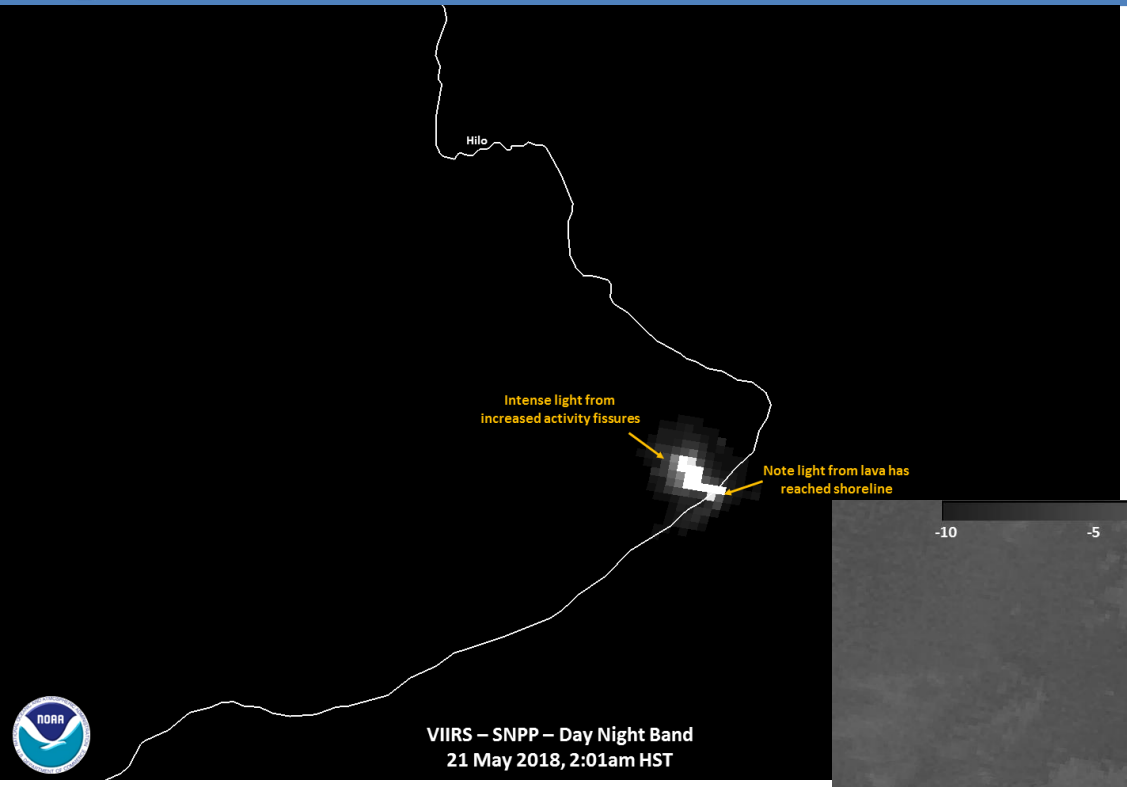
S-NPP – Day Night Band
24 August 2018, 2:20am HST

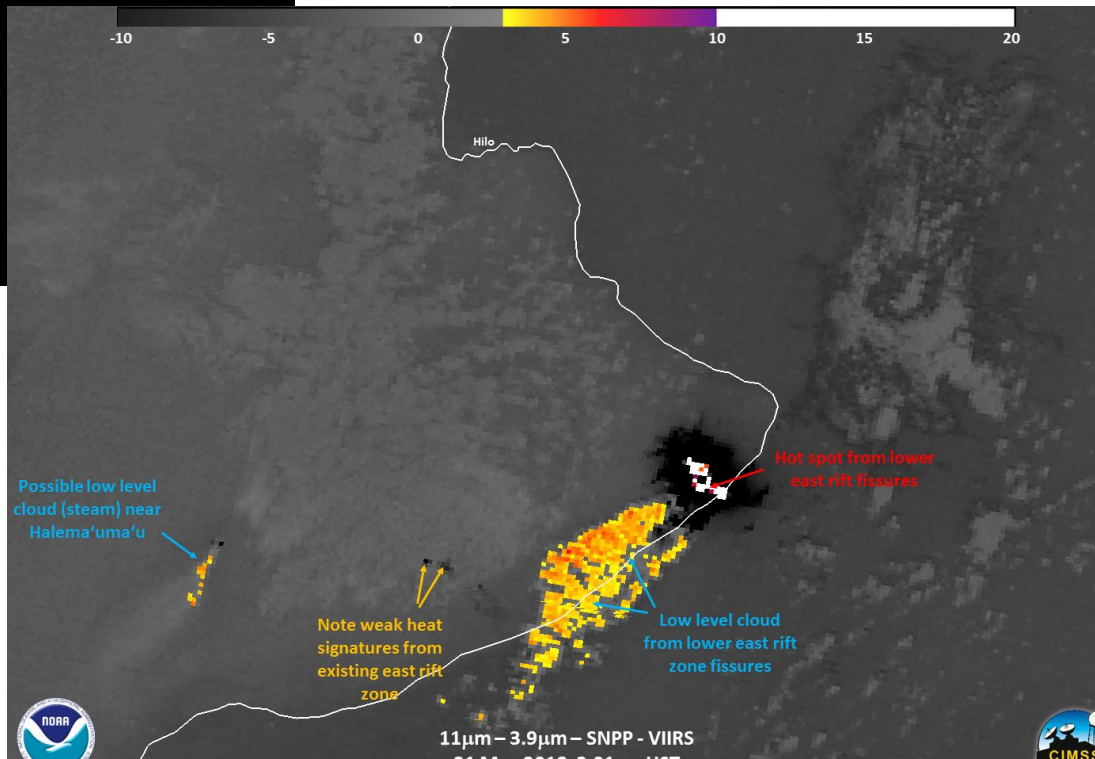
Mesospheric Gravity Wave monitoring



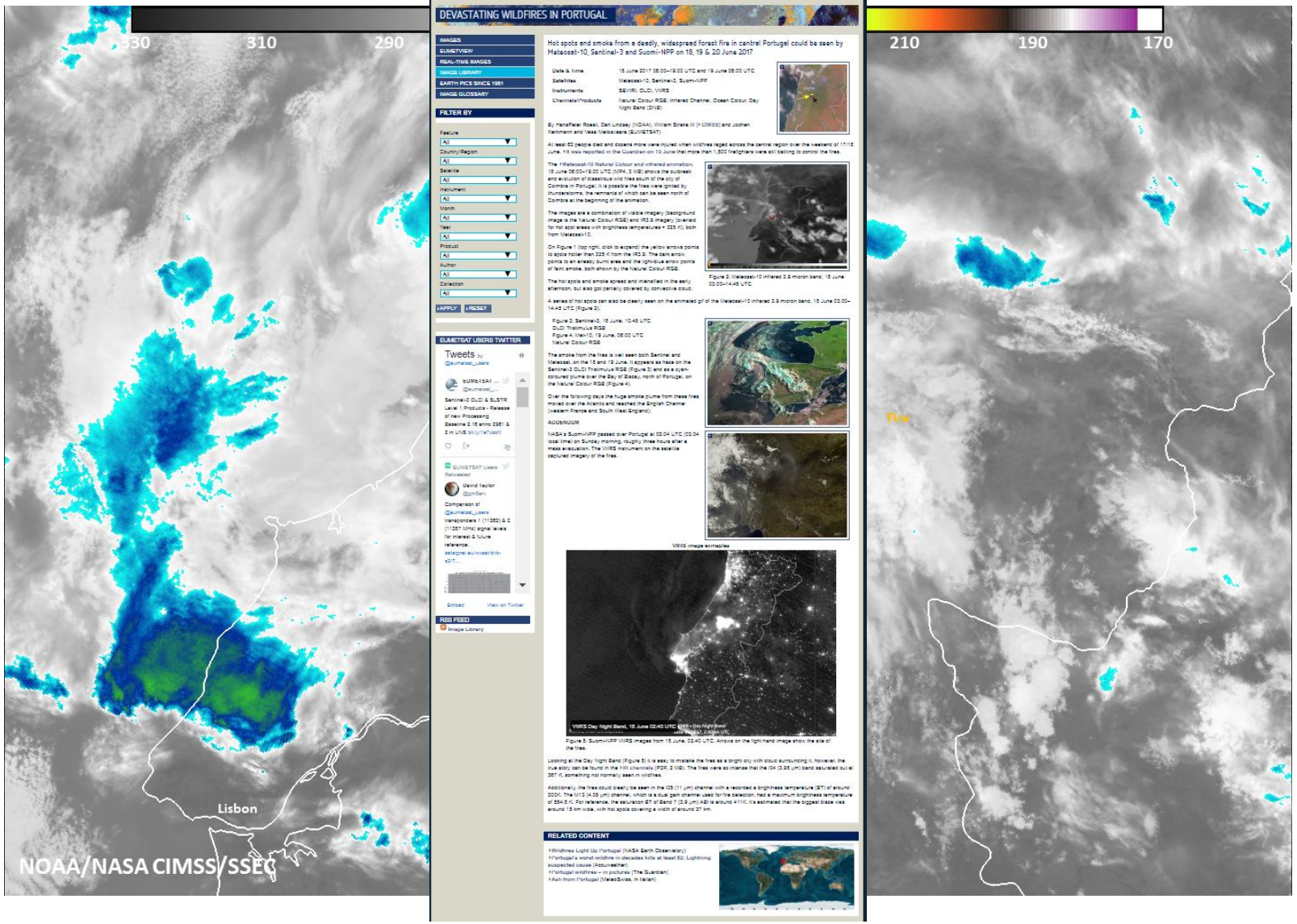
EXTRA SLIDES

SNPP
2018 lower Puna lava outbreaks



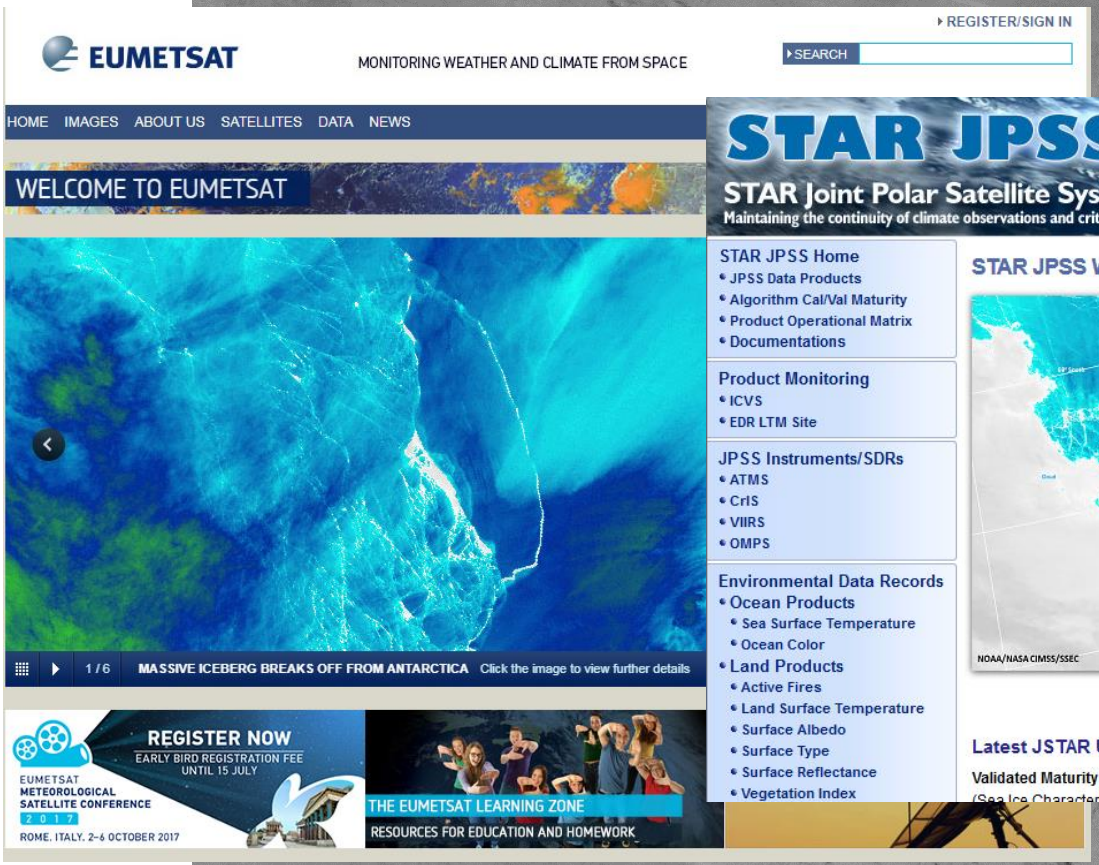


Disaster monitoring
Fires and Smoke support



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

Polar Monitoring Public Outreach





NOAA/NASA CIMSS/SSEC

VIIRS – Day Night Band
12 July 2017, 0326 UTC

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 29, 2018

Lights At Night!



Cities and human settlements



Boats



Industrial Sites



Gas Flares



Fires

How many VIIRS spectral band collect low light imaging data? Five!

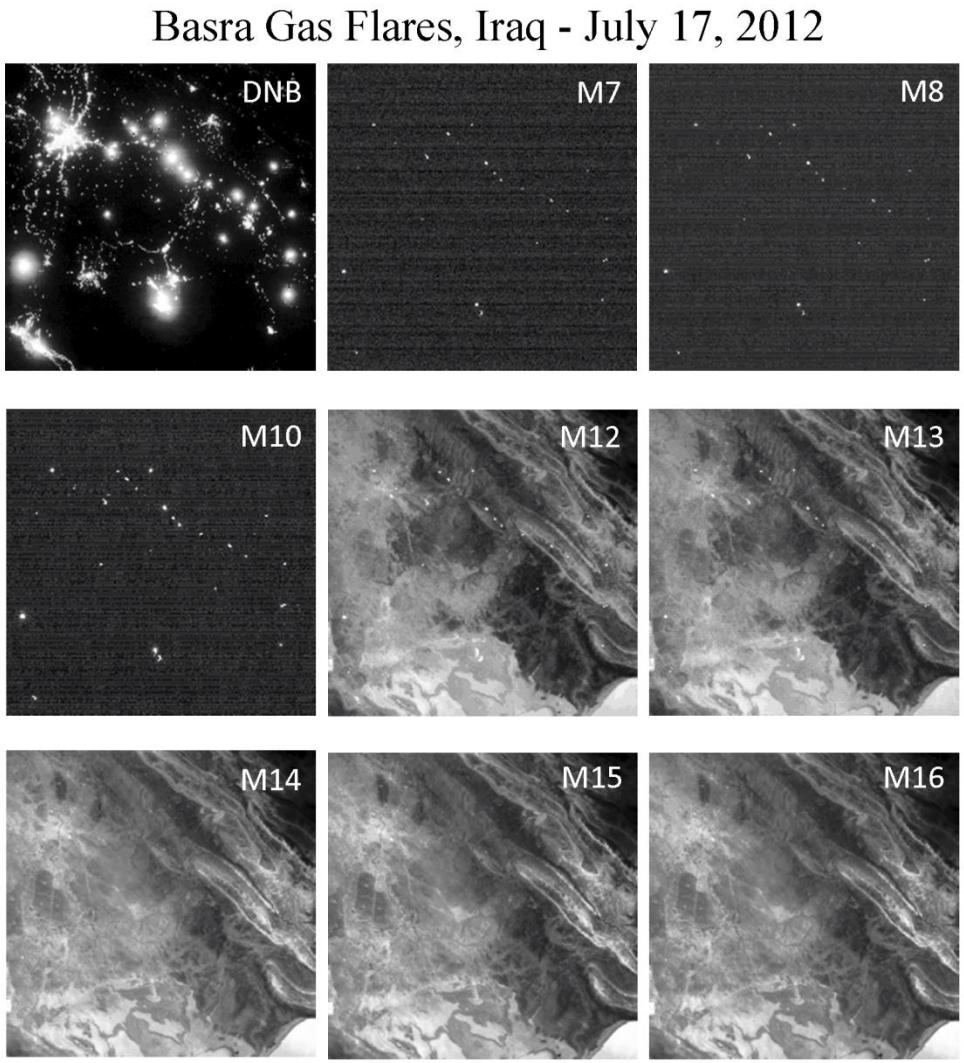
1. Day/night band (DNB) signal intensification detects faint radiant emissions in the visible and near infrared.
2. Daytime channels at night – enabling the detection of radiant emissions that are obscured by reflected sunlight.

   M7 at 0.865 um

   M8 at 1.24 um

   M10 at 1.61 um

   M11 at 2.25 um

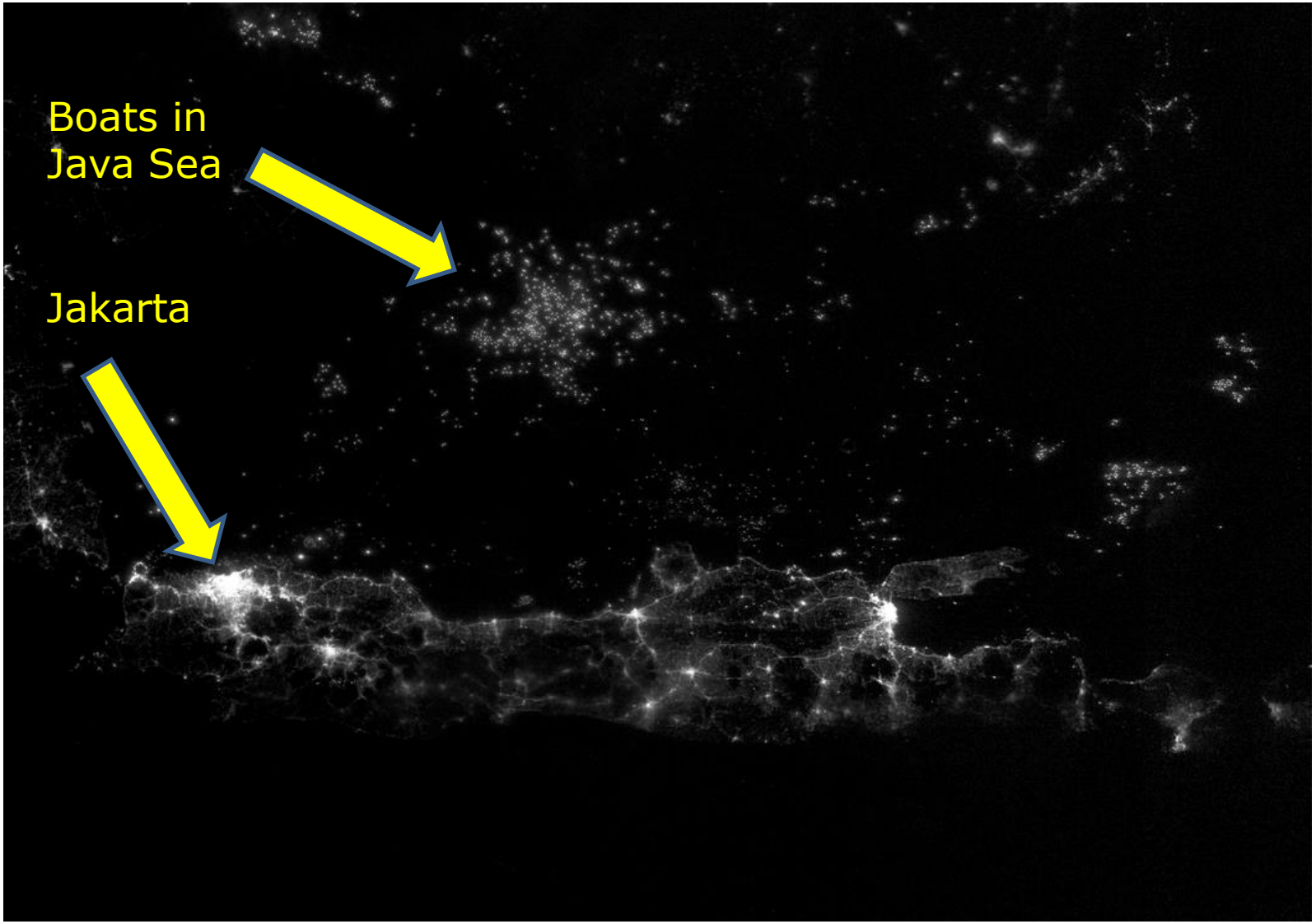


VIIRS low light imaging at night: DNB detects electric lighting, fires and flares. M7,8 & 10 detect combustion sources.

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)

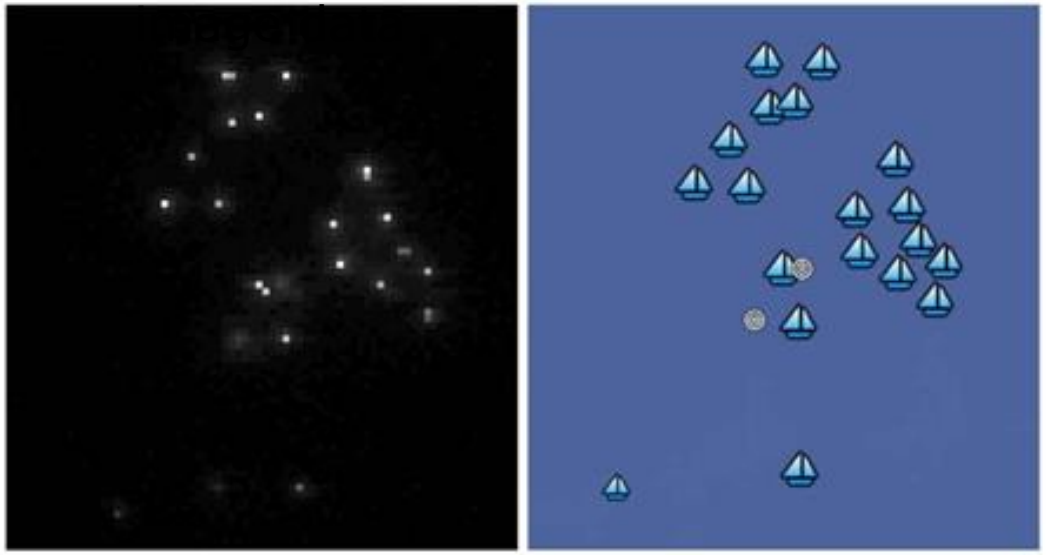


Algorithms run on images, output points, vast data volume reduction



VIIRS day/night band (DNB) nighttime

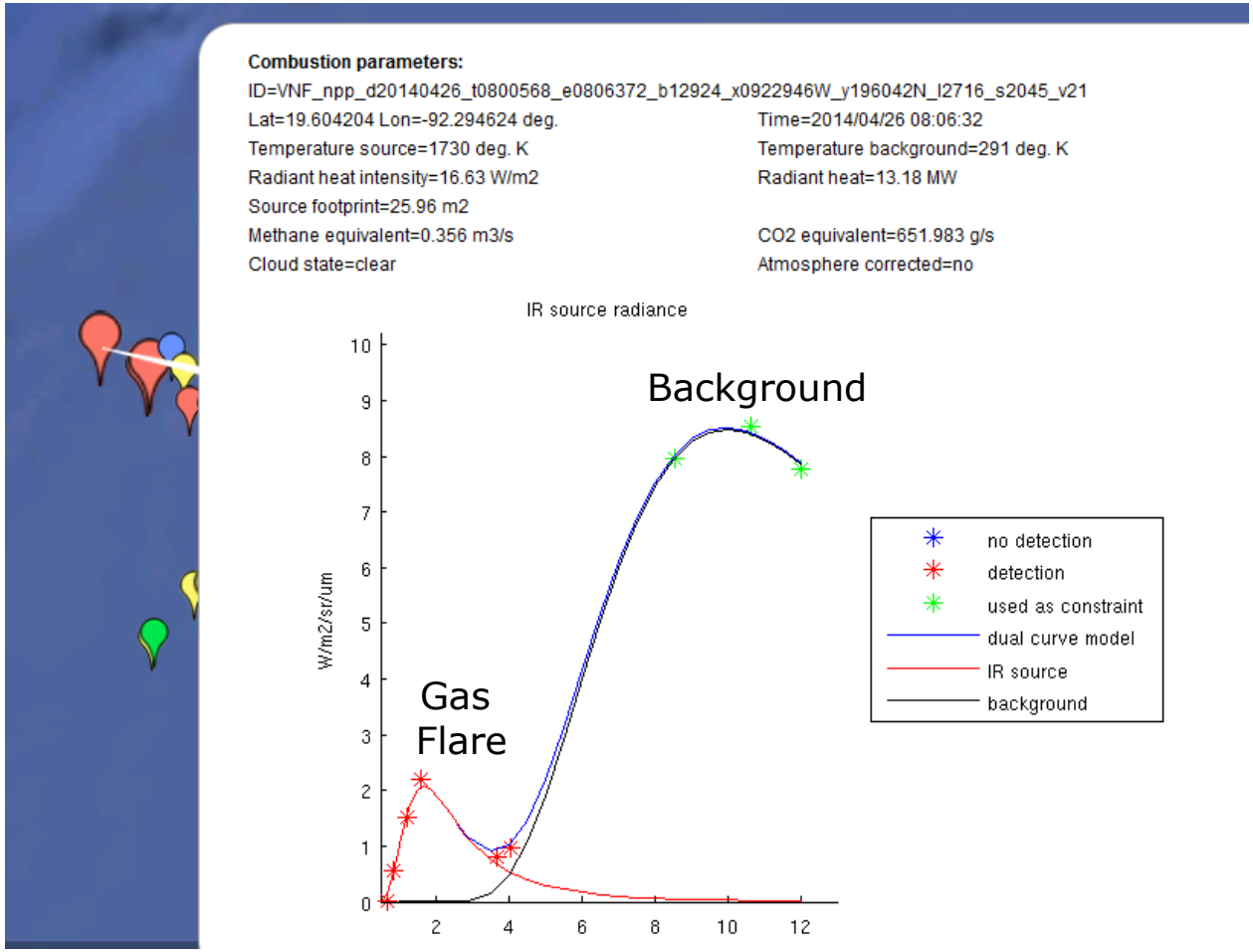
Boat detection data (points)



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?
  - Five independent IR source detection algorithms:
    - M7,8,10 & 11 mean plus x std. devs.
    - 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

Why Multispectral?

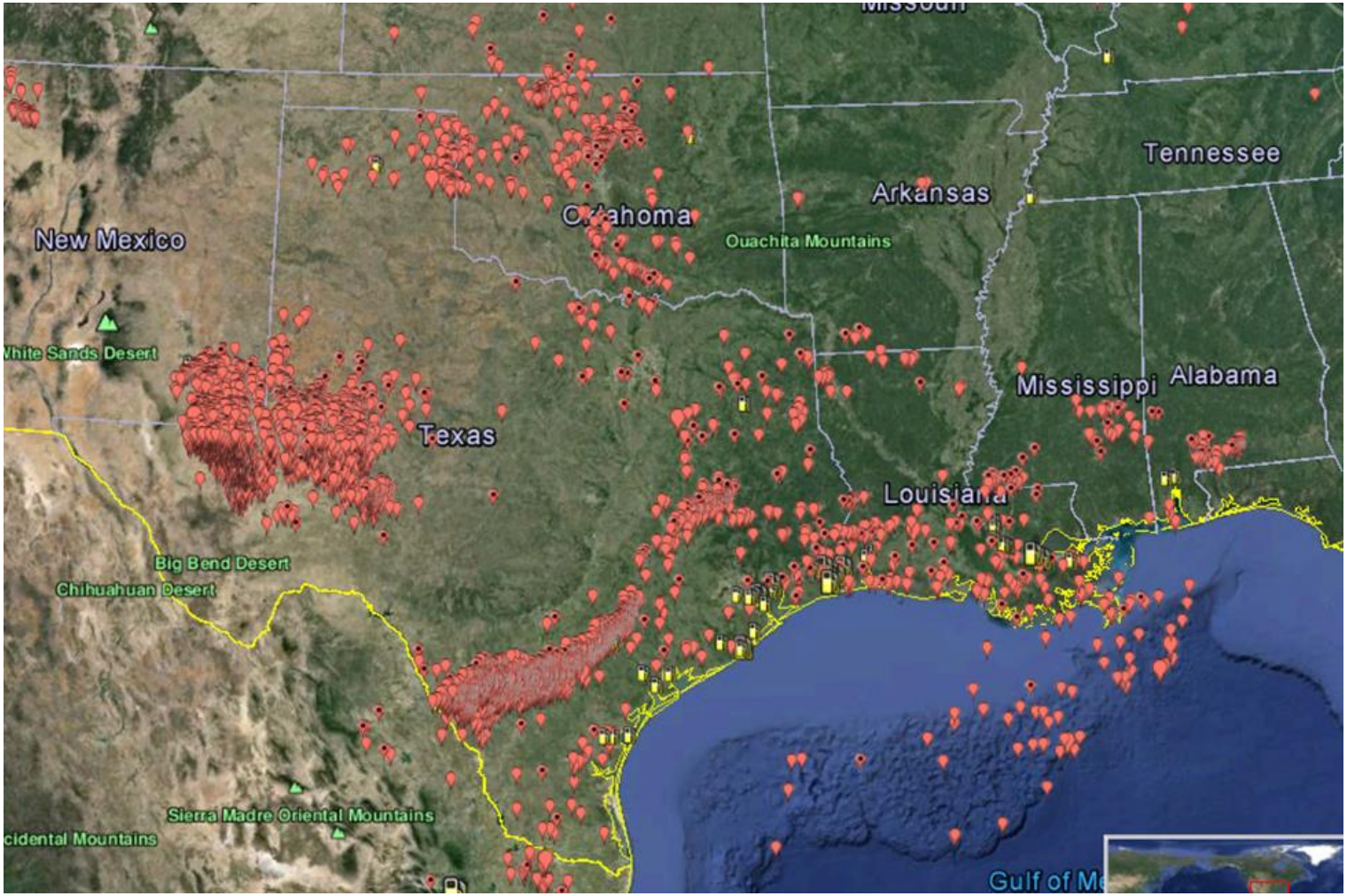


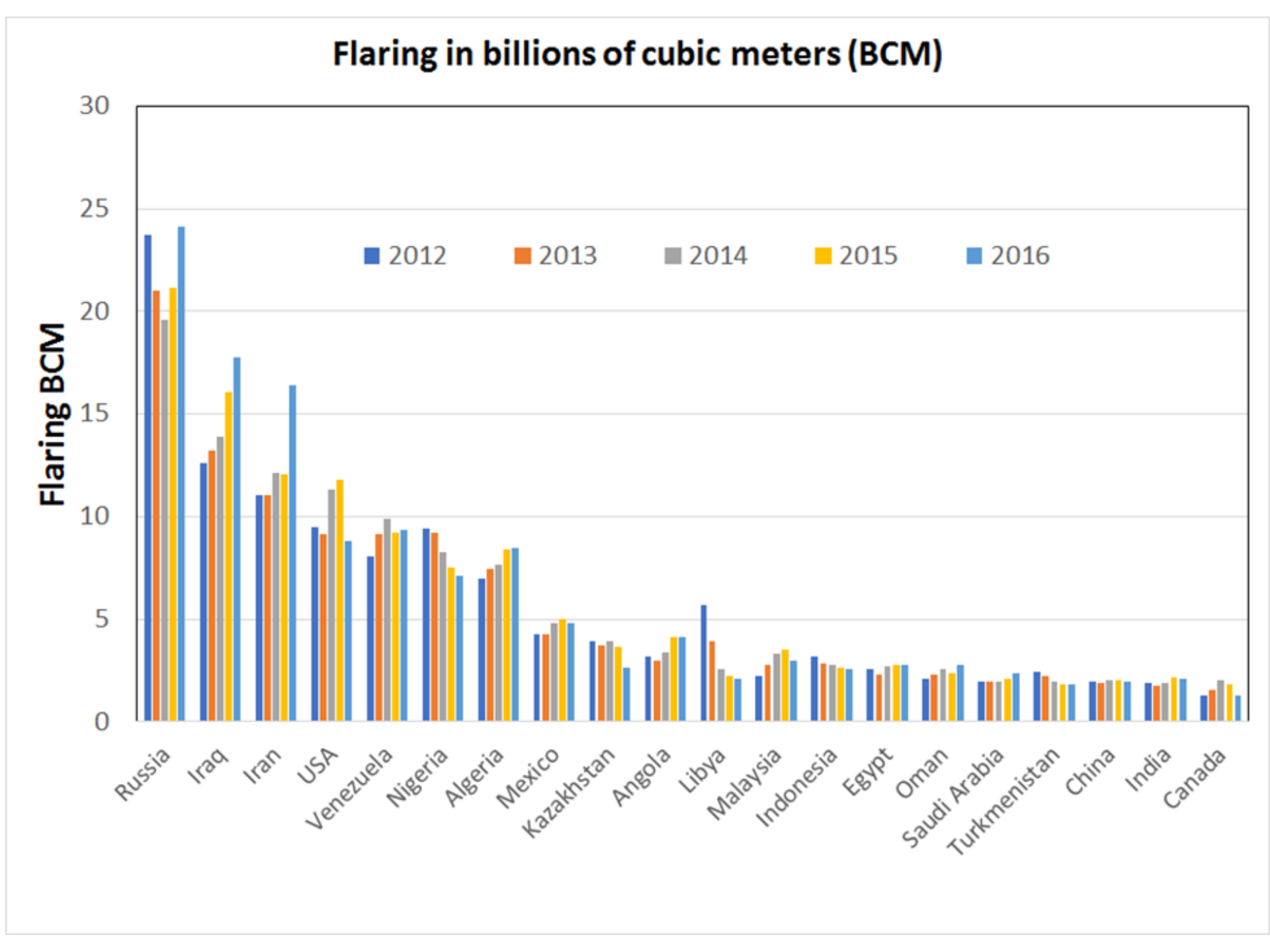
To get at the Planck curves!

Daily files are in csv and kmz formats

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

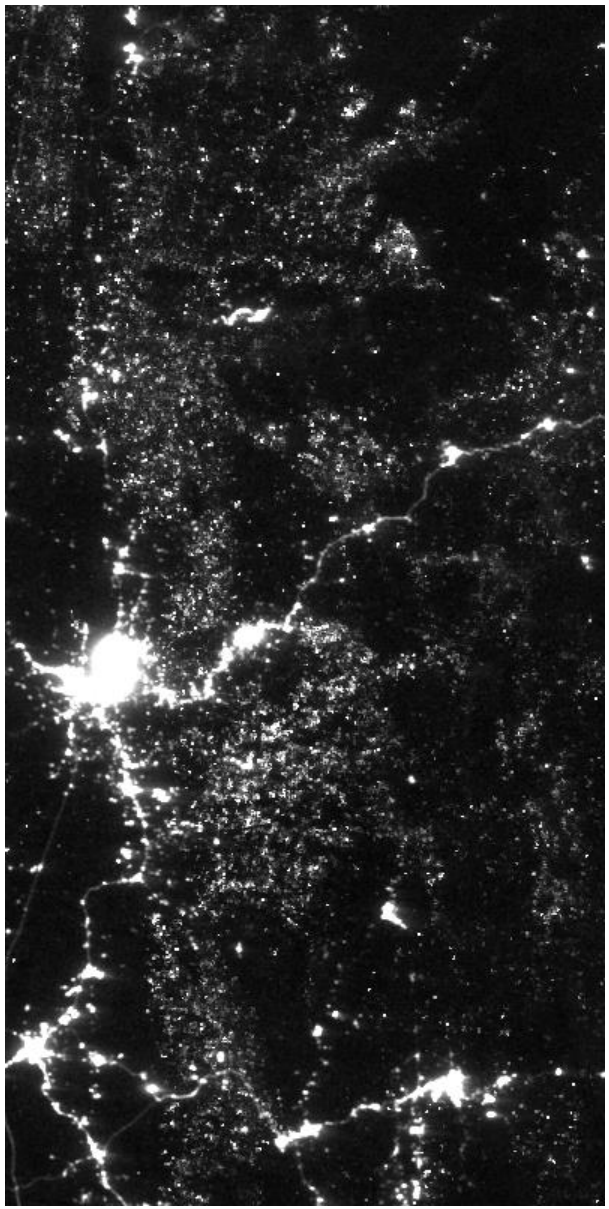
VIIRS Nighttime Lights (VNL)



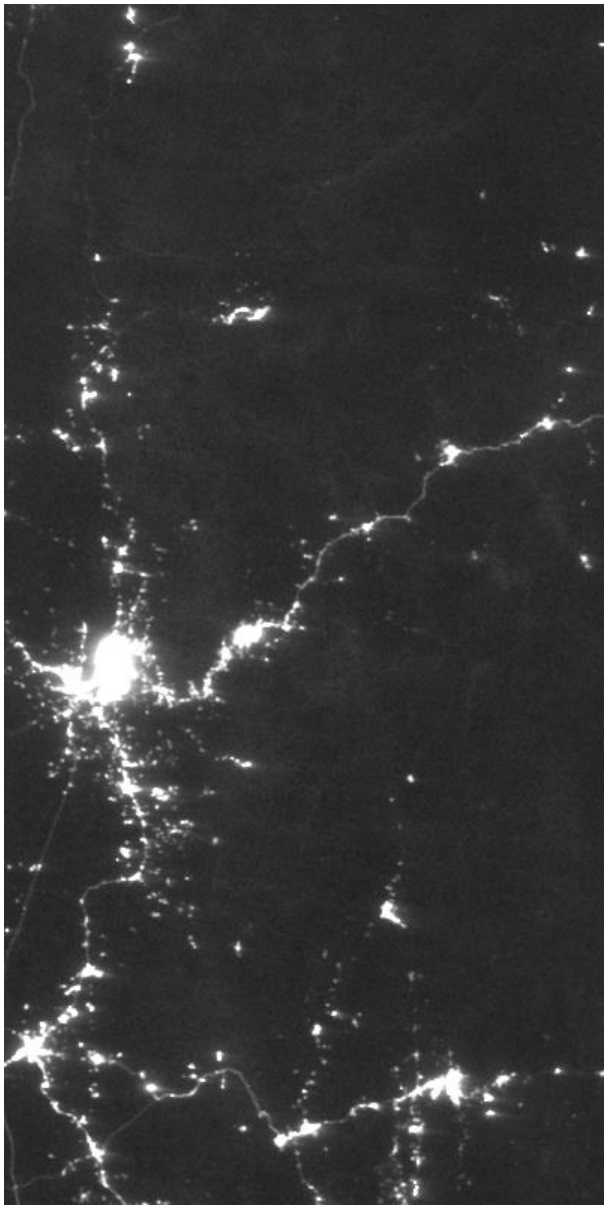
- Raw cloud-free composite: Average DNB radiance filtered to remove sunlit, moonlit, cloudy, and lightning.
- Outlier removal to filter out the biomass burning and most of the aurora contamination.
- VIIRS nighttime lights: Filtered to remove background noise and manual editing to removed remaining aurora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

VIIRS Nighttime Lights (VNL)

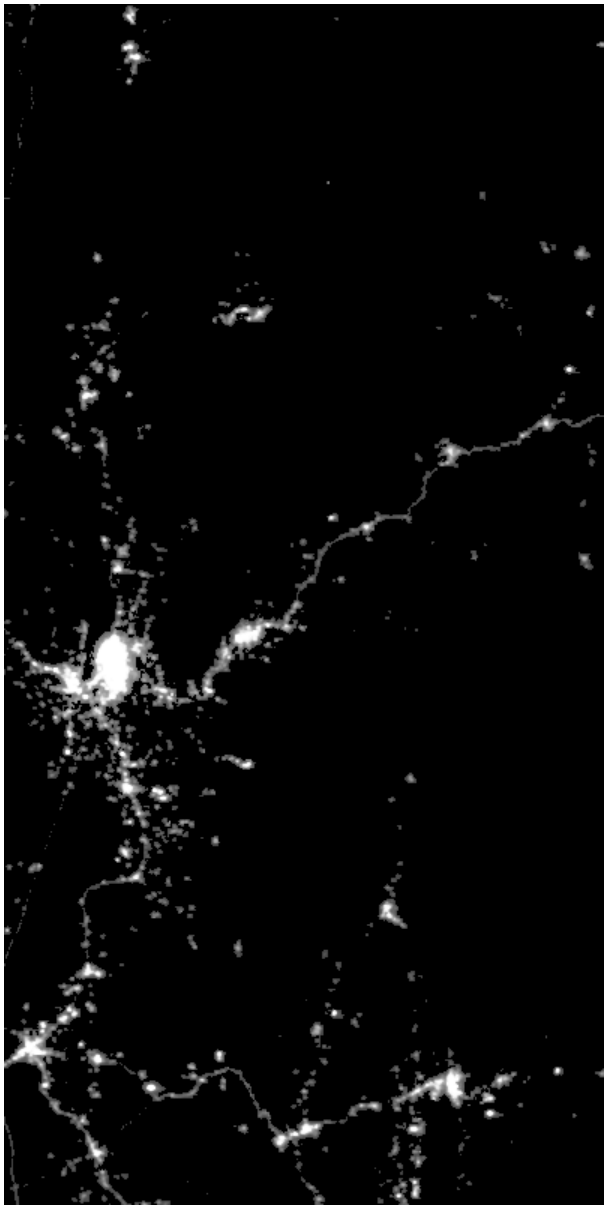
Raw cloud-free composite



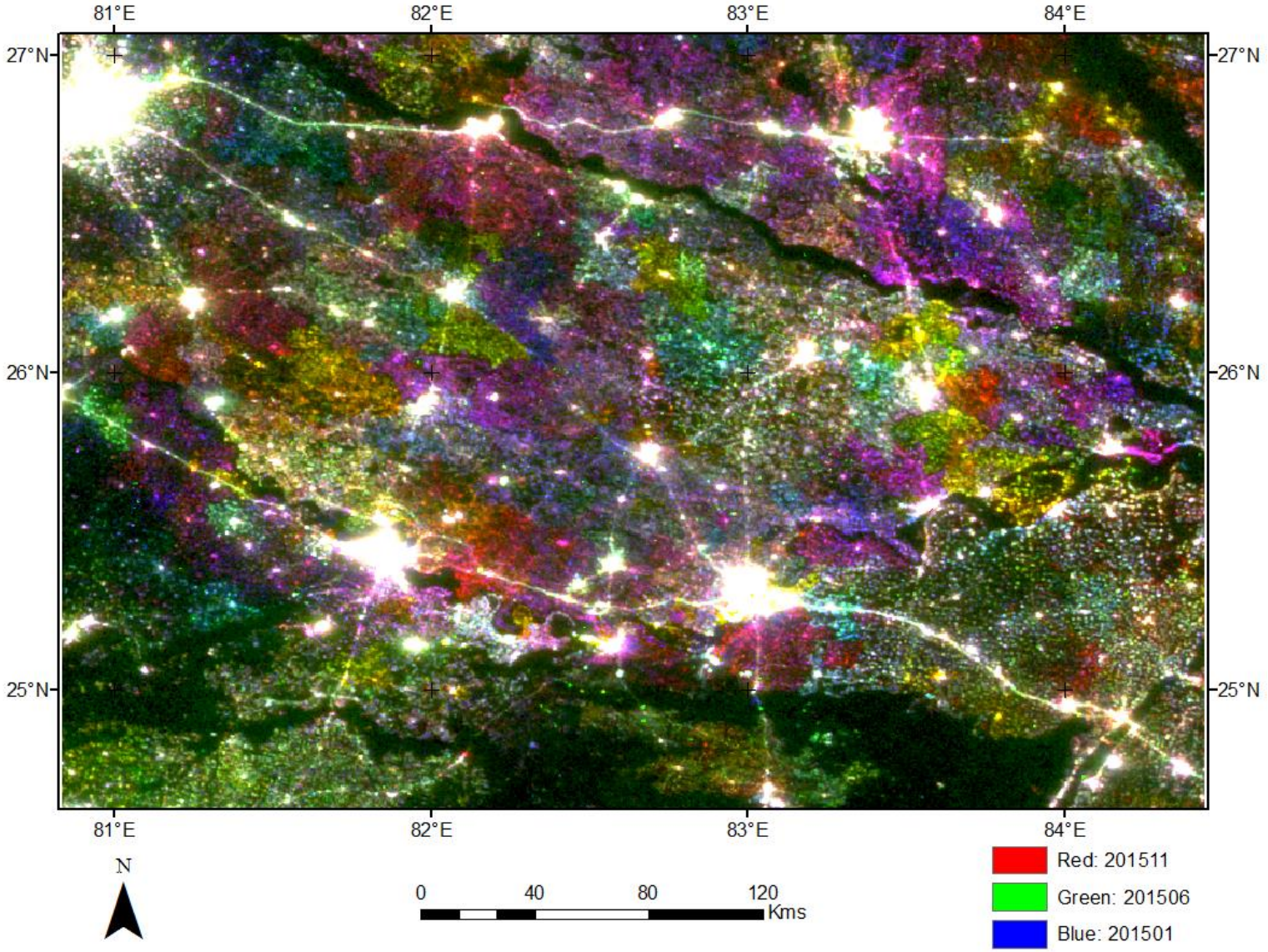
Outlier removed

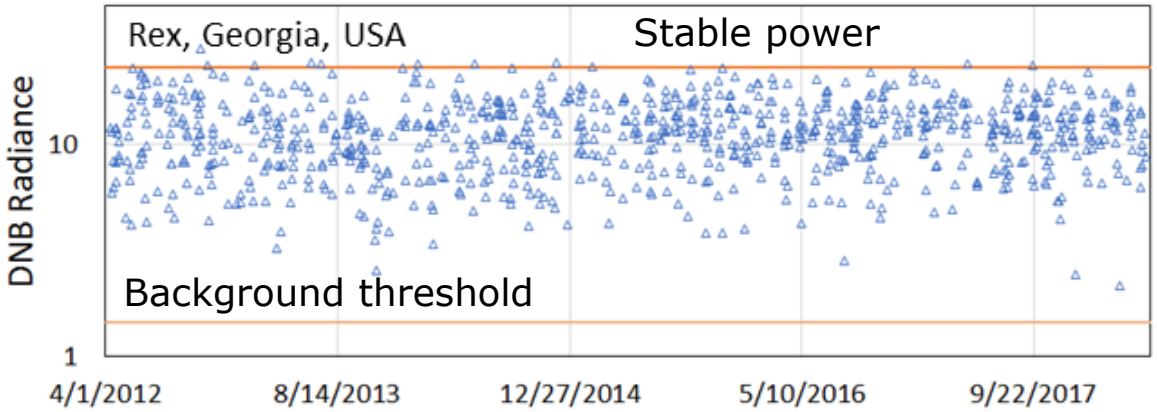


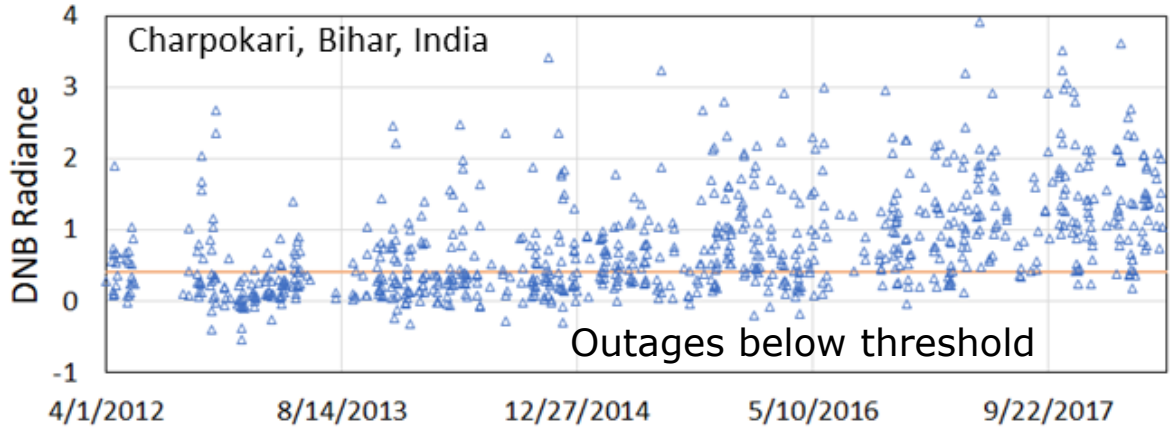
Nighttime lights

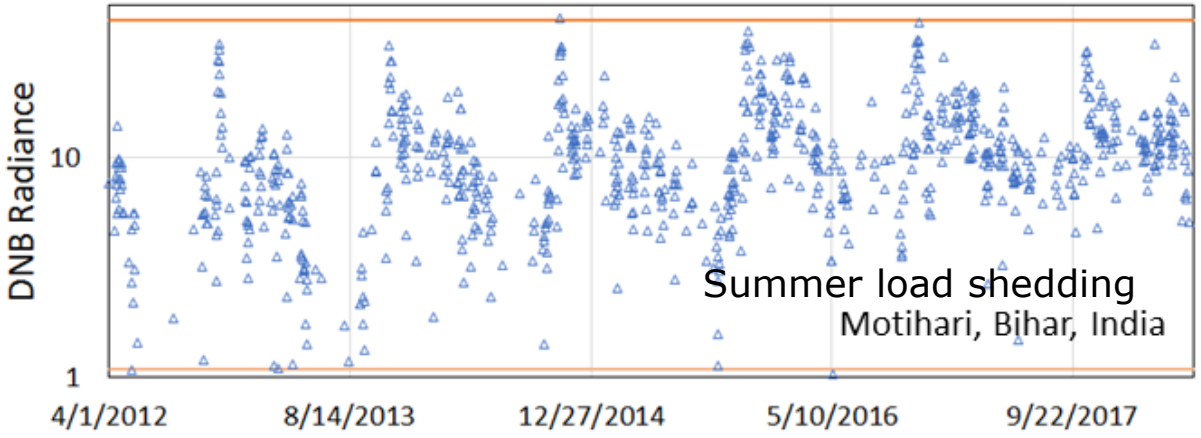


Power instability in India



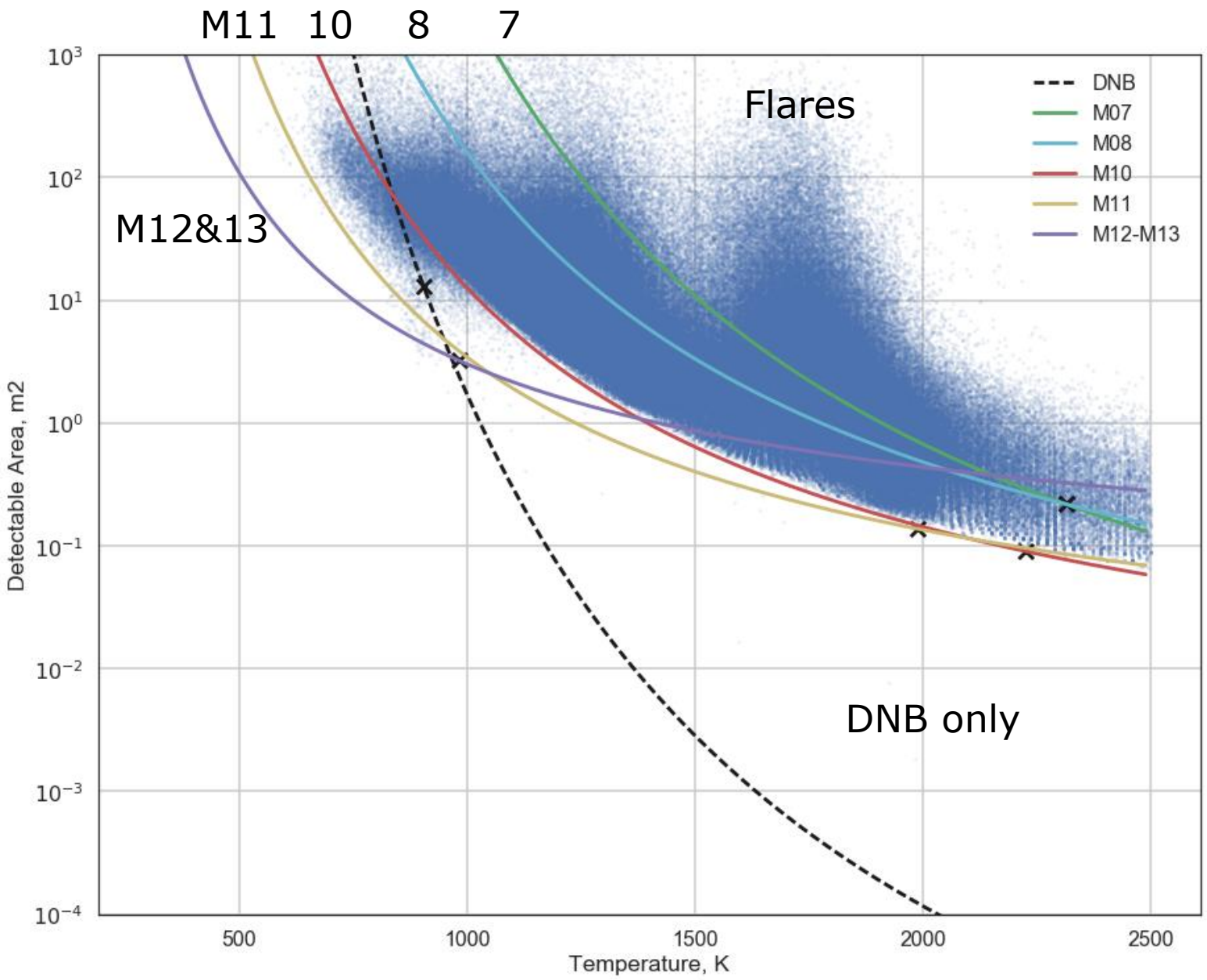






Temporal profiles reveal electric power instabilities

Does DNB detect IR sources unseen by M bands? Yes!



Future Plans

- Continue global product generation for VNL, VNF and VBD.
- R&D on separating flaming from smoldering in VNF (JPSS proving ground project).
- Develop a DNB fire product to augment VNF.
- Develop a DNB road product for use in rating infrastructure connectivity between urban centers.
- Develop an annual power stability index with monthly near real time updates.
- Develop alert system for power outages.

Recent Publications

- Elvidge, C. D., Bazilian, M. D., Zhizhin, M., Ghosh, T., Baugh, K., & Hsu, F. C. (2018). The potential role of natural gas flaring in meeting greenhouse gas mitigation targets. *Energy Strategy Reviews*, 20, 156-162.
- Elvidge, C.D., Ghosh, T., Baugh, K., Zhizhin, M., Hsu, F.C., Katada, N.S., Penalosa, W., Hung B.Q. (2018) Rating the effectiveness of fishery closures with Visible Infrared Imaging Radiometer Suite boat detection data. *Frontiers in Marine Science, section Marine Conservation and Sustainability*, 5, 132.
- Do, Q-T, Shapiro, J.N., Elvidge, C.D., Abdel-Jelild, M., Ahne, D.P., Baugh, K., Hansen-Lewis, J., Zhizhin, M., Bazilian, M. (2018). Terrorism, geopolitics, and oil security: Using remote sensing to estimate oil production of the Islamic State. Energy Research & Social Science, (*in press*).
- Small, C., Sousa, D., Yetman, G., Elvidge, C., & MacManus, K. (2018). Decades of urban growth and development on the Asian megadeltas. *Global and Planetary Change* 165, 62-89.
- Kyba, C.C., Kuester, T., de Miguel, A.S., Baugh, K., Jechow, A., Hölker, F., Bennie, J., Elvidge, C.D., Gaston, K.J. and Guanter, L., (2017). Artificially lit surface of Earth at night increasing in radiance and extent. *Science advances*, 3(11), p.e1701528.
- Coscieme, L., Sutton, P. C., Anderson, S., Liu, Q., & Elvidge, C. D. (2017). Dark Times: nighttime satellite imagery as a detector of regional disparity and the geography of conflict. *GIScience & Remote Sensing*, 54(1), 118-139.
- Elvidge, C. D., Baugh, K. E., Zhizhin, M., Hsu, F -C., & Ghosh, T. (2017). VIIRS night-time lights. *International Journal of Remote Sensing*, 38(21), 5860-5879.
- Elvidge, C. D., Zhizhin, M., Baugh, K. E, Hsu, F -C., & Ghosh, T. (2015). Methods for global survey of natural gas flaring from Visible Infrared Imaging Radiometer Suite Data. *Energies*, 9(1), 1-15.
- Elvidge, C. D., Zhizhin, M., Hsu, F -C., Baugh, K. E., Khomarudin, R., Vetrita, Y., Sofan, P., Suwarsano, S., & Hilman, D. (2015). Long-wave infrared identification of smoldering peat fires in Indonesia with nighttime Landsat data. *Environmental Research Letters*, 10(6), 1-12.
- Elvidge, C. D., Zhizhin, M., Baugh, K. E., & Hsu, F -C (2015). Automatic boat identification system for VIIRS Low Light Imaging Data. *Remote Sensing*, 7(3), 3020-3036.
- Elvidge, C. D., Zhizhin, M., Hsu, F -C., & Baugh, K. (2013).VIIRS nightfire: Satellite pyrometry at night. *Remote Sensing 5*(9), 4423-4449.

JPSS Products from Direct Broadcast in Alaska

2018 UPDATE

CARL DIERKING & JAY CABLE

UAF / GINA

Direct Broadcast Products from GINA

Satellite Sensors

- SNPP and NOAA-20
  - VIIRS
  - ATMS
- Terra and Aqua MODIS
- NOAA-19, NOAA-18, NOAA-15, MetOp
  - AVHRR
  - AMSU

Product Types

- AWIPS single band products (RGBs created on AWIPS client)
- GeoTiff single bands and RGBs (ASIP, AFS)
- SDRs (AVO, CIMSS, CIRA, SPoRT)

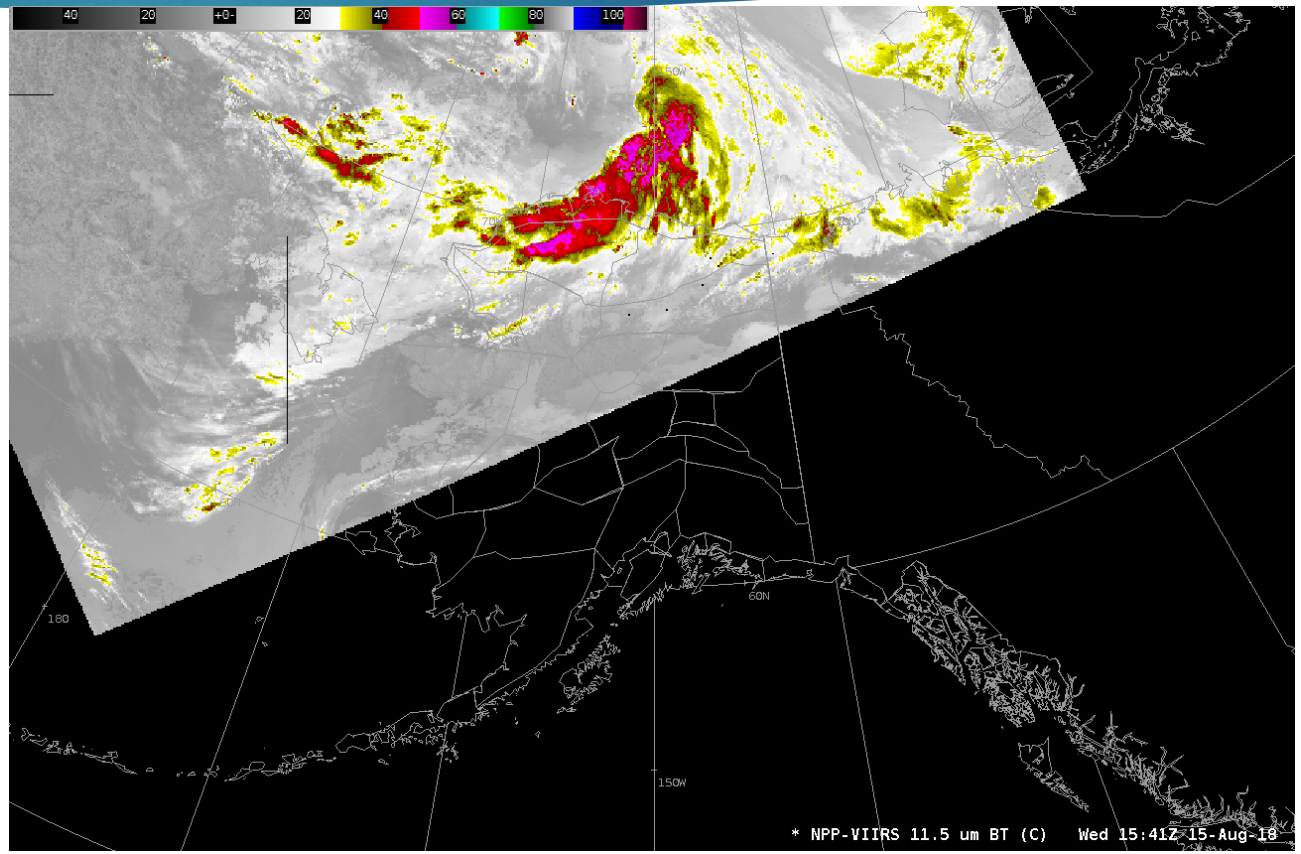
N-20 Products Currently Received at NWS

- Single Bands
- RGBs generated on AWIPS client
- River Flood (Sanmei Li)
- GeoTiff imagery for GIS (ASIP, RFC)
- NUCAPS*

** Recently fixed problem with long processing times*

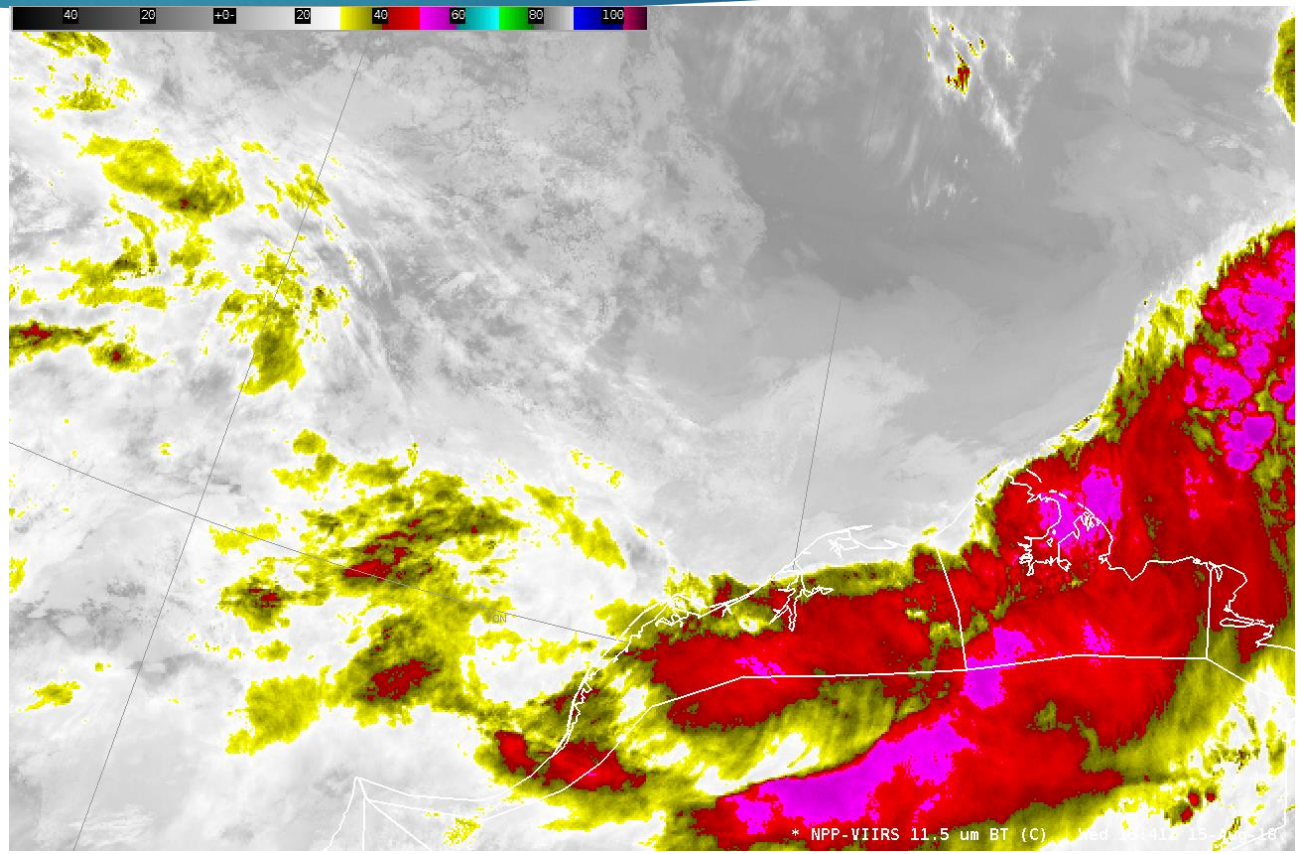
NOAA-20 & SNPP - Double Image Frequency

- Two satellite combination doubles image coverage over Alaska
- Northern Alaska - around 18 passes per day.
- Southern Alaska - 3-4 early morning and 3-4 afternoon passes per day.
- Negligible difference between SNPP and NOAA-20



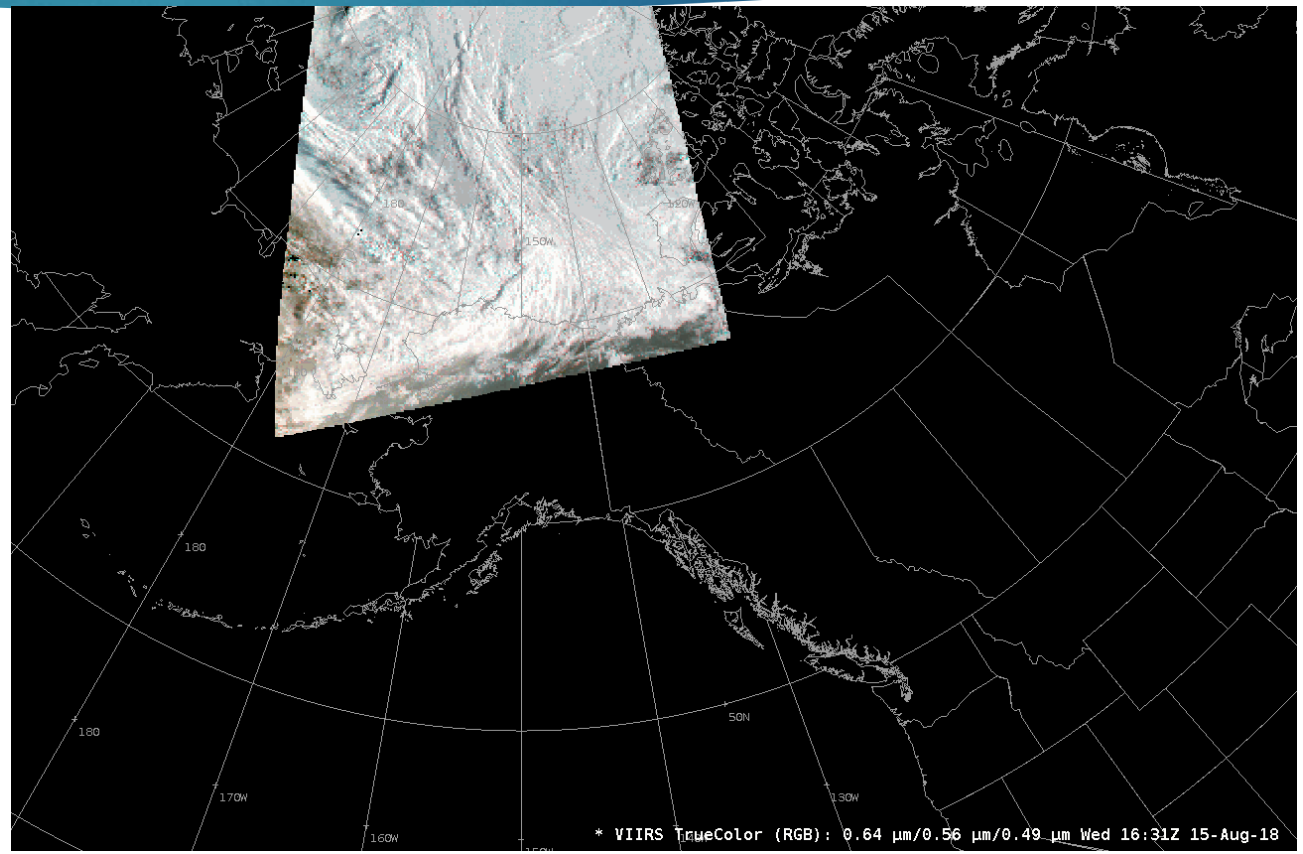
Consistent Coverage over the Arctic

- Nearly continuous coverage over Alaska's northern coast
- Pass frequency ~ 50 min
- I-band resolution 375 m with minimal parallax



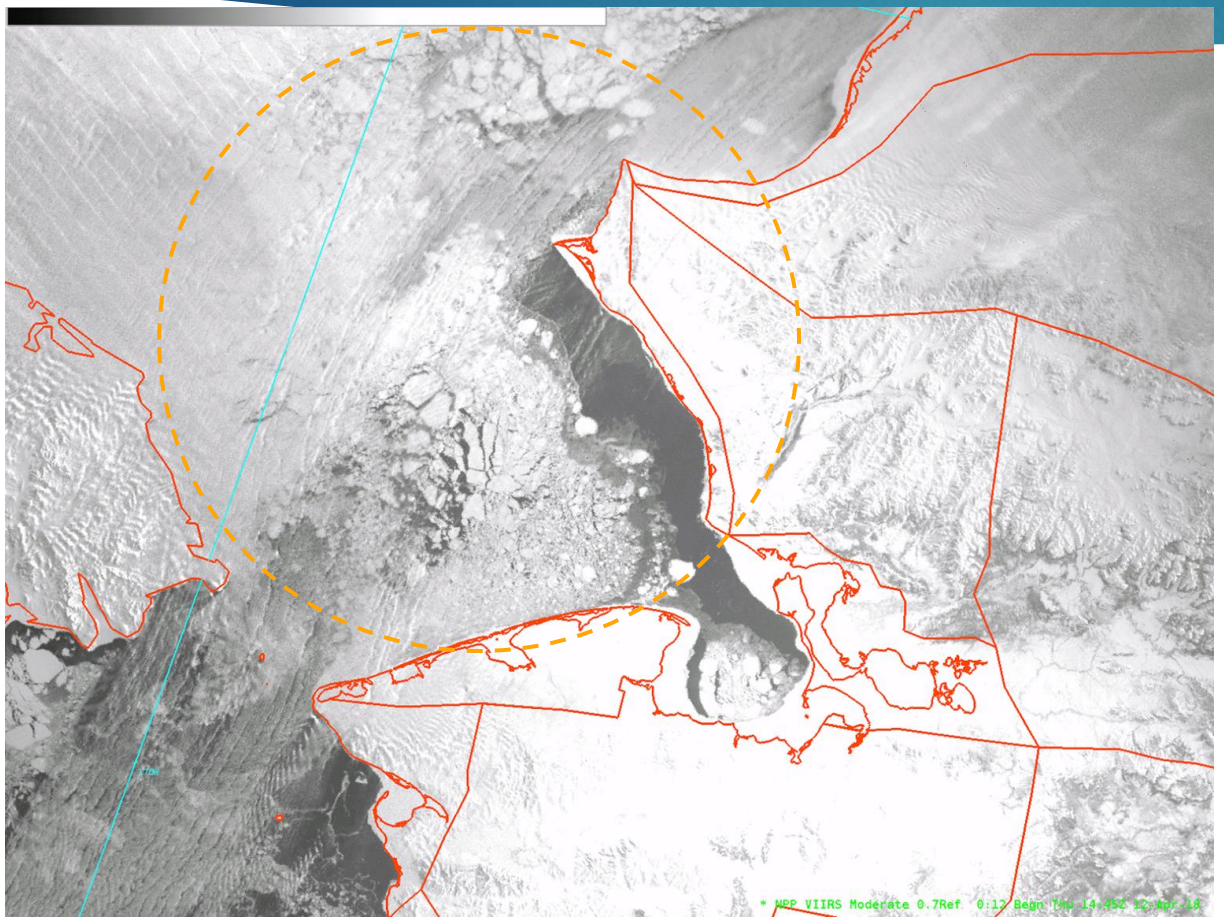
NOAA-20 & SNPP - Double Image Frequency

- Good daytime coverage of reflectance channels
- Improved support for Fire weather and Sea Ice programs



TrueColor RGB: Red=0.64 µm Green=0.56 µm Blue=0.49 µm

NOAA-20 DNB Imagery



Tracking sea ice movement:

April 12, 2018

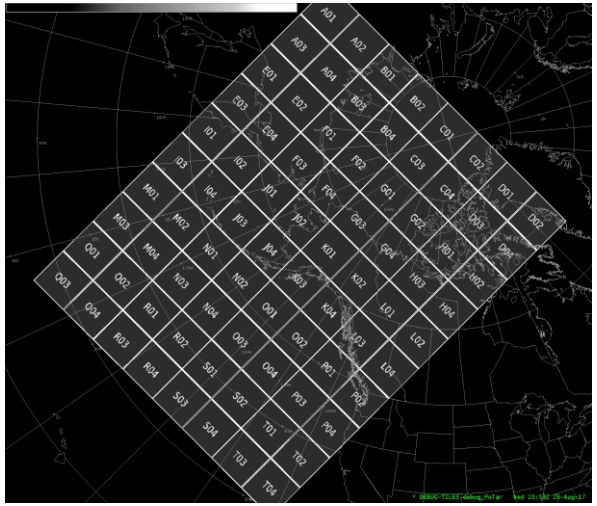
- 14:45z
- 16:25z
- 18:01z
- 19:37z
- 21:22z
- 23:00z

Melissa Kreller (WFO Fairbanks)
@ JPSS Arctic Summit May 8

Conversion to SCMI Tile Format

Benefits

- Full Resolution & precision (375m/750m)
- Previous "regionalsat" format restricted to 1 km and 8-bit unsigned chars.
- Same ingest process as GOES-R series
- Only tiles with data are distributed
- Provided to the NWS late June



Challenges

- Larger data files (1.5-2.0 GB per pass)
- More demand on Bandwidth
- Somewhat longer processing, delivery & display times.

Satellite Data Volume (AWIPS only)

SCMI Tiles

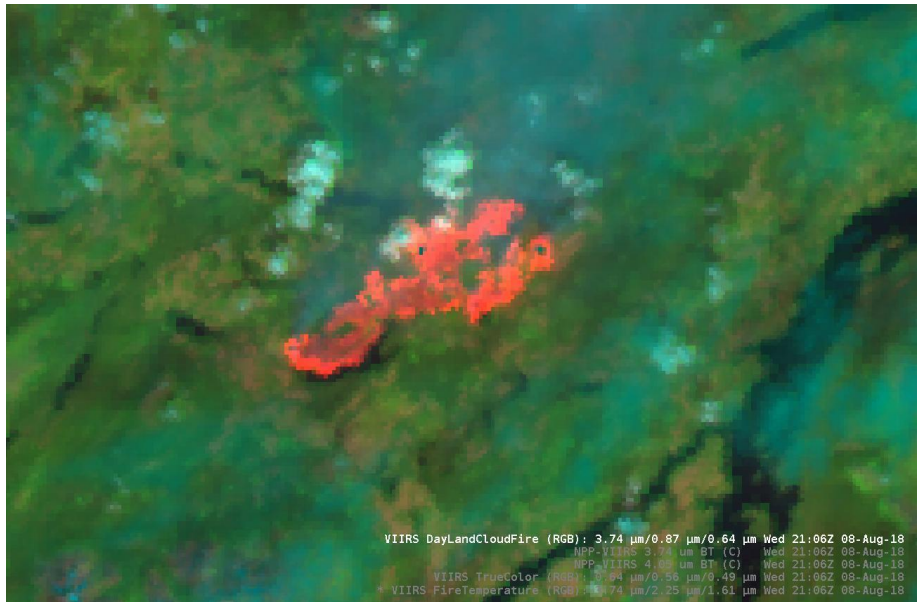
Avg File Size (MB)	Num Products	Week	Avg Daily Volume (GB)
1.82	212288	31	54.17
1.80	211100	32	53.13
1.75	14327	33	35.02 *

Regionalsat

Avg File Size (MB)	Num Products	Week	Avg Daily Volume (GB)
4.56	9259	31	5.90
4.38	9281	32	5.68
4.42	6332	33	3.91 (*)

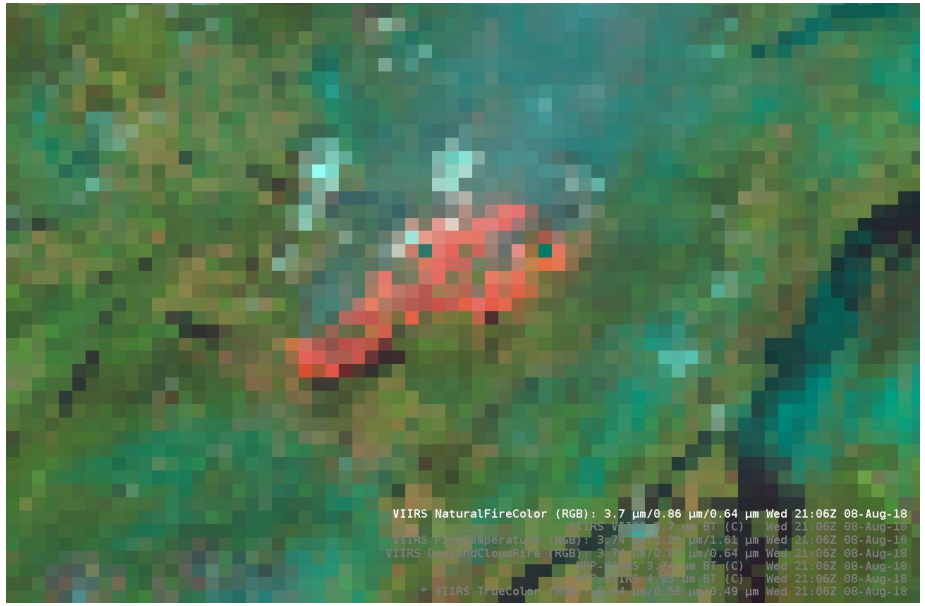
SCMI vs Regionalsat Formats

DayLandCloudFire RGB - SCMI



375 m resolution

DayLandCloudFire RGB - Regionalsat



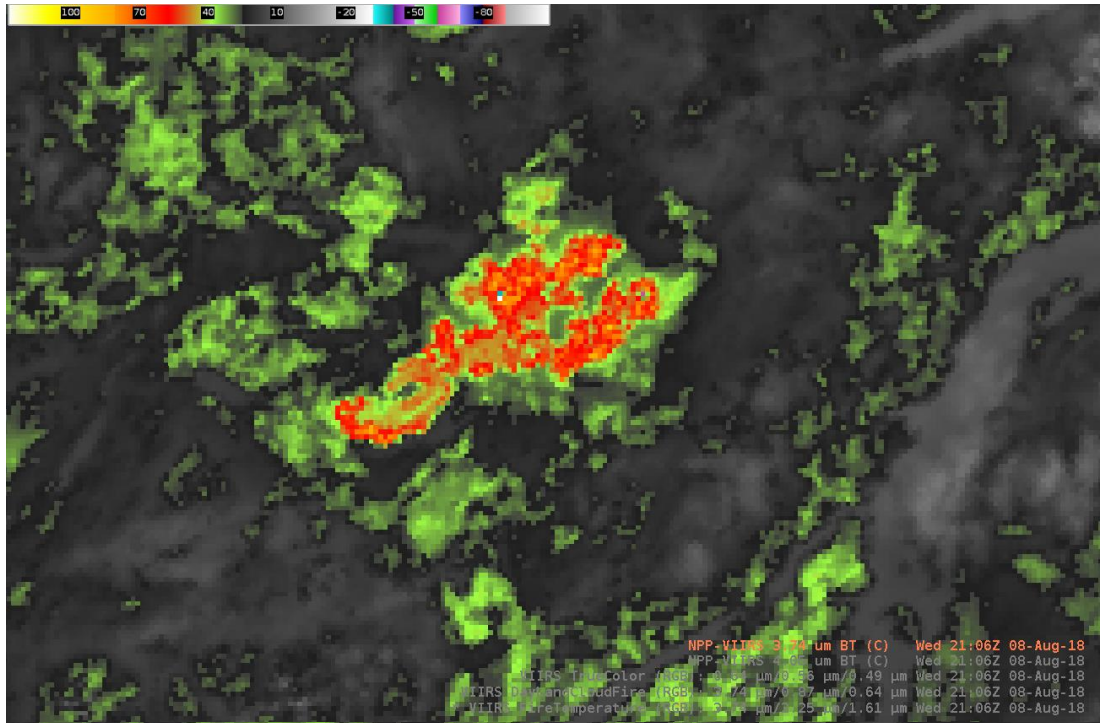
1 km resolution

DayLandCloudFire RGB*: Red=3.74 µm Green=0.87 µm Blue=0.64 µm

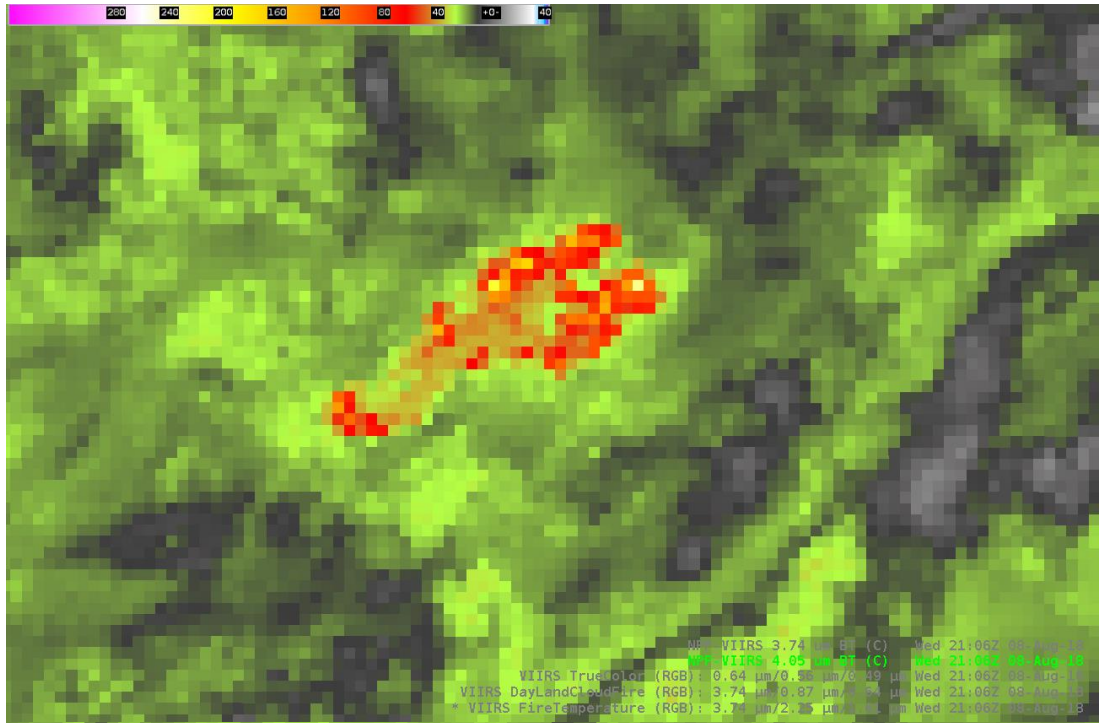
**** Also called: NaturalFireColor RGB***

VIIRS in the 2018 Fire Season

NOAA-20 2018 08 Aug 2018



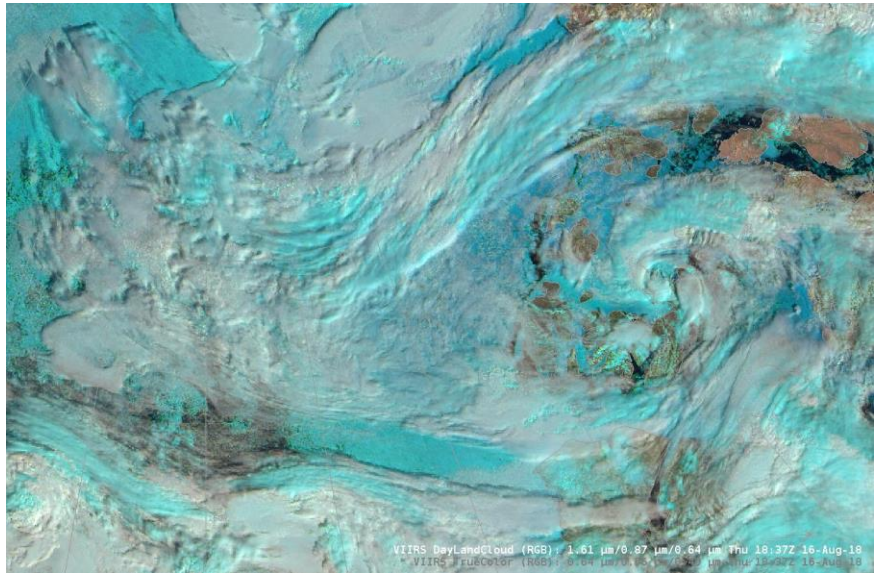
VIIRS I04 (3.74 µm)



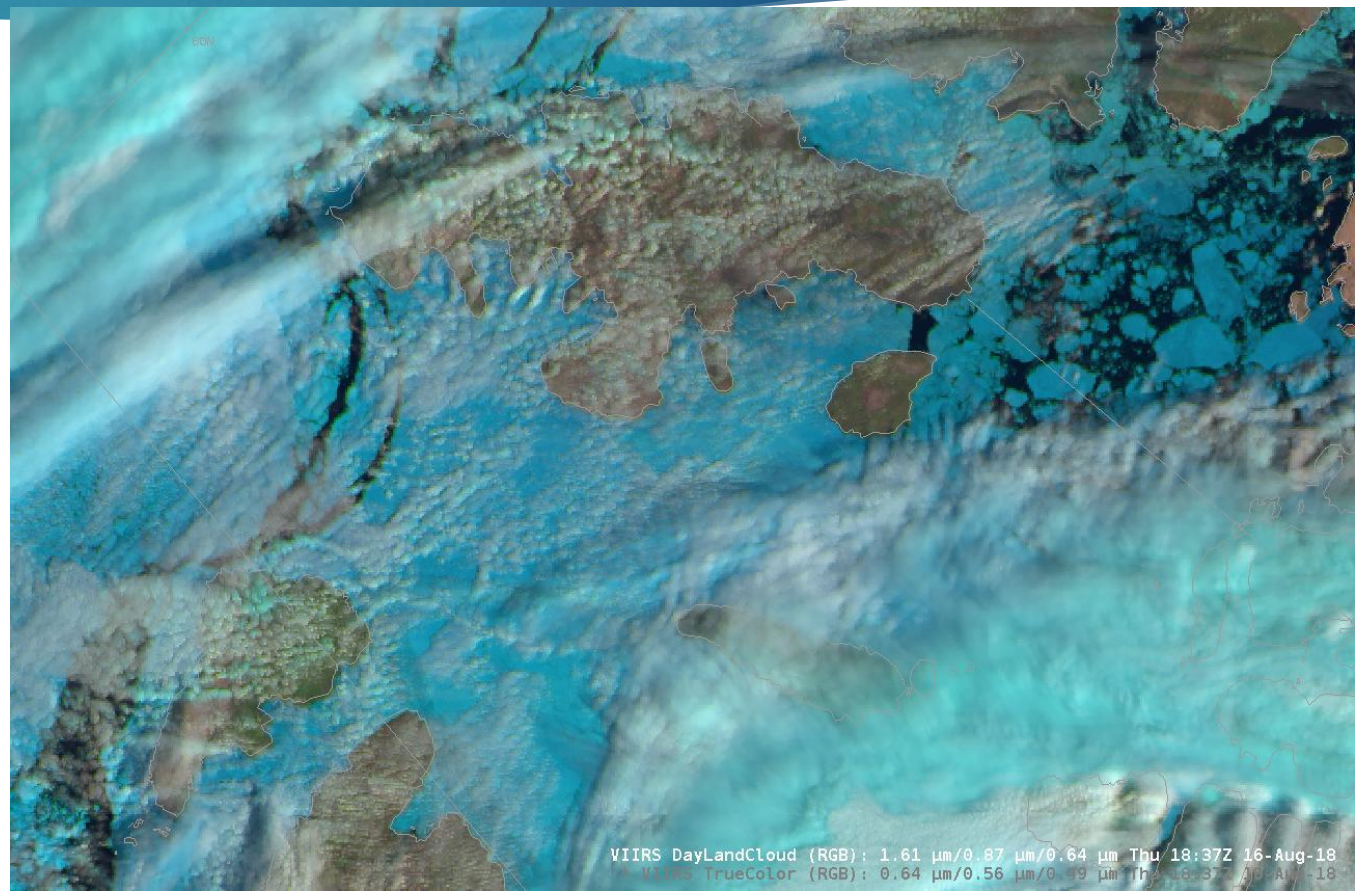
VIIRS M13 (4.05 µm)

VIIRS on Ice: DayLandCloud RGB

16 Aug 2018 (Banks Is. Prince Patrick Is.)
1750z SNPP / 1837z N-20



DayLandCloud RGB (or Natural Color RGB):
Red=1.61 µm Green=0.87 µm Blue=0.64 µm



Support/Partnership for CI Development

- CIMSS:
  - River Flood and River Ice Products
  - Volcanic Ash Products
  - Low stratus and fog
- SPoRT:
  - Limb and Bias corrected RGBs
  - Gridded NUCAPS
- CIRA:
  - FireTemperature RGB & DayLandCloudFire RGBs
  - SnowCloud Discriminator

- Direct Broadcast Data
- Servers, Virtual Machines (VM)
- Processing & Distribution
- Support

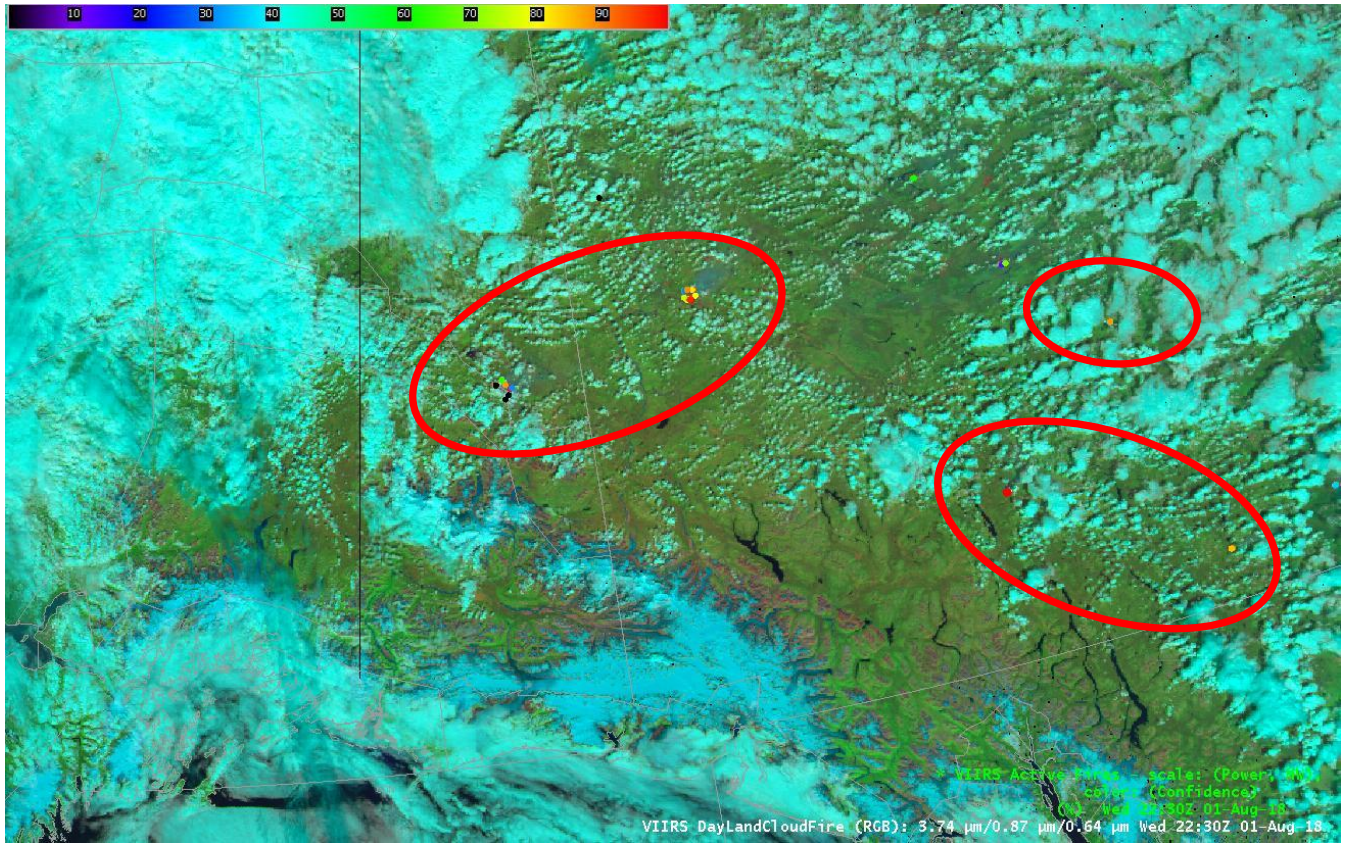
Support for JPSS Product Evaluations

- Arctic Initiative Demonstration project
  - April 2018
  - Evaluation of Sea ice products (Concentration, Thickness, Temperature, Motion)
- Aviation Initiative: Cloud Products Demonstration project
  - Planned for Sep or Oct
  - CLAVR-x cloud products

- Direct Broadcast Data
- Servers, Virtual Machines (VM)
- Processing and distribution
- Support

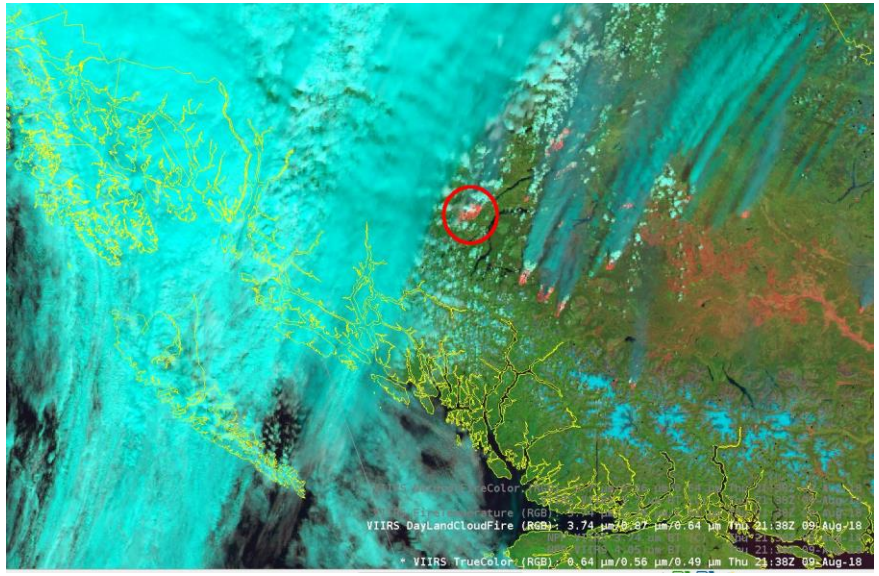
Active Fire Points

- Previously used NASA DRL software (requested by AFS)
- VIIRS Fire Point are now displayable in AWIPS
- GINA is converting to NOAA NDE Active Fire for processing

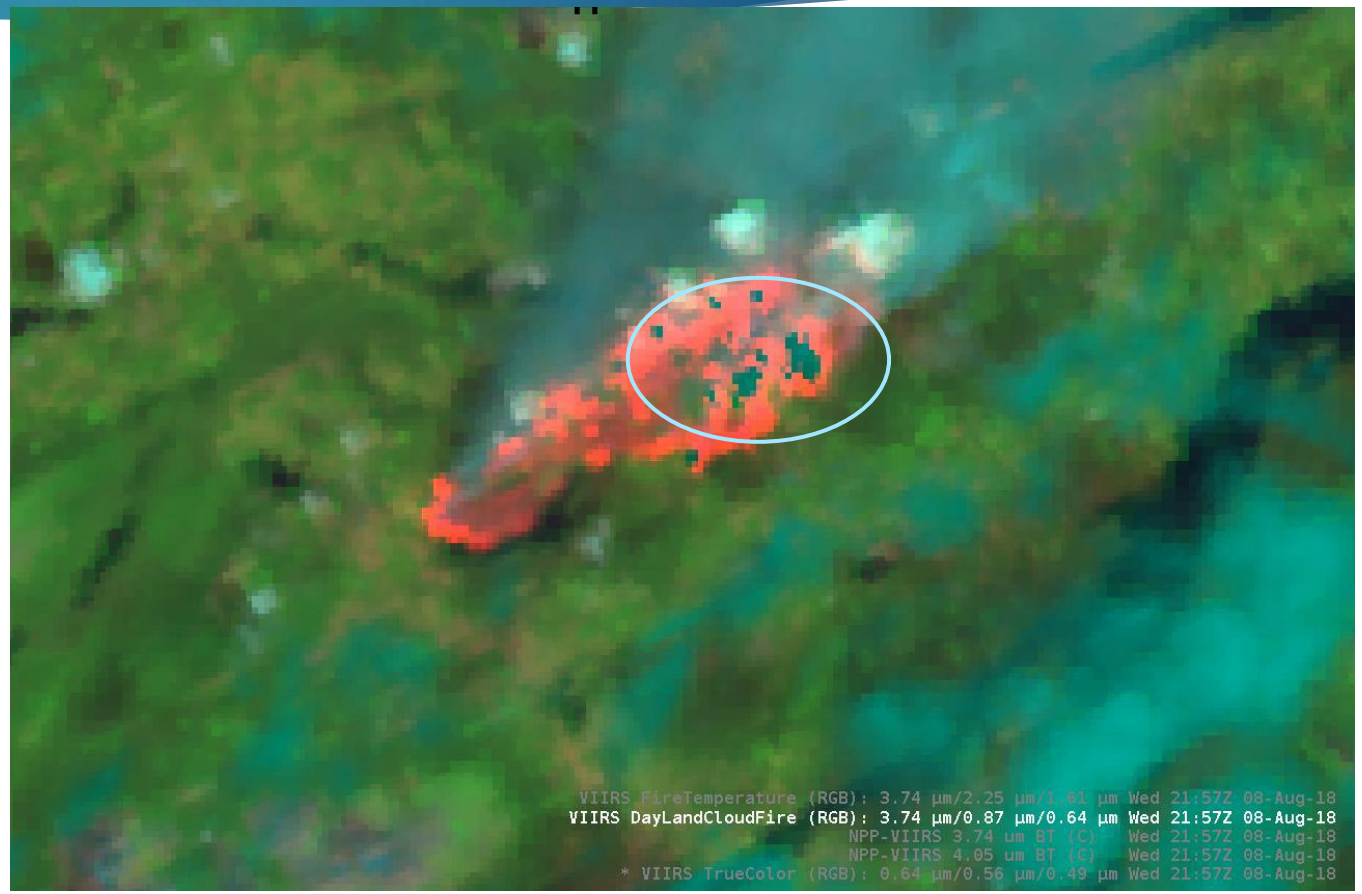


VIIRS in the 2018 Fire Season

08 Aug 2018
2017z SNPP / 2106z N20 / 2157z SNPP

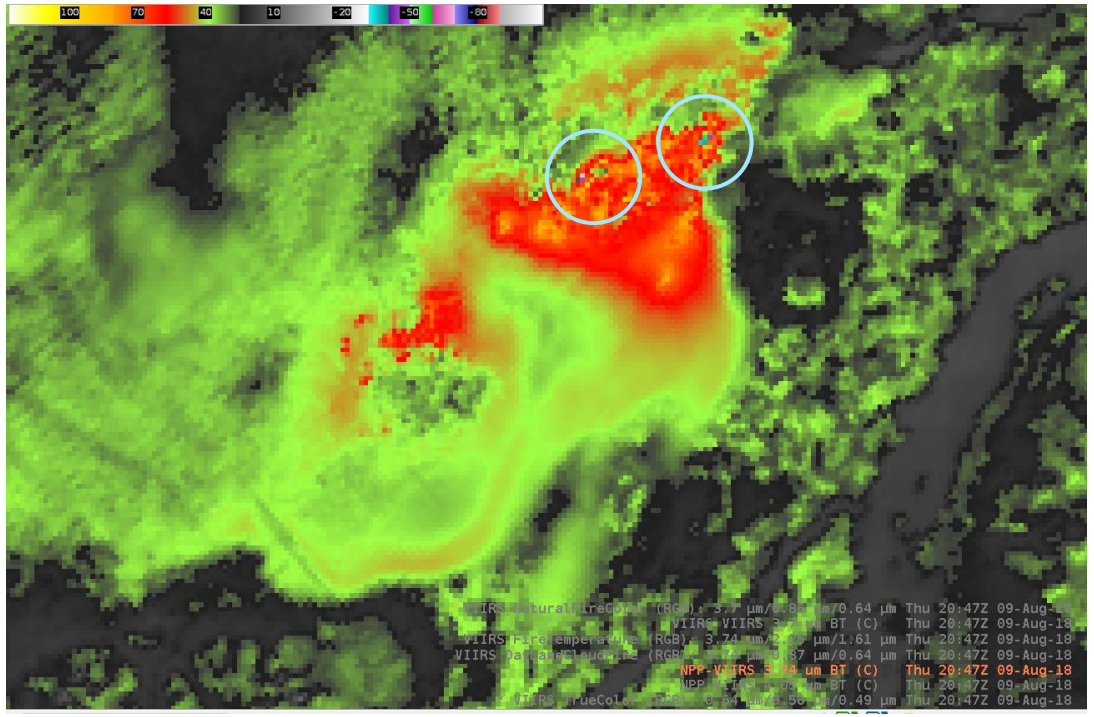


DayLandCloudFire RGB Recipe:
Red=3.74 µm Green=0.87 µm Blue=0.64 µm



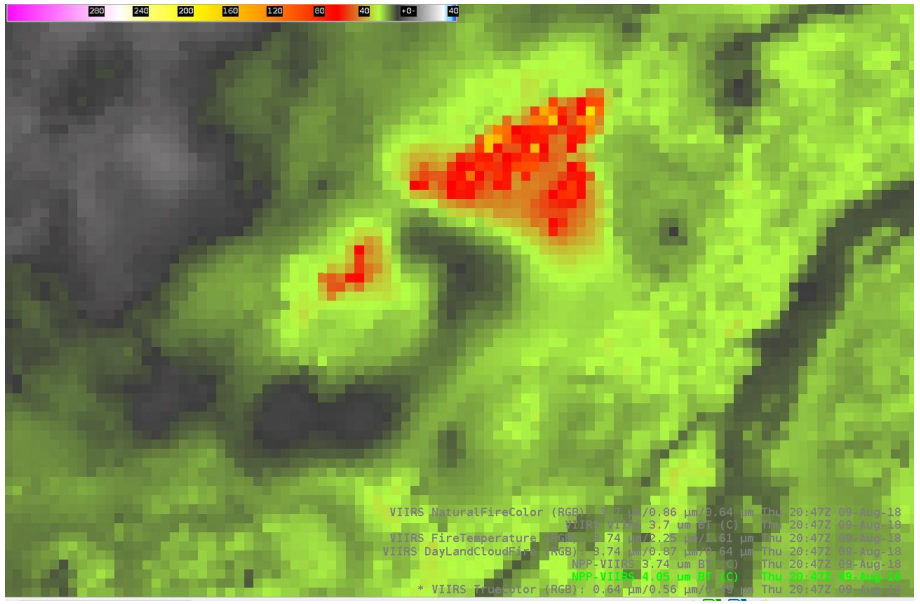
Sensor Saturation from Intense Fires

N-20 VIIRS I04 (3.74 µm) – 2047z 09 Aug 2018



Sensor Max 94 deg C

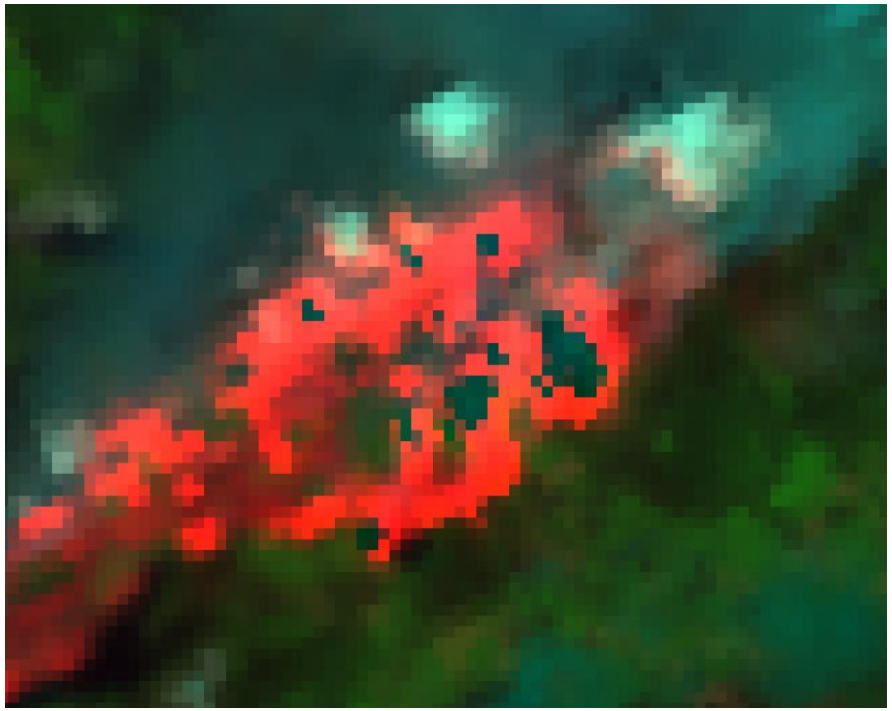
N-20 VIIRS M13 (4.05 µm) – 2047z 09 Aug 2018



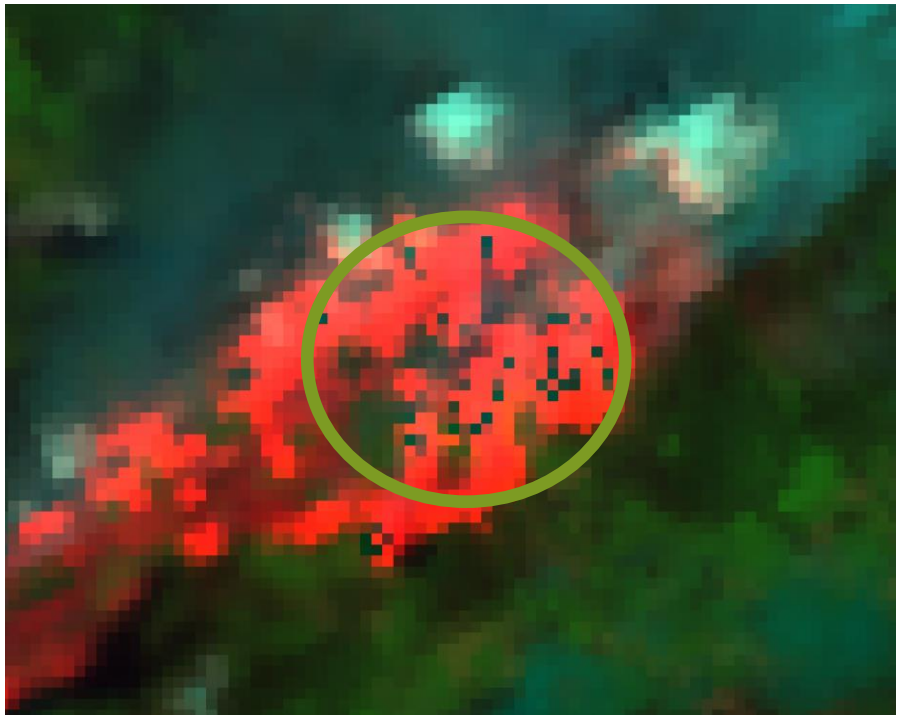
Sensor Max 360 deg C

VIIRS I04 Band Saturation Correction

DayLandCloudFire (3.74µm) – 2157z 08 Aug 2018



Uncorrected



Correction: Where I04 band < 0 and M13 band > 50

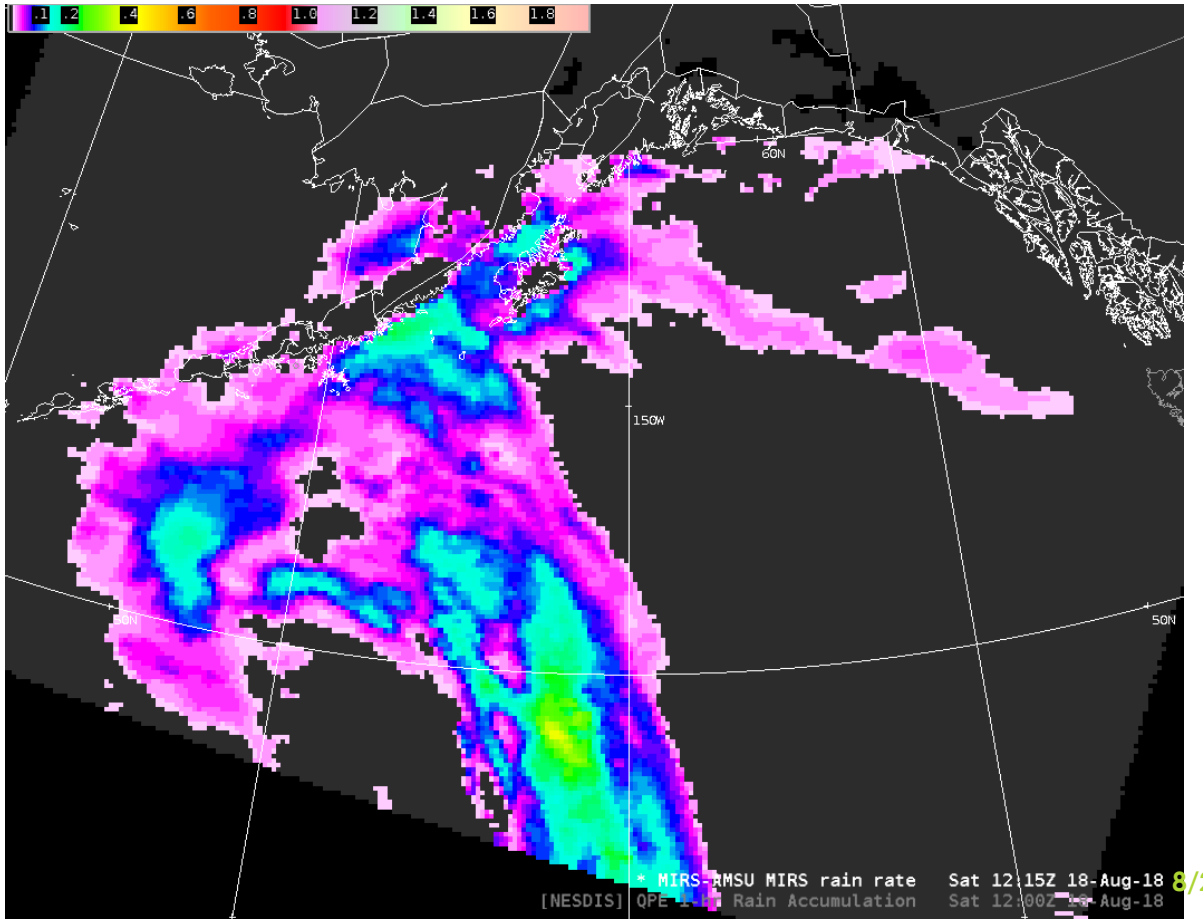
A few pixels still not being corrected.

Possibly due to SCMI reprojection.

MIRS

MIRS Products

- Rain Rate
- Total Precipitable Water (TPW)
- Cloud Liquid Water (CLW)
- Snow Water Equivalent (SWE)
- Sea Ice Concentration

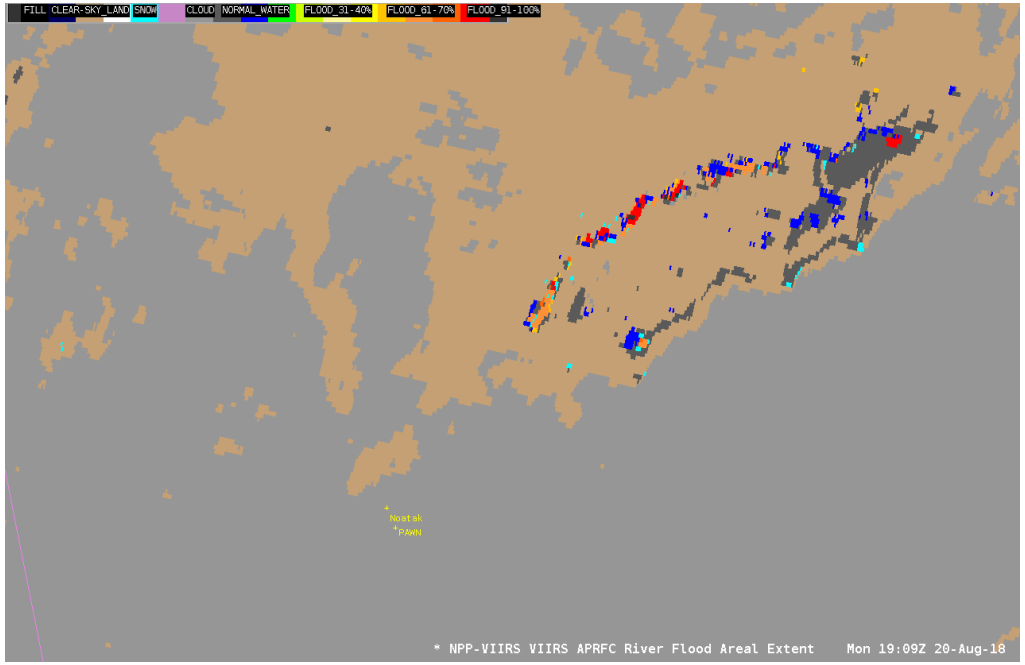


VIIRS River Flood Product

Sanmei Li (GMU) & Jay Hoffman (CIMSS)

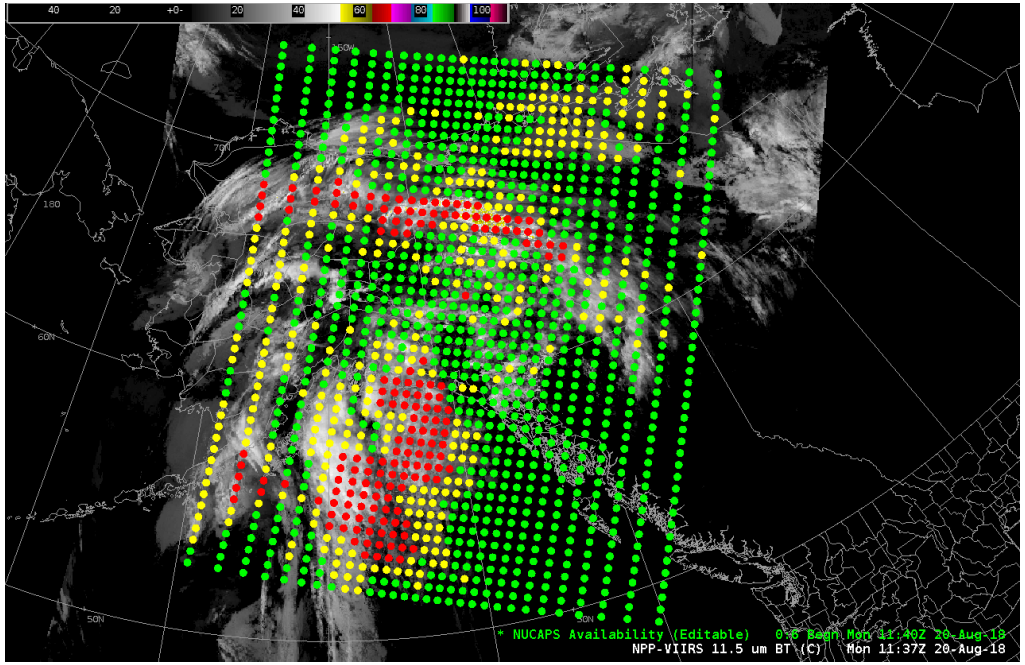


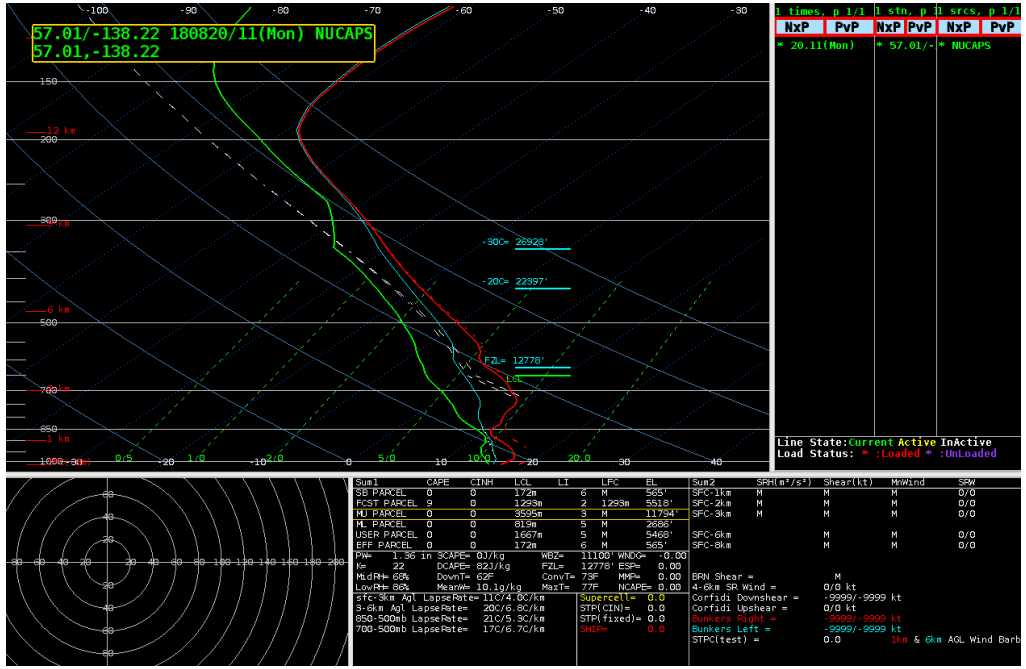
Noatak River – Noatak National Reserve



20 Aug 2018: SNPP 1821z / N20 1909z

CSPP NUCAPS





SNPP NUCAPS from CSPP - 1140z 20 Aug 2018

Processing time problem recently fixed

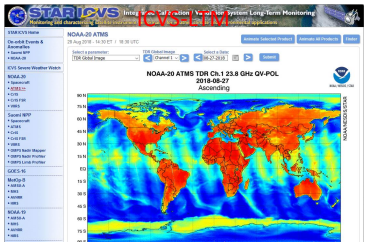
Future Plans

- Expand NOAA-20 products:
  - MiRS Microwave
  - River Ice Products (CCNY)
  - VIIRS Active Fire Points (I&M band)
- Distribute ACSPO SST products
- Evaluate CLAVR-x: JPSS Cloud Products Demonstration - Fall 2018

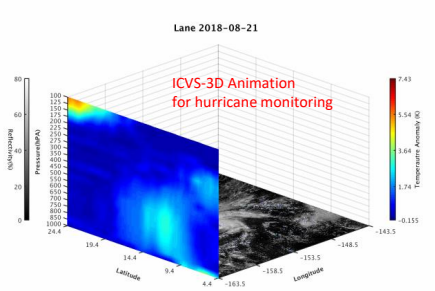
JPSS/STAR
Integrated Calibration/Validation System (ICVS): Status and Prospective

Banghua Yan*

NOAA/STAR/Satellite Calibration and Data Assimilation Branch



On behalf of ICVS Team



*Other contributors: Tong Zhu, Lihang Zhou, Mitch Goldberg, Arron Layns, Alexander Ignatov, Xinjia Zhou, Ryan Smith, Lori Brown, Tom Atkins, and STAR SDR/EDR teams

Outline

- **ICVS Team Members**
- **FY18 Accomplishments Highlight**
- **New ICVS Monitoring Capabilities Development**
  - Simultaneous Nadir Overpass (SNO) Intersensor Comparison
  - Double Difference (DD) Monitoring: $(O\text{-}B)_{sensor1}$ - $(O\text{-}B)_{sensor2}$
  - ICVS Clear/Sky Mask Machine-Learning Algorithm
  - ICVS Severe Event Watch (iSEW) System
- **Summary and Path Forward**

JPSS/STAR ICVS Team Members

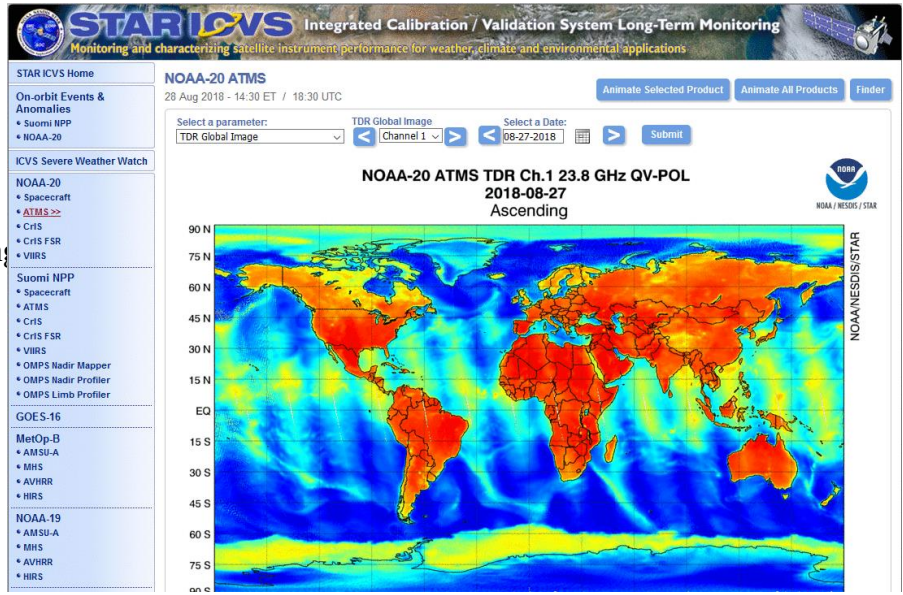
Name	Organization	Major Task
Banghua Yan (Gov. Lead,)	NOAA/STAR	ICVS science and development plan, technical oversight, project budget and schedule
Ninghai Sun (Tech. lead) (50%)	ProTech	ICVS system, **ATMS** ICVS software maintenance and development, inter-sensor comparison, and anomaly (technical) reports
Xingming Liang	ProTech	**VIIRS** ICVS software maintenance and development, VIIRS clear/sky mask algorithm/module, inter-sensor comparison, VIIRS O-B bias module, double difference module, and anomaly (technical) reports
Ding Liang	ProTech	**OMPS** ICVS software maintenance and development, inter-sensor comparison, cloud/clear detection module, O-B bias module, double difference module, **3D animation** of ATMS/VIIRS hurricane monitoring module, and anomaly (technical) reports,
Jingfeng Huang	ProTech	ICVS Severe Event[1] Watch (**iSEW**) System, **VIIRS** RGB module, **CrIS** O-B bias module, CrIS anomaly (technical) reports, and ICVS weekly report support
Xin Jin (50%)	ProTech	**CrIS** ICVS software maintenance and updates, inter-sensor comparison, double difference, and anomaly (technical) reports
Warren Porter	ProTech	**ATMS** inter-sensor comparison, double difference module, TDR/SDR **DCT-PLS** data smoothing processing module, **ICVS** system **upgrade**, and ICVS weekly report

[1] Events include but not limited to hurricane, volcano, fire, snow storm, dust storm, and other disaster events.

FY18 Top 5 Accomplishments

- **Successfully updated the ICVS for NOAA-20 (ATMS, CrIS, OMPS and VIIRS) to support NOAA-20 prelaunch, In-Orbit Verifications (IOVs) and postlaunch calval tasks**
  - Delivered NOAA-20 ICVS-Beta Modules to password-required users
  - Completed NOAA-20 spacecraft parameters monitoring
  - Developed CrIS full spectral resolution (FSR) SDR trending module
  - Added VIIRS high resolution imagery module
  - Developed new VIIRS SDR and GEO product quality monitoring module
  - Improved OMPS telemetry and other modules
- **Further developed new modules to support NOAA-20 instruments SDR provisional/validated reviews**
  - NOAA-20 ICVS-Beta Modules Transferred to Operation to ICVS website for public access
  - Developed ATMS SDR O-B angular dependent bias modules
  - Initialized CrIS O-B bias time series module
  - Initialized CrIS relative responsivity change module
  - Unified SNPP/NOAA-20 VIIRS imaging modules
  - Added VIIRS DNB analysis module for NOAA-20
  - Updated VIIRS H/F Factors trending module for NOAA-20
  - Fully functionalized NOAA-20 VIIRS TEB O-B biases monitoring
  - Initialized OMPS NM Reflectivity O-B monitoring code
- **Successfully delivered the first version of NOAA-20 ICVS packages to GRAVITE (Ceased on August 7, 2018)**
- **Completed the beta version of ICVS documents**
  - ICVS SNPP instrument technical reports
  - ICVS maintenance manual and ICVS User manual
- **Provided Customer/User-oriented Support**
  - Added "SNPP" and "NOAA-20" On-orbit Events & Anomalies Tables, Weekly/Monthly Reports

Welcome ICVS



Refer to ICVS: https://www.star.nesdis.noaa.gov/icvs/

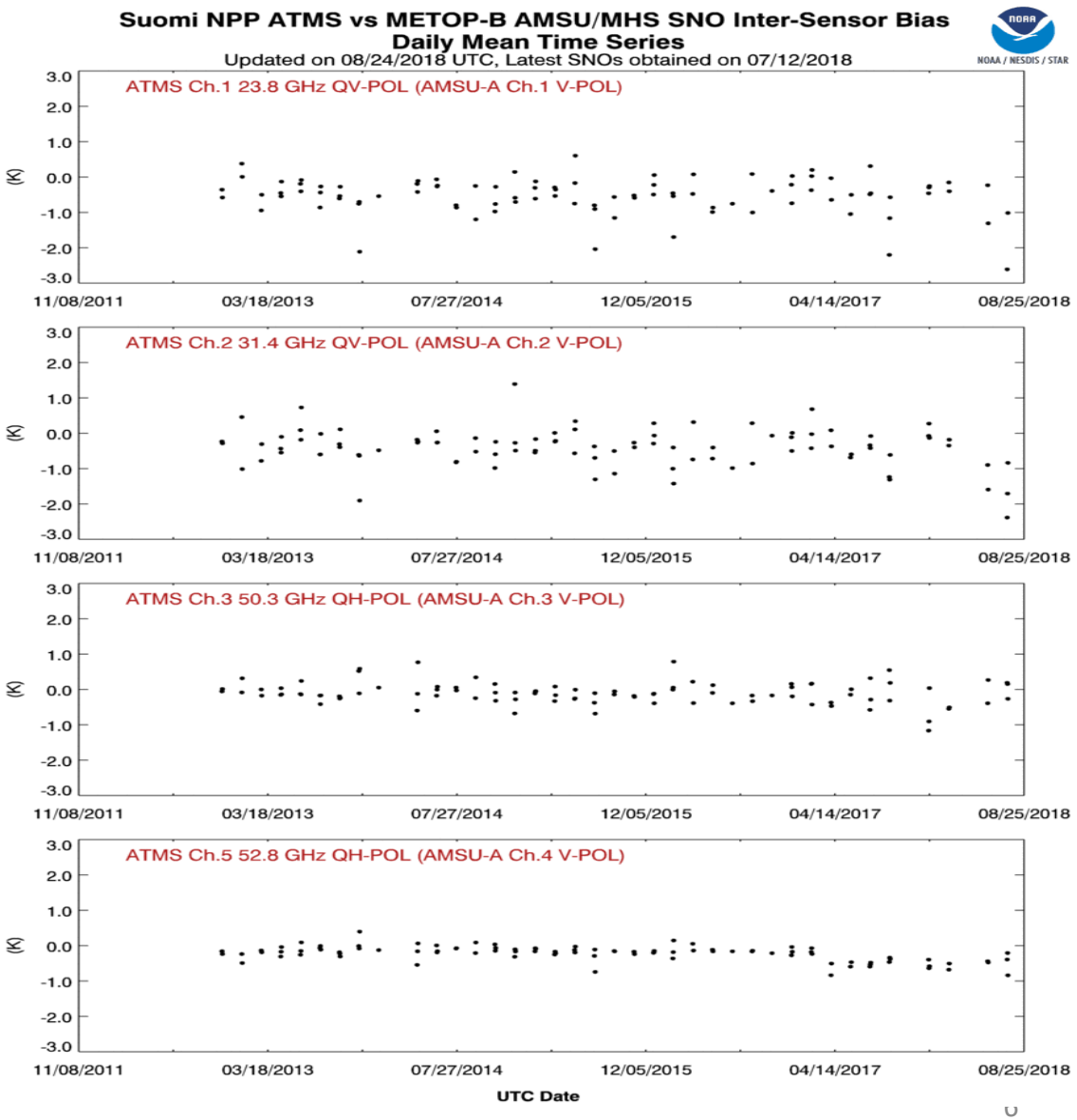
New ICVS Monitoring Capabilities Development

- **Objectives**
  - Provide on-orbit quantitative assessment of SNPP/NOAA-20 antenna (brightness) temperatures quality for user communities within and outside NOAA
  - Provide timely satellite observation information directly from multi-sensors SDR data in closely observing USA and global severe events (fire, hurricane, dust storm, snow storm, etc.) affecting public safety
    - Facilitate JPSS program office and NOAA line-office decision making
    - Assist SDR and EDR product developers and users in better validating product quality

- **New Advanced ICVS Monitoring Capabilities, e.g.,**
  - ATMS/AMSU-A Simultaneous Nadir Overpass (SNO) Intersensor Comparison Monitoring
  - VIIRS Double Difference: (O-B)NOAA-20 - (O-B)SNPP
  - ICVS Cloud Mask Machine-Learning Algorithm
  - ICVS Severe Event Watch (iSEW) System
    - 9 experimental VIIRS RGB combination imaging products
    - DCT-PLS Smooth algorithm for gap-filling ATMS observations
    - 3D ATMS/VIIRS animation for hurricane monitoring

ICVS Simultaneous Nadir Overpass (SNO) Intersensor Comparison: Preliminary Results

- Planned ICVS-SNO Intersensor Comparison Activities:
  - ATMS/AMSU-A/MHS
  - VIIRS/ABI
  - CrIS/VIIRS
  - OMPS/GOME-2
- Preliminary results: life-time monitoring of SNPP ATMS and Meop-A/B and NOAA-19 AMSU-A/MHS SNO intersensor comparisons
  - ATMS Ch. 1 to 15 except Ch. 4 vs. AMSU-A Ch. 1 to 14
  - ATMS Ch. 18, 20, 22 vs. MHS Ch. 5 to 3
  - ATMS Ch. 16 (88.20 GHz) vs. MHS Ch. 1 (89 GHz)
  - ATMS Ch. 17 (165 GHz) vs. MHS Ch. 2 (157 GHz)



(Reference: https://www.star.nesdis.noaa.gov/icvs/status_NPP_ATMS.php)

Brightness Temperature Double Difference (DD): Preliminary Results (1)

- **DD Calculation:**

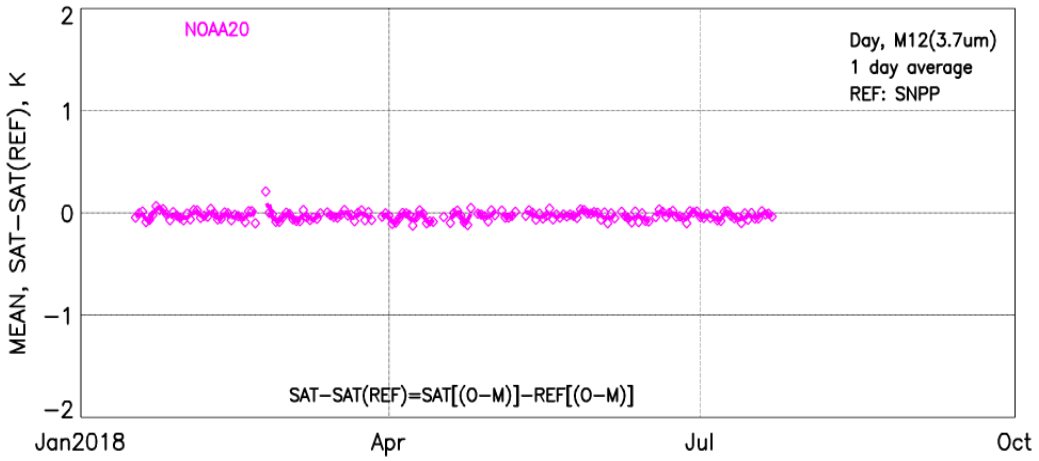
  DD = NOAA-20 (O-B) – SNPP (O-B)

  O: Satellite observations

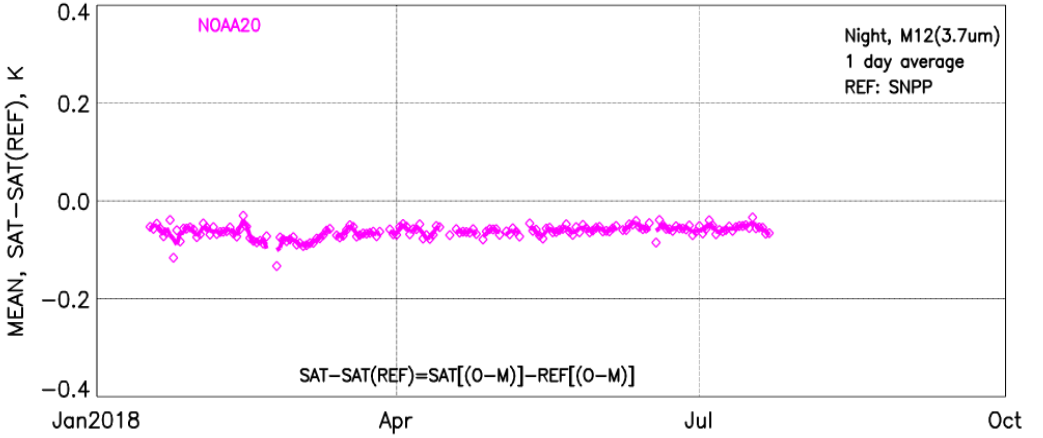
  B: CRTM simulations using ECMWF ancillary data of atmospheric profile and surface properties

  Purpose: Mostly cancel biases and uncertainties in used radiative transfer model and atmospheric profiles ; Reproduce more accurately the difference between NOAA-20 and SNPP sensor TDR/SDR data

Day Time



Night Time



- **Preliminary Results: VIIRS TEBs from M12 through M16**
  - M12: 0.003 K (Day) and -0.05 K (Night)
  - M13: -0.03 K (Day) and -0.02 K (Night)
  - M14: 0.11 K (Day) and 0.12 K (Night)
  - M15: 0.04 K (Day) and 0.03 K (Night)
  - M16: 0.05 K (Day) and 0.04 K (Night)

(Will add to ICVS web site soon)

Brightness Temperature Double Difference (DD): Preliminary Results (2)

- **DD Calculation:**

  DD = NOAA-20 (O-B) – SNPP (O-B)

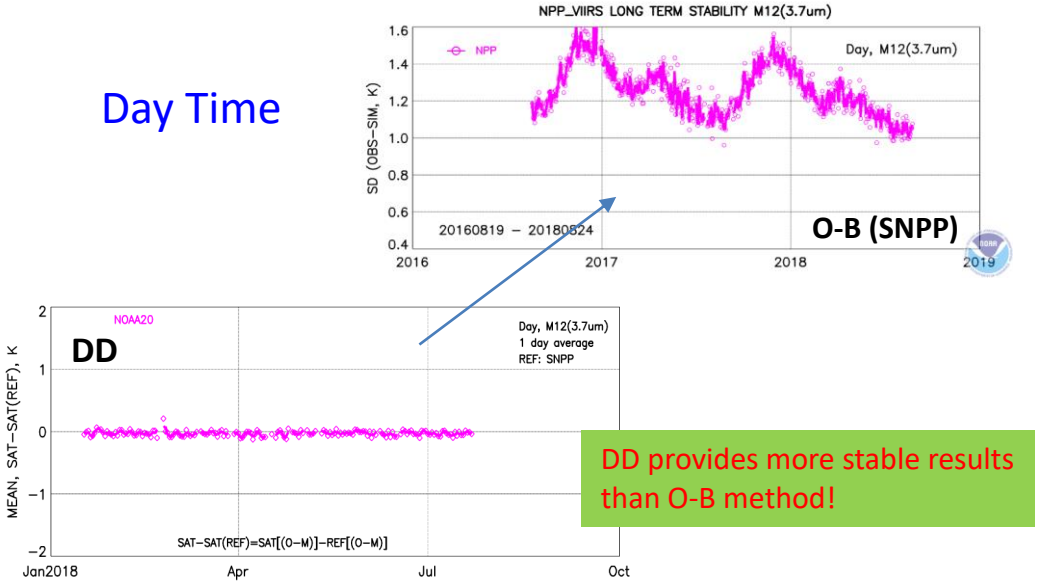
  O: Satellite observations

  B: CRTM simulations using ECMWF ancillary data of atmospheric profile and surface properties

  Purpose: Mostly cancel biases and uncertainties in used radiative transfer model and atmospheric profiles ; Reproduce more accurately the difference between NOAA-20 and SNPP sensor TDR/SDR data

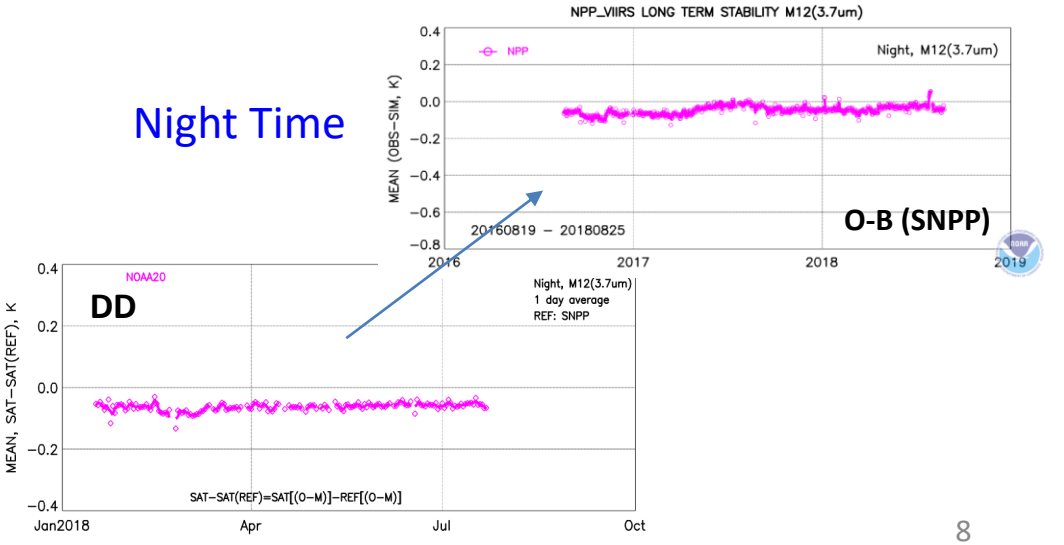
- **Preliminary Results: VIIRS TEBs from M12 through M16**
  - M12: 0.003 K (Day) and -0.05 K (Night)
  - M13: -0.03 K (Day) and -0.02 K (Night)
  - M14: 0.11 K (Day) and 0.12 K (Night)
  - M15: 0.04 K (Day) and 0.03 K (Night)
  - M16: 0.05 K (Day) and 0.04 K (Night)

Day Time



DD provides more stable results than O-B method!

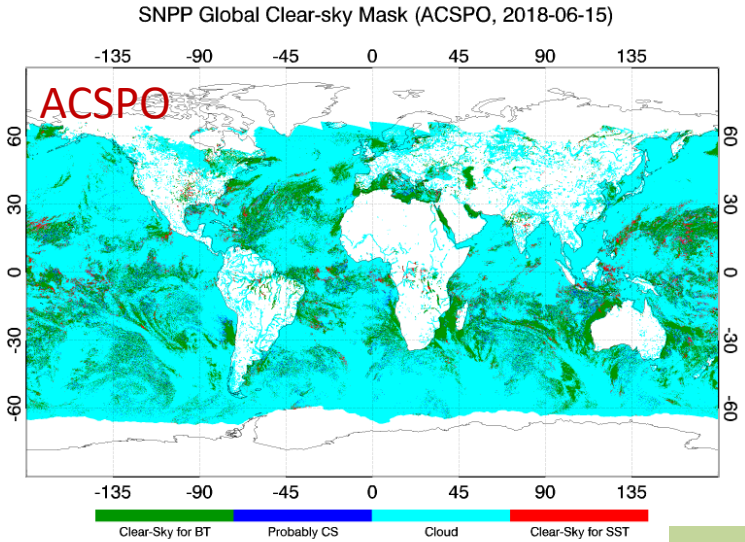
Night Time



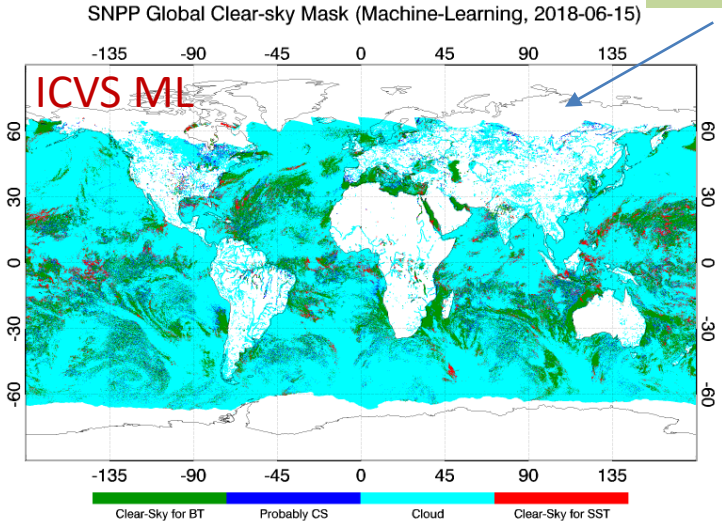
(Will add to ICVS web site soon)

Machine Learning Clear/Sky Mask (CSM) Algorithm for ICVS VIIRS: Preliminary Results

- **Background/Objective**
  - The existing ICVS CSM is a sensor-specific and not available for SDR Cal/Val immediately after launch
  - Develop a fast, platform-independent VIIRS-based CSM for ICVS
- **Machine Learning Algorithm**
  - **Training Data Set**: STAR Advanced Clear-Sky Processor for Ocean (ACSPO) SST system (A. Ignatov et al.)
  - **Inputs**: observed and simulated radiance data at bands 12, 15 and 16; satellite view zenith and solar zenith angles; regress and model SST; spatial variance
  - **Outputs:** clear sky (CS) for BT and SST, probable clear sky, and cloud



The retrieved ML CSM is about 94-98% match ACSPO.



Refer to the poster about "**A Machine Learning-Trained ICVS VIIRS Clear-Sky Mask Algorithm Applicable for Multiple Satellites**" by Liang et al.)

ICVS Severe Event Watch (iSEW) System

- **Objective:**
  - provides a timely and unique information about severe events closely linked to public safety by combining multi-sensors of SNPP/JPSS SDR observations
- **ICVS Severe Event Watch (iSEW) to innovatively use multi-sensor SDRs**
  - Nine experimental VIIRS RGB combinations imaging products for severe events monitoring
  - Gap-filling ATMS observations with limb correction for hurricane monitoring monitoring
  - 3D ATMS/VIIRS animation for hurricane warm core structure monitoring



Benefits:

- Provide valuable JPSS satellite observations to facilitate decision making
- Provide creative ideas in advancing new technologies and developing new algorithms from multiple sensor SDR data
- Assist SDR and EDR product developers and users in better validating product quality

iSEW: 9 ICVS Experimental RGB Combination Imaging Products for Severe Event Monitoring

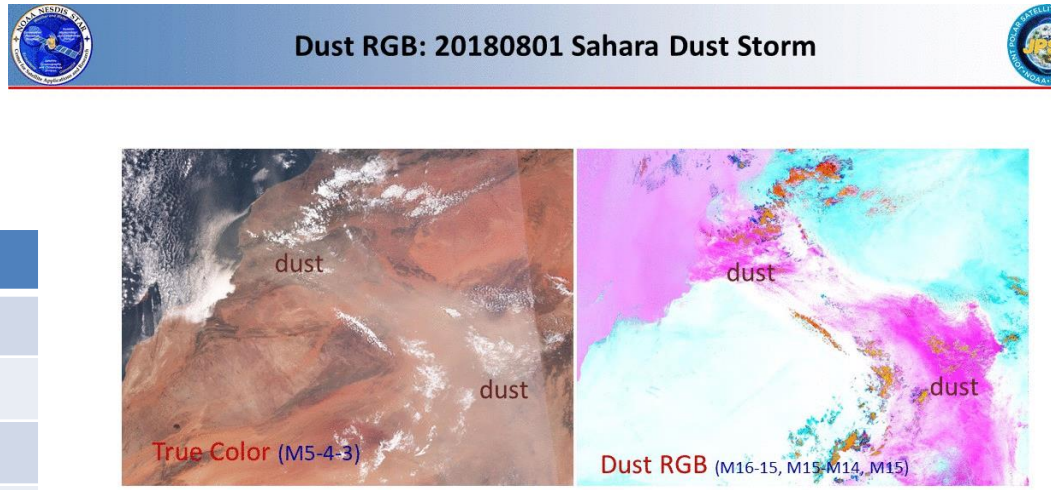
ICVS Nine Experimental RGB Combination Imaging Products

	R	G	B
True Color	M5	M4	M3
Nature Color (M)	M10	M7	M5
Nature Color (I)	I3	I2	I1
Dust*	M16-M15	M15-M14	M15
Snow/Cloud	M3	M10	M11
Fire Temperature	M12	M11	M10
DNB+M15	DNB	DNB	M15
Nature Fire Color	I4	I2	I1
Nature Color #2	M11	M7	M5

- Dust RGB combination is referred to NASA SPORT link: https://weather.msfc.nasa.gov/sport/jpsspg/rgb.html

(Refer to the poster about **"JPSS/STAR ICVS Severe Event Watch (iSEW) System Development and Applications**" by Huang et al.)

Examples: RGB combinations imaging



Evolution of Mendocino Complex Fire using Fire RGB Image (07/26 through 08/27, 2018)

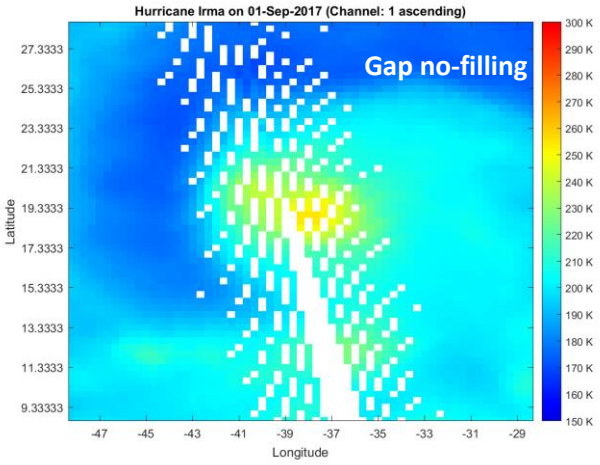


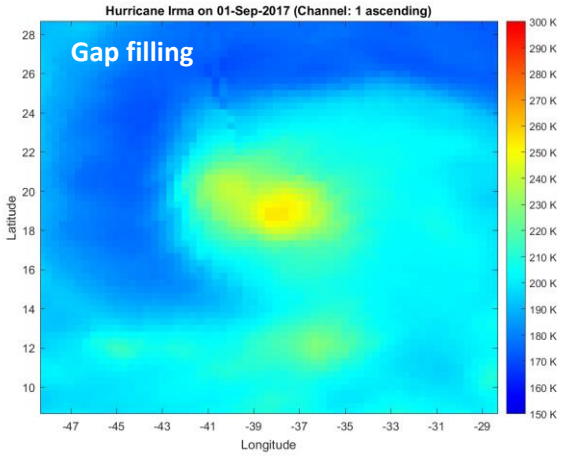
The Mendocino Complex Fire started on July 27 is the largest recorded fire complex in California history

iSEW: Gap-Filling ATMS Observations for Hurricane Monitoring

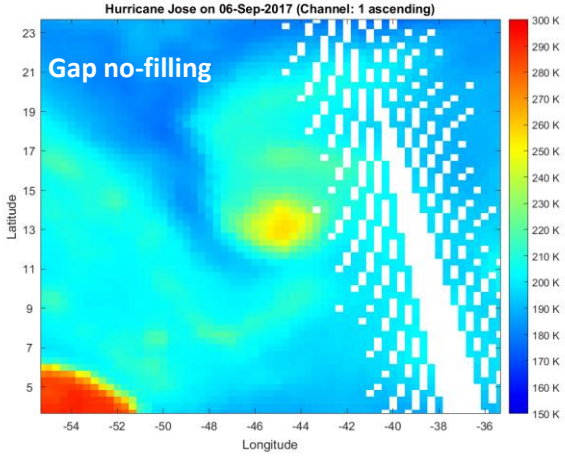
- Gap-filling method:
  - Garcia Discrete Cosine Transform (DCT)-Penalized Least Squares (PLS) (D. Garcia 2009)
- Uncertainty upon 33 cases analyses:
  - Errors are no more than 1 Kevin for temperature sounding channels
  - Errors are less than a few Kelvin for window and water vapor sounding channels amounted
- The gap-filling method has been applied to all hurricane cases influencing USA in 2017/2018 (here are two examples)

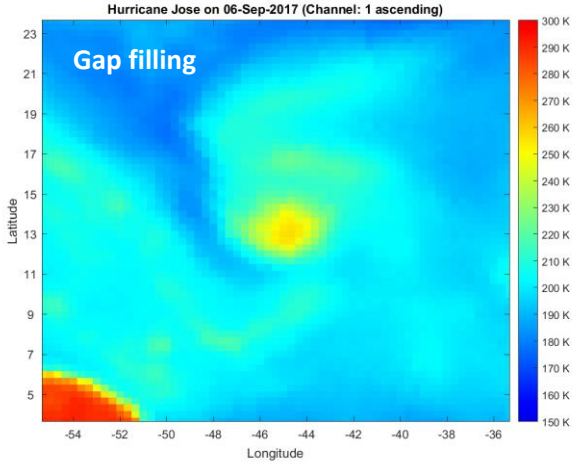
Examples: **Hurricane Irma (Aug. 31, 2017)**





Hurricane Jose (Sept. 5, 2017)



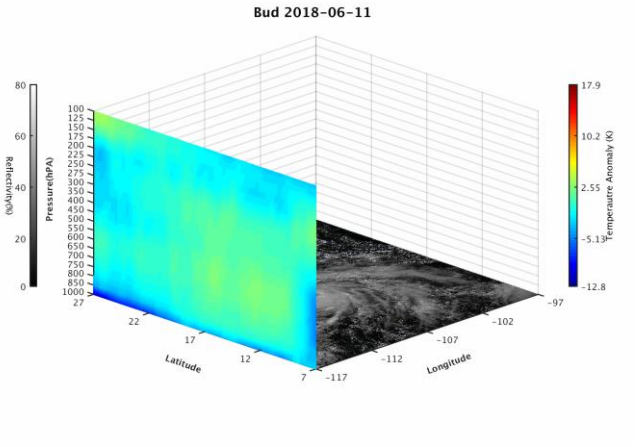


Refer to the poster with "**Application of a 2D DCT-PLS Smoothing Algorithm for ICVS Hurricane Event Watch**" by Porter et al.

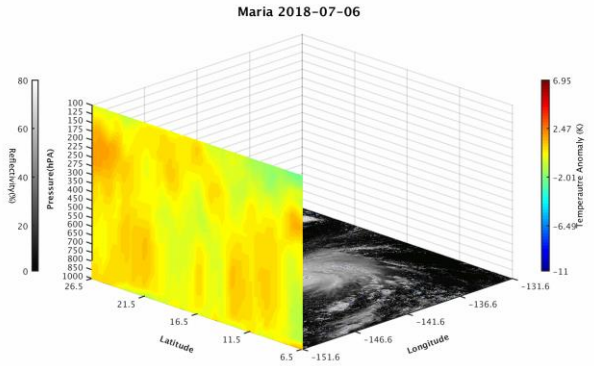
iSEW: 3D ATMS/VIIRS Animation Monitoring of Hurricane Warm Core Structure

- 3D animation image consists of 21 pressure levels of temperature profile information and VIIRS I1 band (0.64 μm) as backgrounc in the bottom and
- Brightness temperatures are <u>limb-corrected ATMS</u> observations from channels 1 to 15 (Zhang et al. 2017)
- <u>Temperature anomaly</u> at 21 pressure levels from 1000 hPA to 100 hPA are retrieved from ATMS brightness temperature observations from channels 5 to 12 (Zhu and Weng 2013)
- <u>Data gaps are filled</u> by 2-D spline smoothing algorithm (refer to W. Porter et al.'s poster)
- 3D animation is made of slices of hurricane volume along latitude, longitude, altitude direction and around center

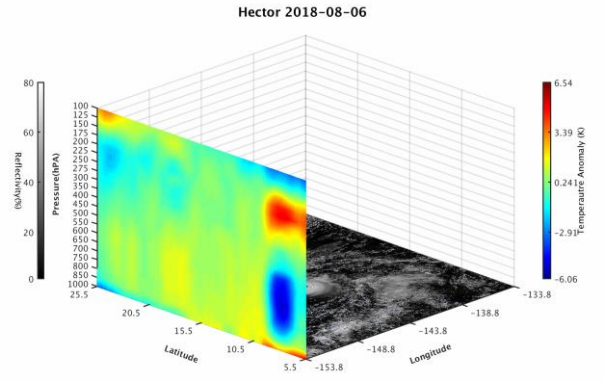
Hurricane Bud (June 11)



Hurricane Maria (July 06)



Hurricane Hector (Aug. 06)



Hurricane Lane (Aug. 21)

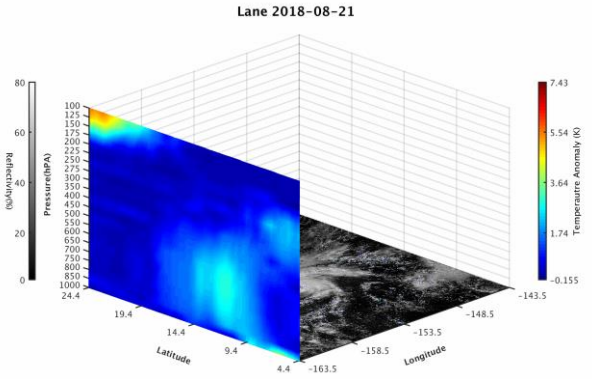


Figure Four hurricane cases: typically, warm anomaly was detected in the upper level though cold temperature anomalies occurred in the lower level of hurricane center (Refer to the poster about "Hurricane Structure 3D Animation Demo at STAR ICVS" Liang et al.)

(Curtesy of T. Zhu and L. Zhou for providing algorithm code and/or valuable suggestions as well W. Chun and F. Weng for their legacy effort)

Summary

- The ICVS has provided successfully a significant and timely technical support to JPSS NOAA-20 instrument on-orbit Cal./Val. and SDR/EDR Reviews
- The ICVS is being updated to provide more valuable information of SDR data quality and severe events (e.g., hurricane, fire, dust storm, and snow storm) for SDR/EDR teams, JPSS program office, STAR managements, and other users.
  - ATMS/AMSU-A/MHS SNO Intersensor Comparison
  - VIIRS TEBs DD Monitoring
  - ICVS VIIRS CSM Machine-Learning Algorithm
  - ICVS Severe Event Watch (iSEW) System

Quality, Technology and Science are the essential of the ICVS!

Path Forward

- **Continue to advance the quality, technology and science of the ICVS system to support SDR/EDR teams, JPSS program and NOAA Users needs, e.g.,**
  - SNPP/NOAA-20 instrument SDR data quality modules (e.g., O-B)
  - SNPP/JPSS1 cross-sensor SDR data comparison monitoring package (e.g., SNO and DD)
  - A fast, platform-independent CSM for ICVS multiple sensors
  - ICVS SNPP/JPSS1 SDR iSEW system
  - SNPP/JPSS1 geolocation accuracy trending package
- **Upgrade to a new generation ICVS Monitoring System to improve the quality, efficiency, and timeliness of the system**
  - Improve the ICVS monitoring timeliness and latency performance
  - Improve ICVS Interactive capability
  - Conduct a user survey to collect new needs/feedback from users to enhance the ICVS capabilities
- **Assist STAR SRD/EDR teams in preparation of J2 prelaunch test**

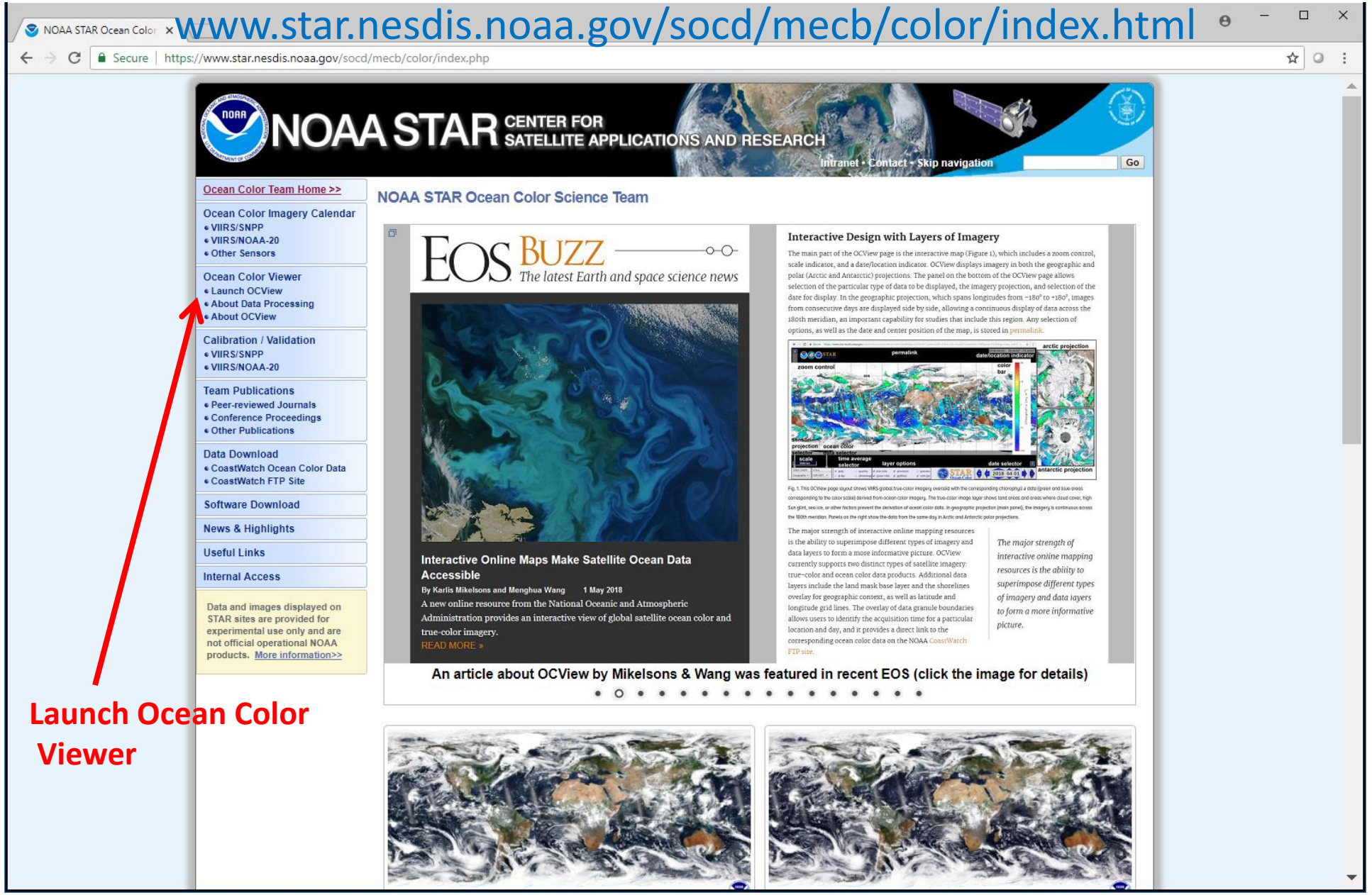
OCView – Online display and monitoring of ocean color product imagery

Karlis Mikelsons
NOAA Ocean Color Science Team

STAR JPSS
2018 Annual Science Team Meeting
August 29, 2018

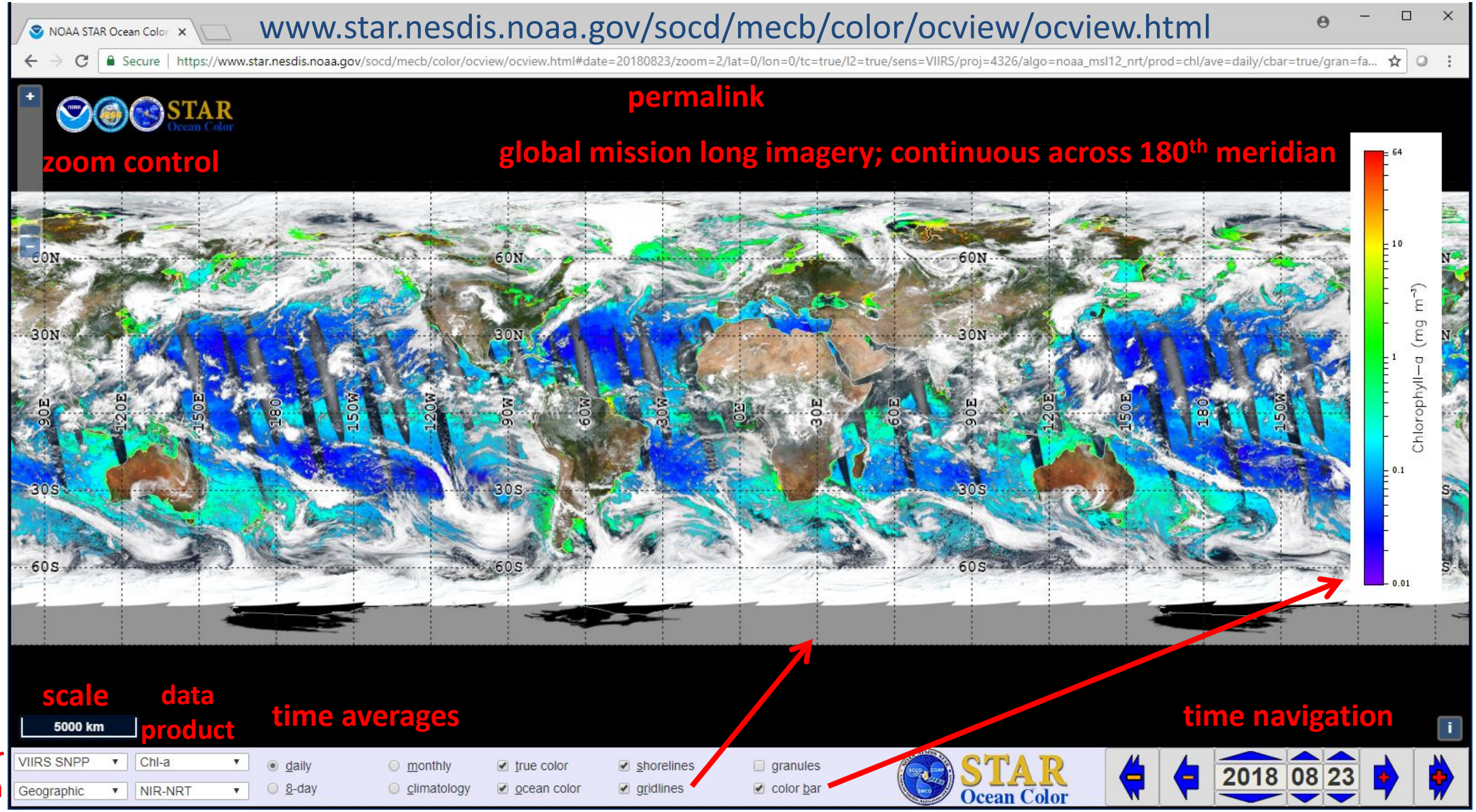
NOAA Ocean Color Science Team web page

www.star.nesdis.noaa.gov/socd/mecb/color/index.html



Launch Ocean Color Viewer

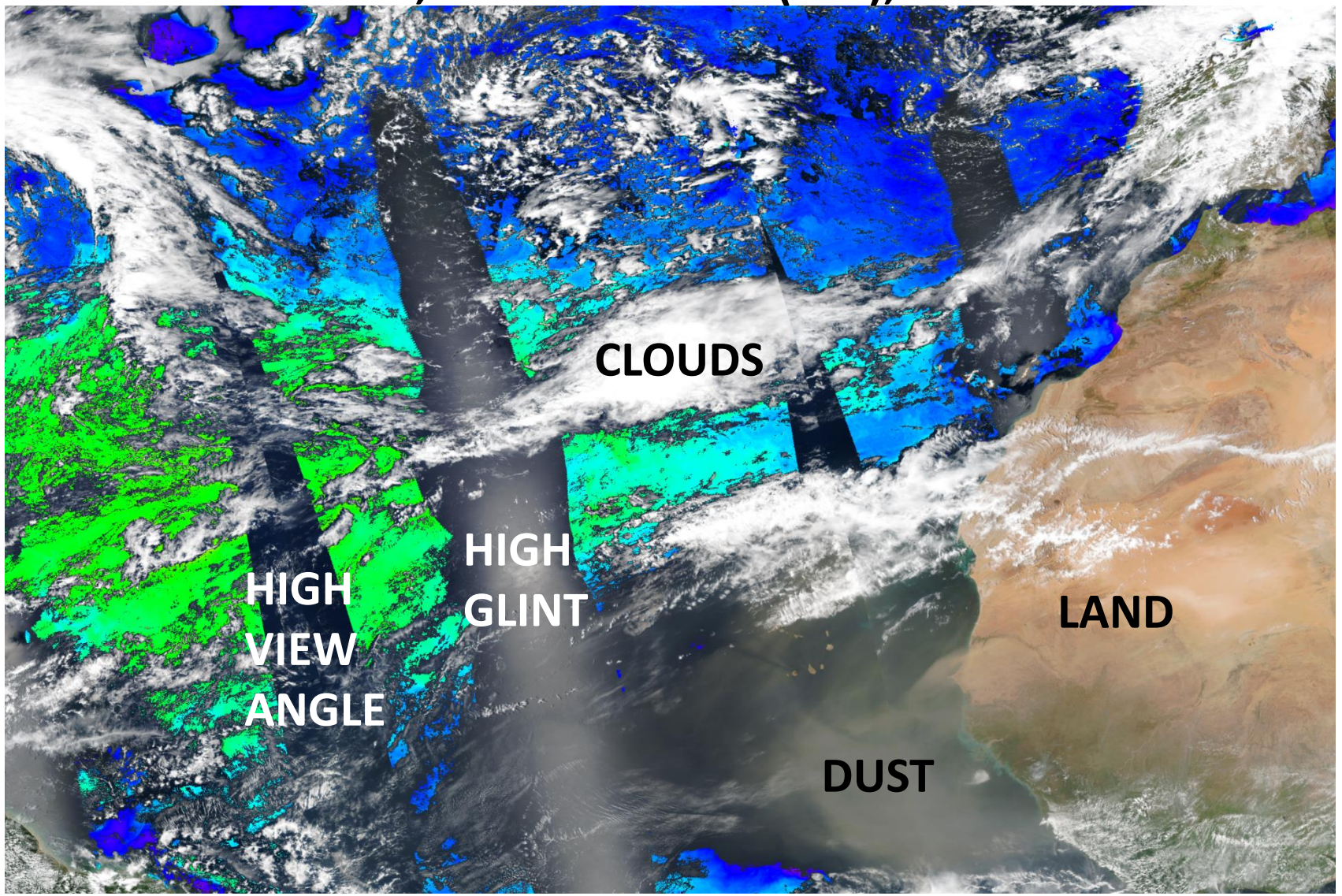
OCView – Ocean Color Viewer



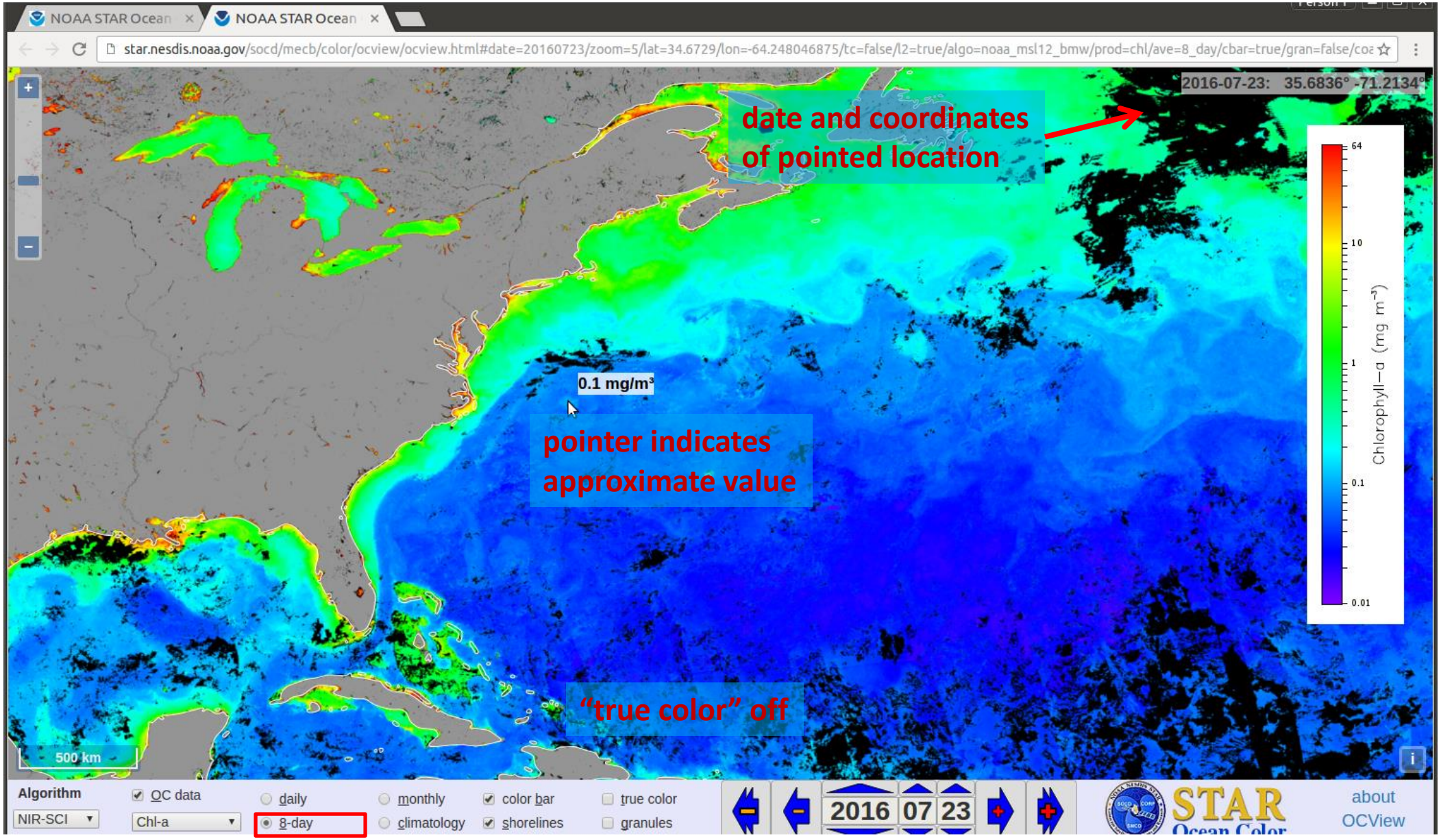
Interactive tiled imagery driven by openlayers javascript library

OCView – regional view

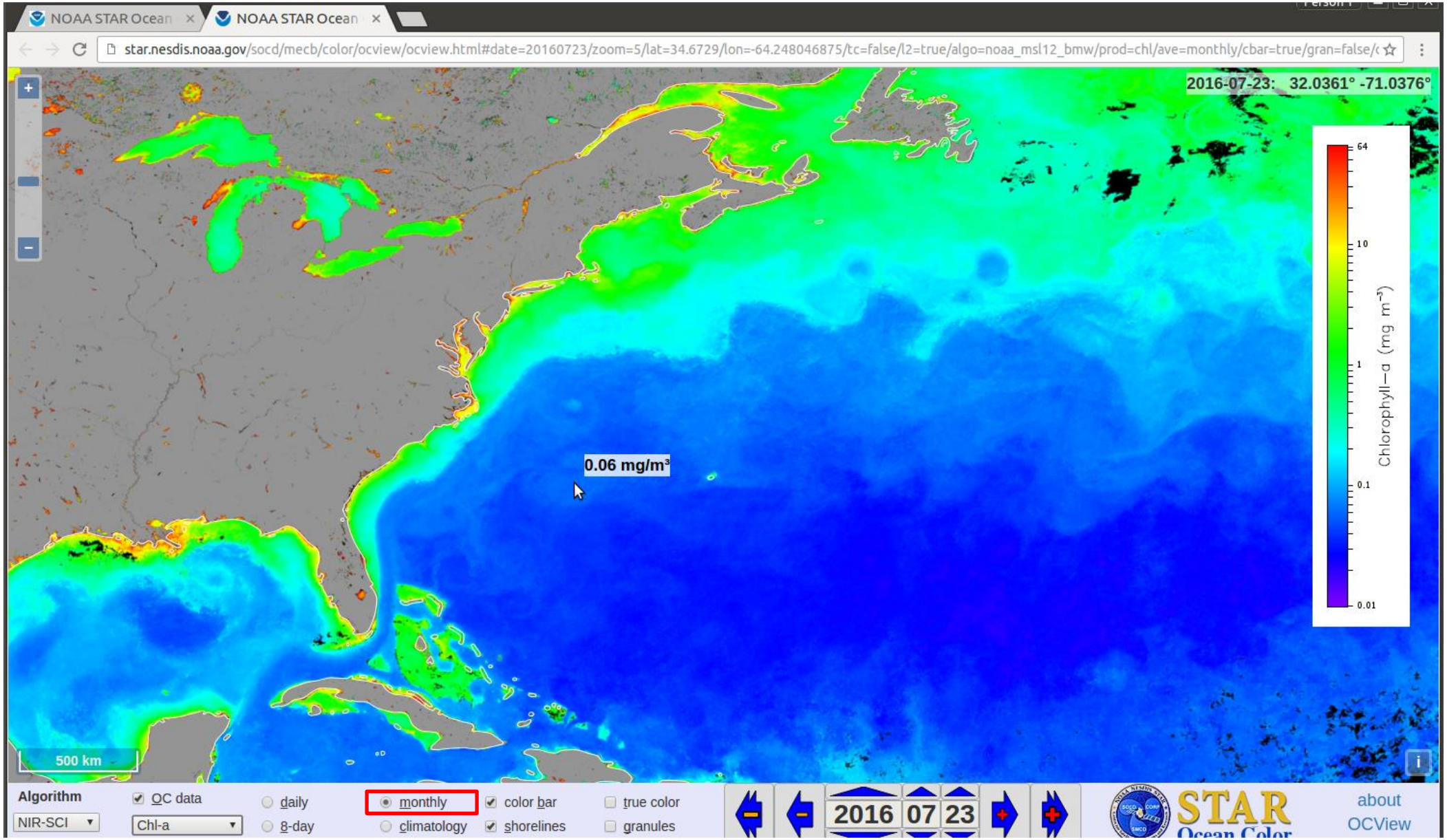
SNPP-VIIRS, true color + *nLw*(443), 2017-04-15



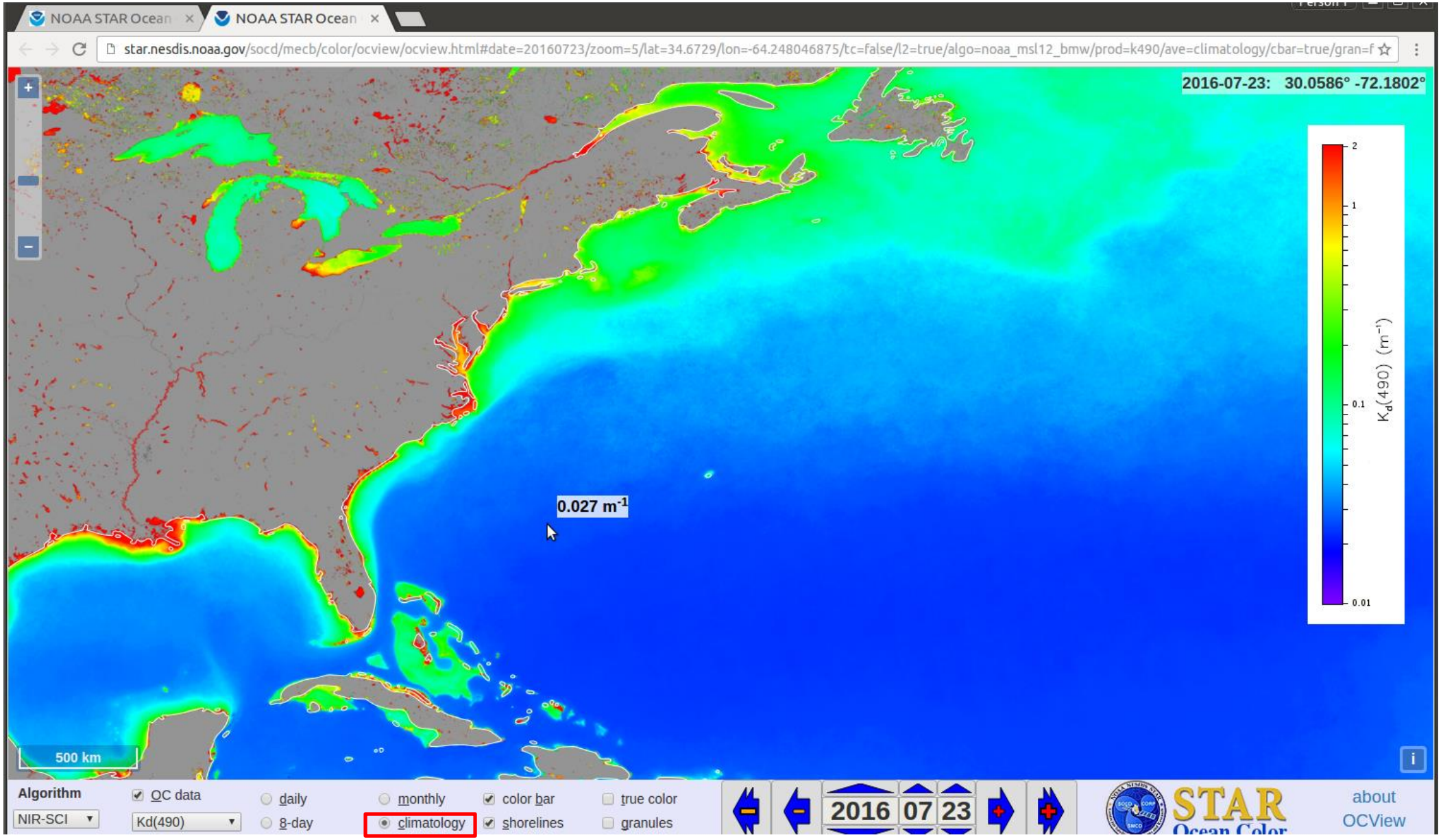
Chl-a 8 day time average



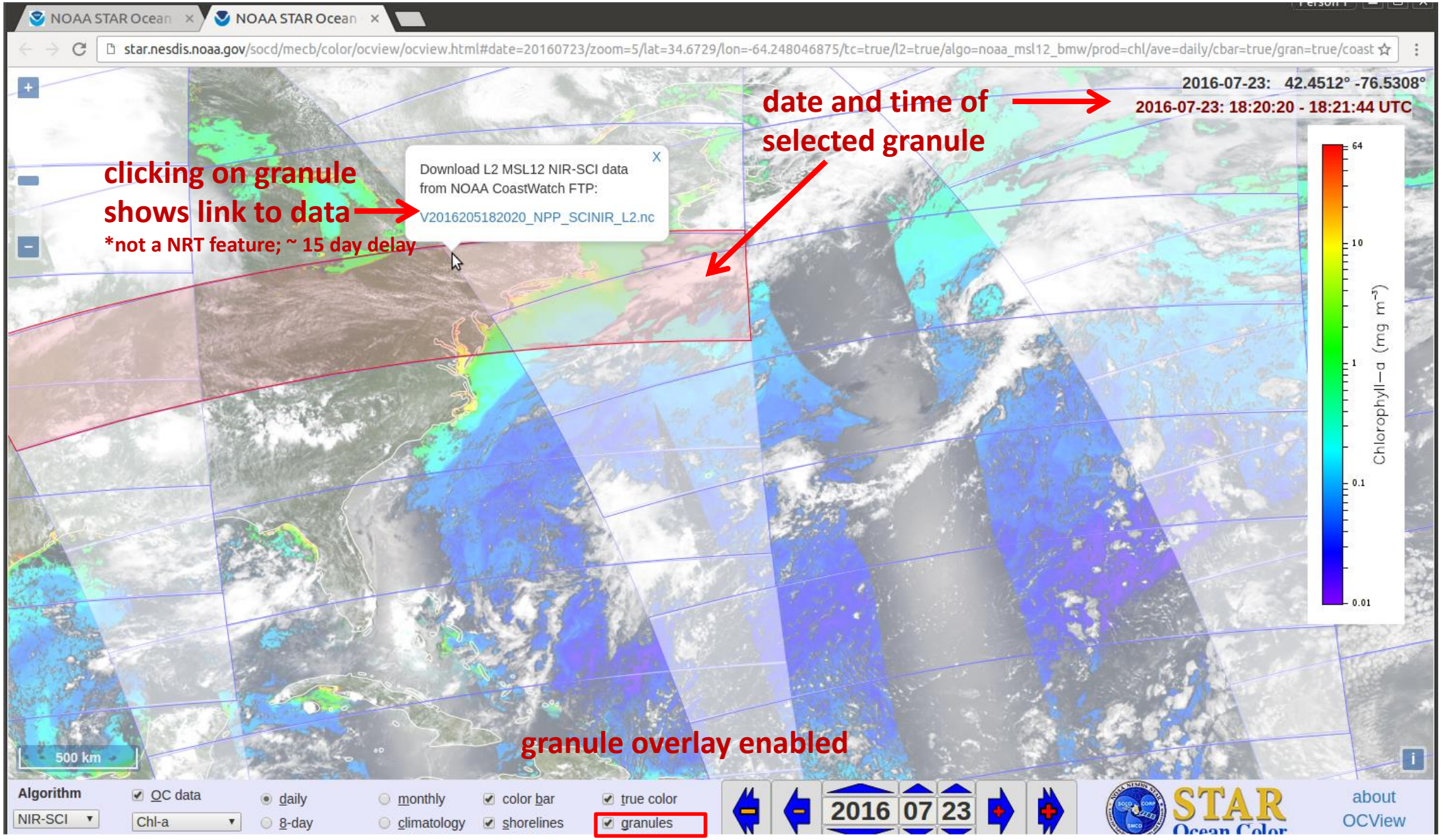
Chl-a monthly time average



$K_d(490)$ climatology

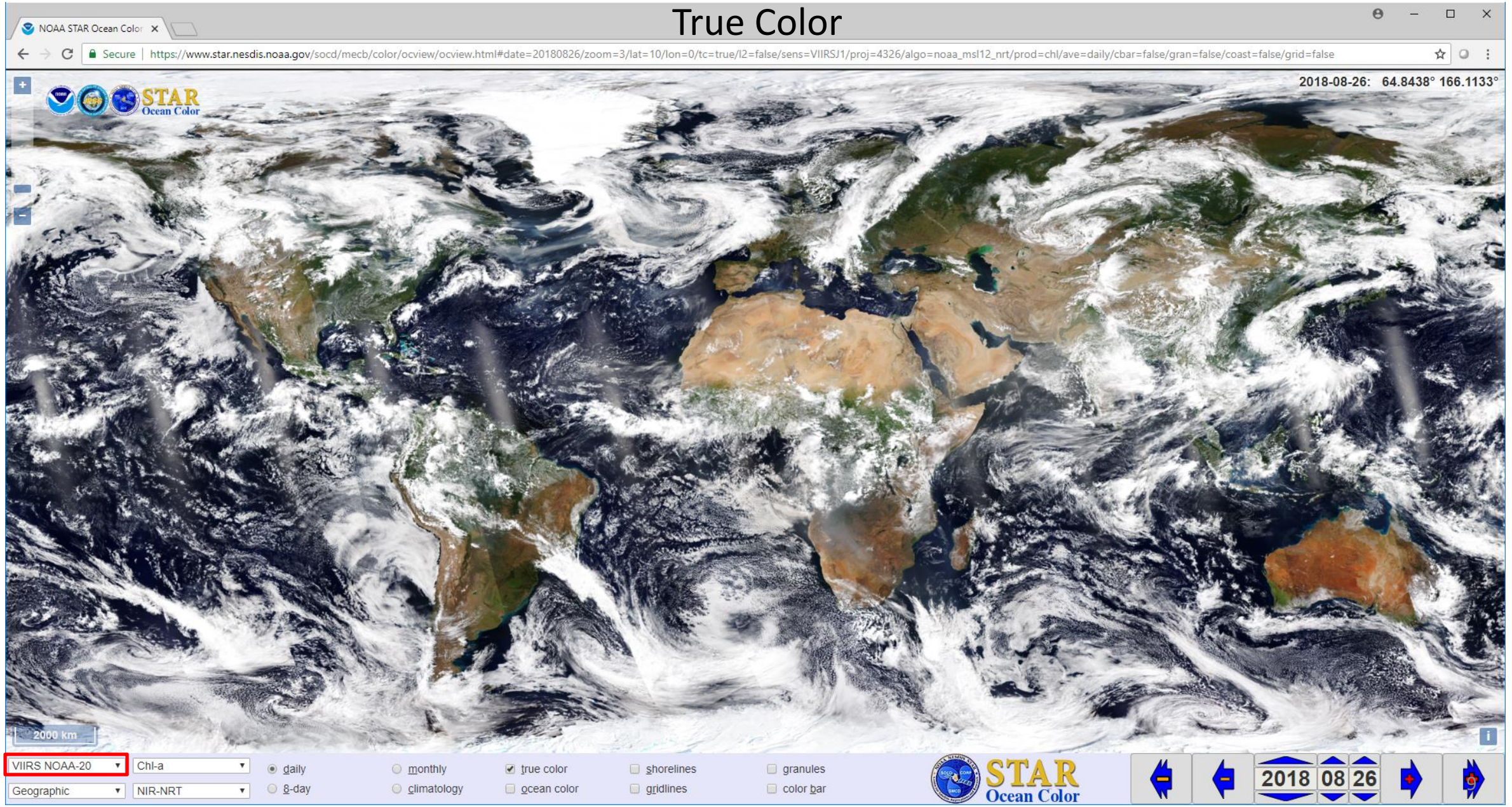


Granule display, selection, and download



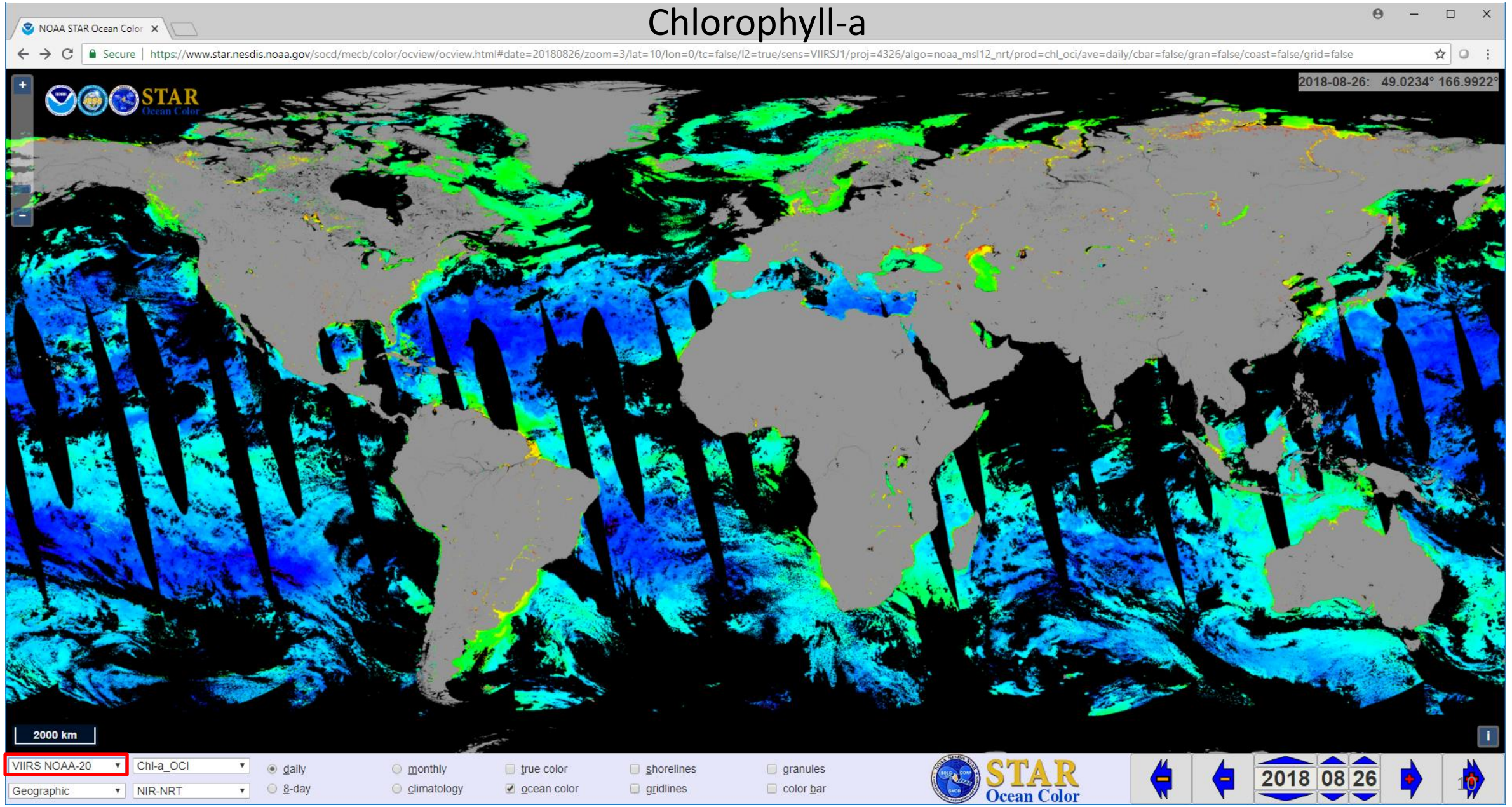
VIIRS NOAA-20

True Color



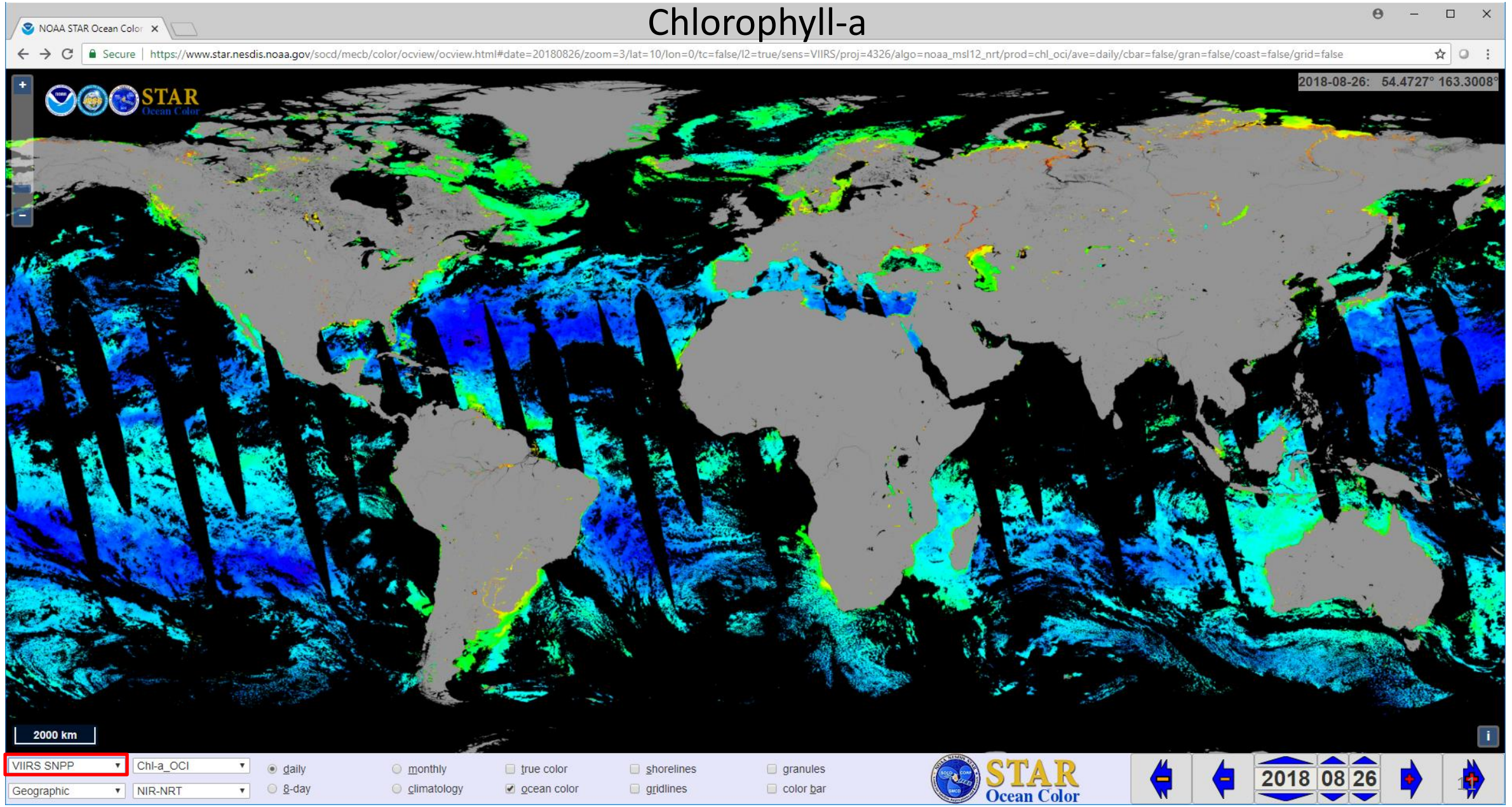
VIIRS NOAA-20

Chlorophyll-a



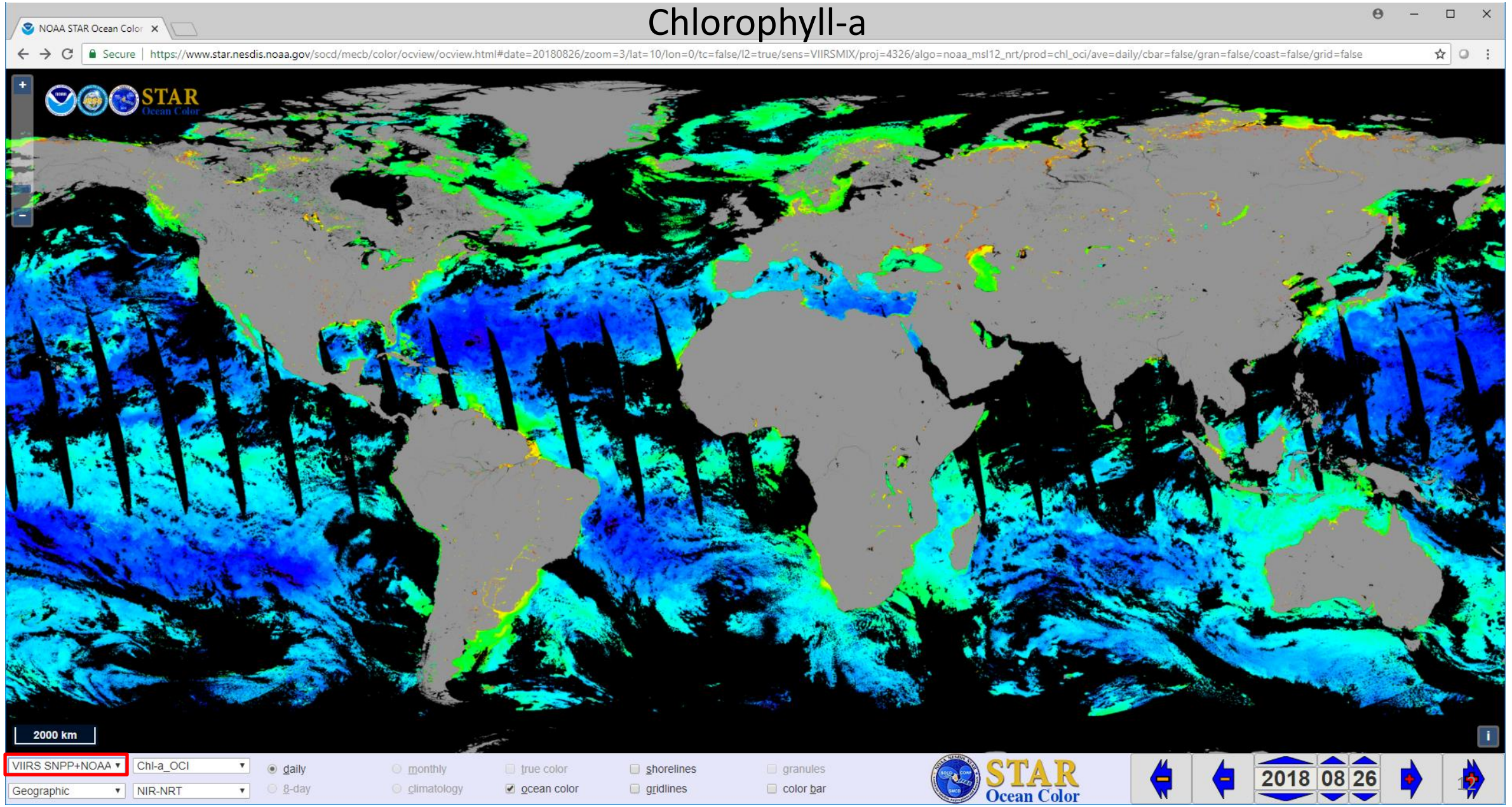
VIIRS SNPP

Chlorophyll-a

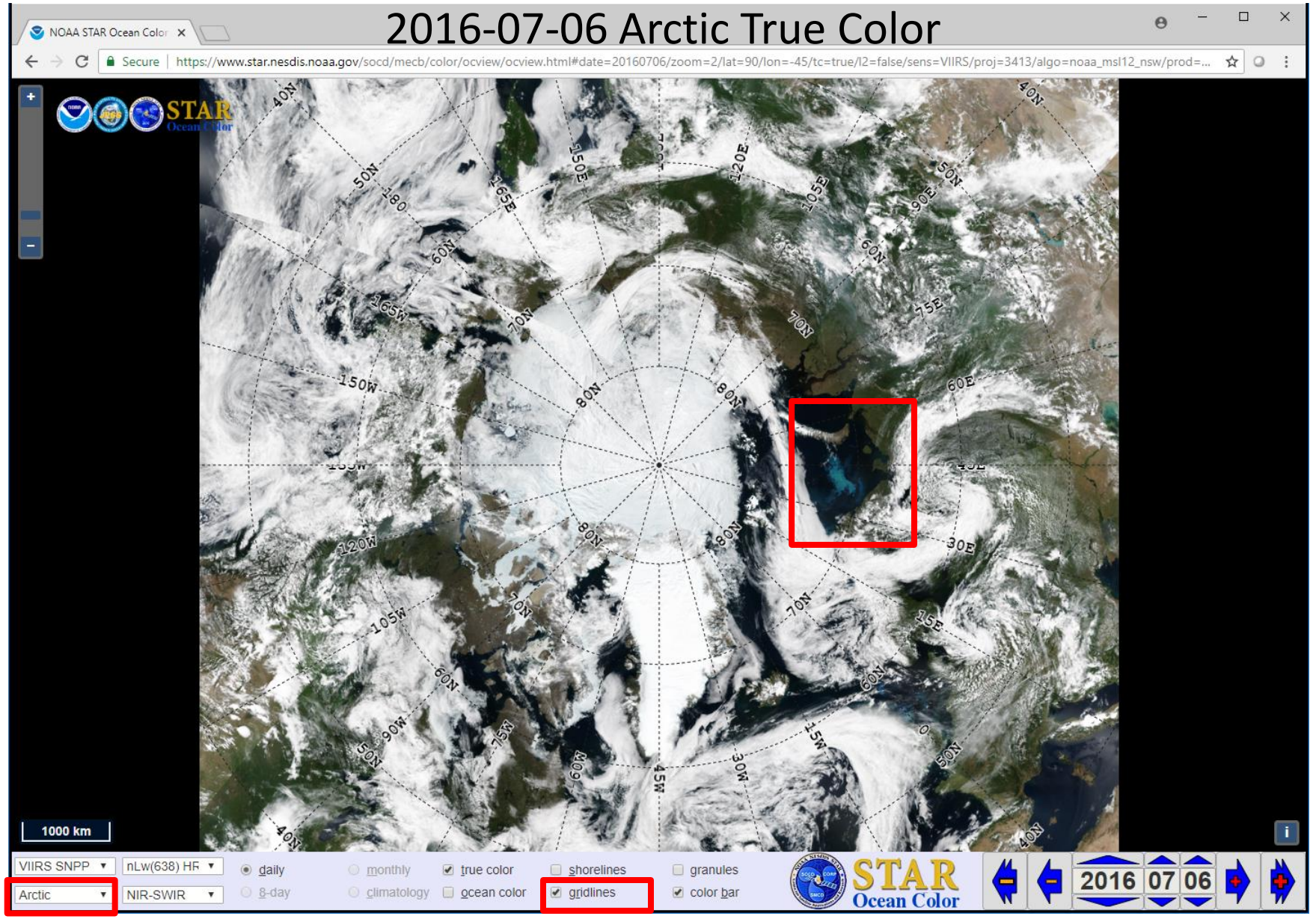


VIIRS SNPP + NOAA-20

Chlorophyll-a

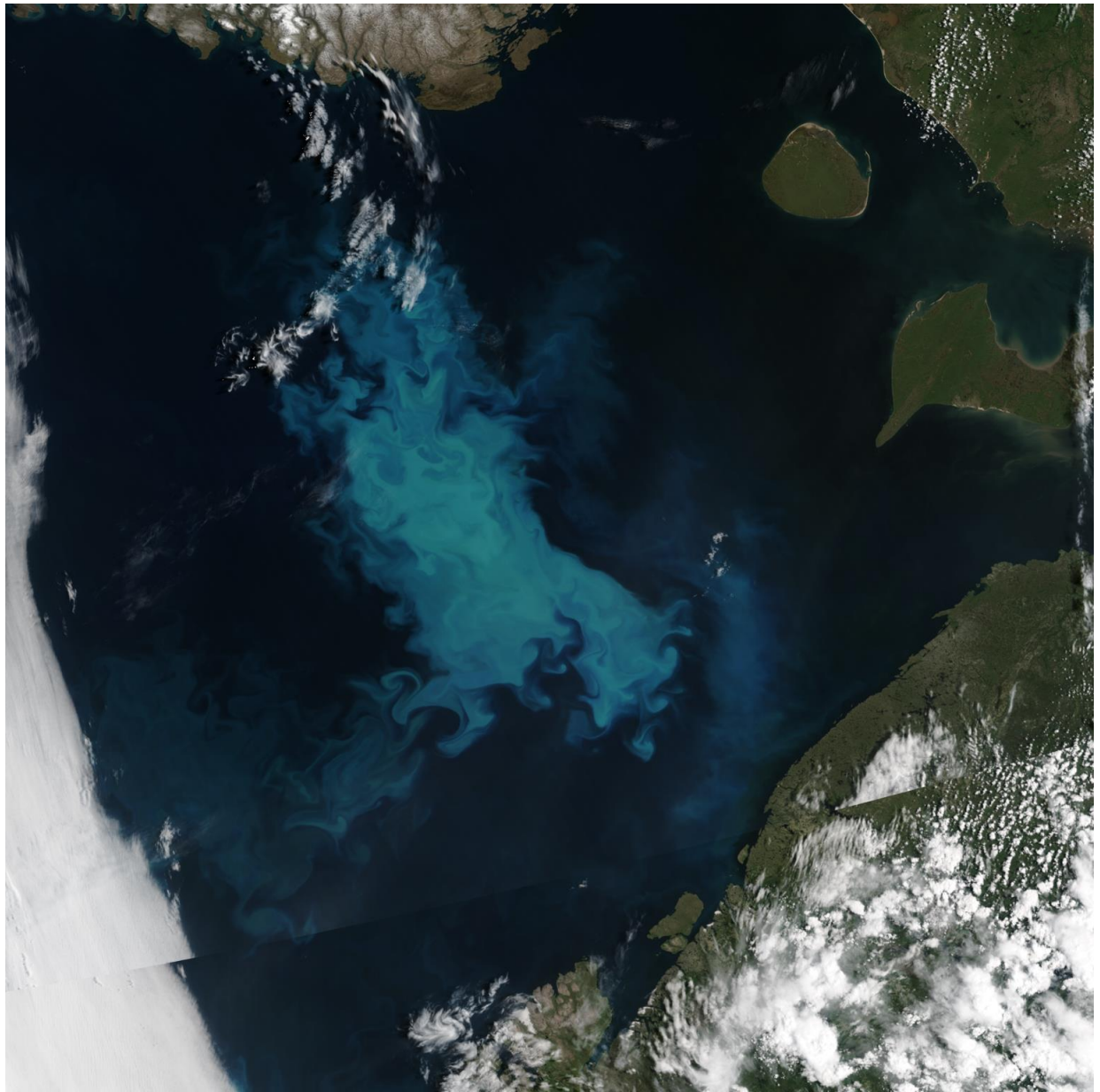


OCView Polar Projections



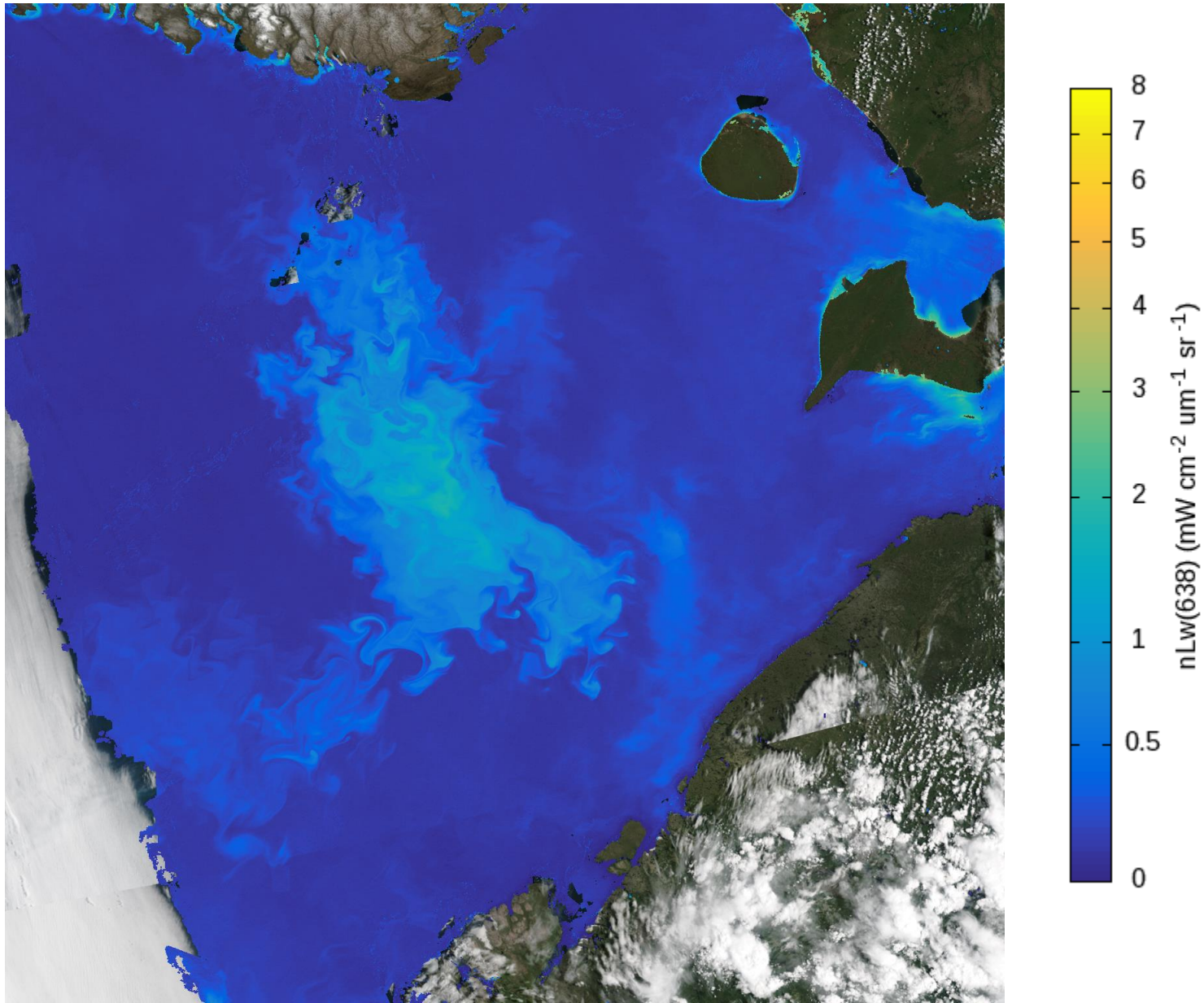
OCView Polar Projections

2016-07-06 Barents Sea True Color



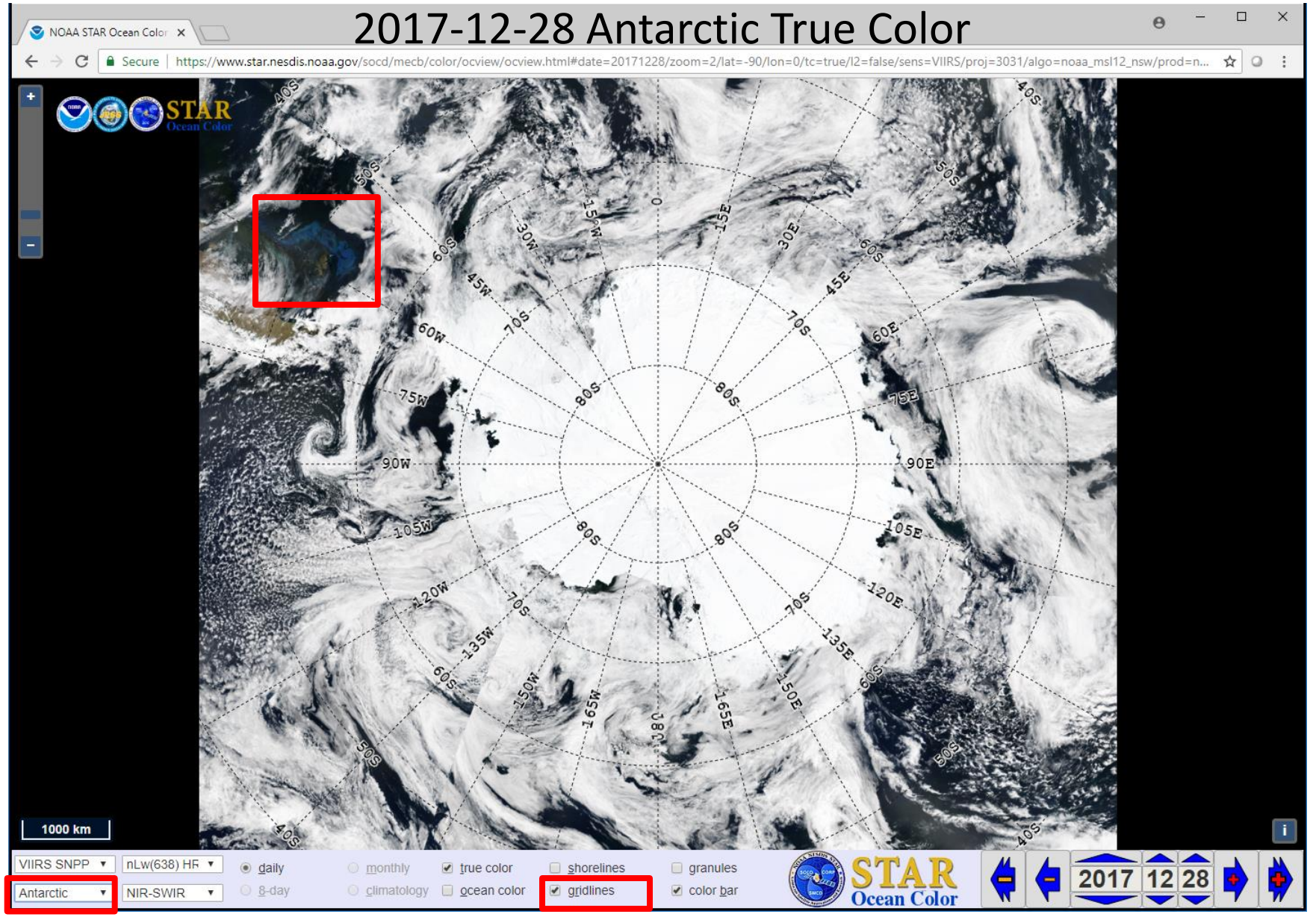
OCView Polar Projections

2016-07-06 Barents Sea True Color + nLw(638)



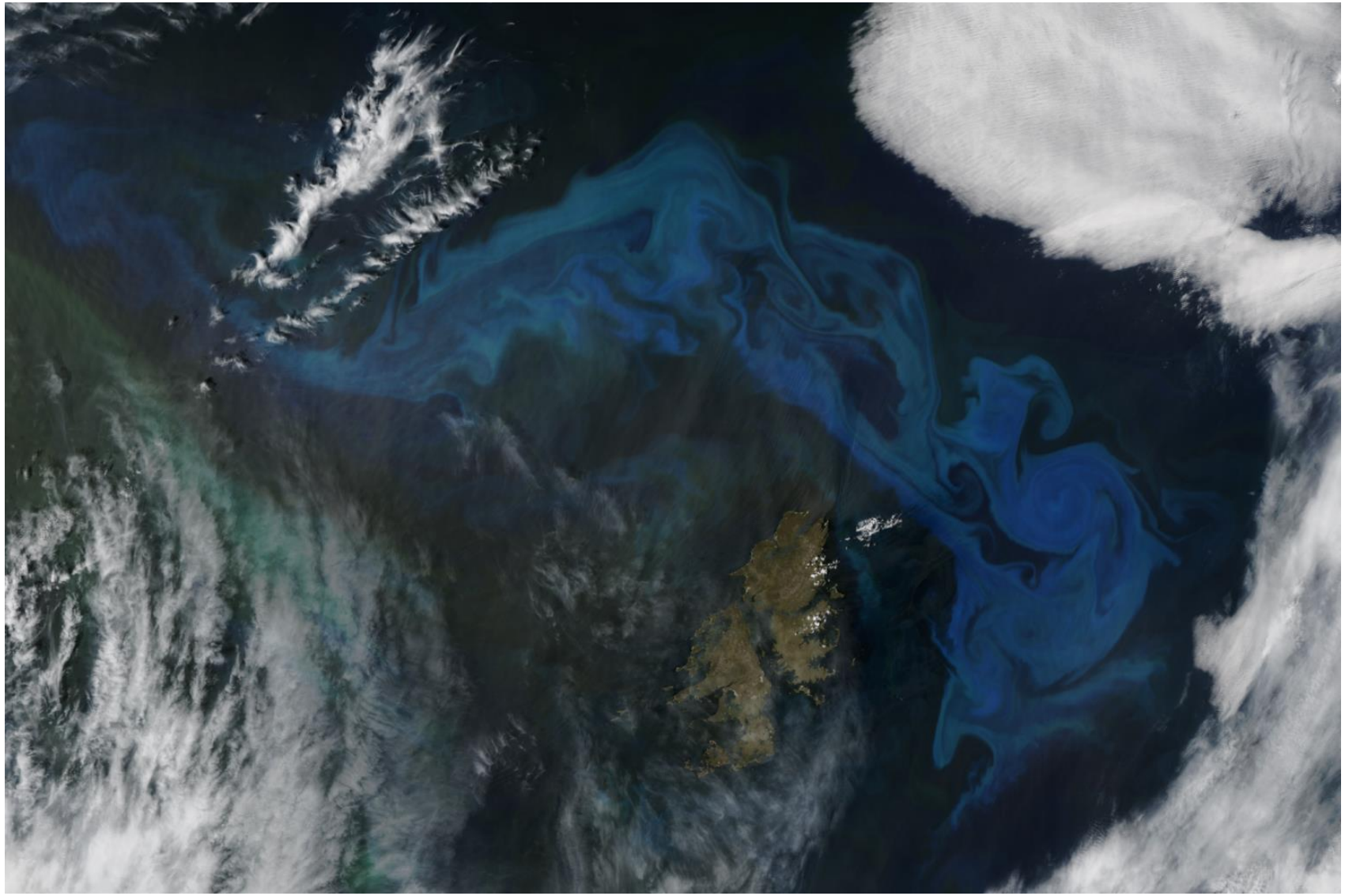
OCView Polar Projections

2017-12-28 Antarctic True Color

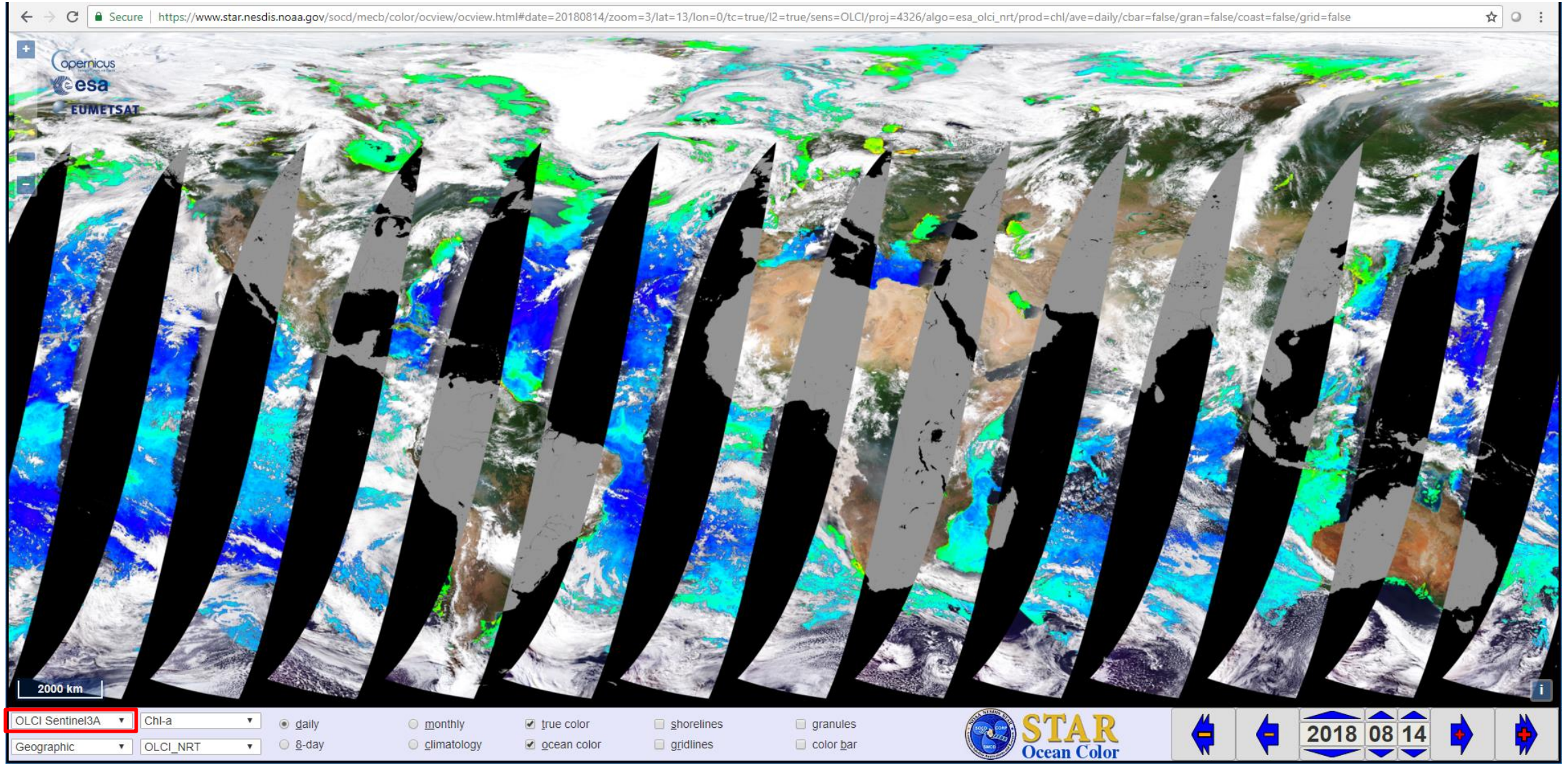


OCView Polar Projections

2017-12-28 Falklands algae bloom

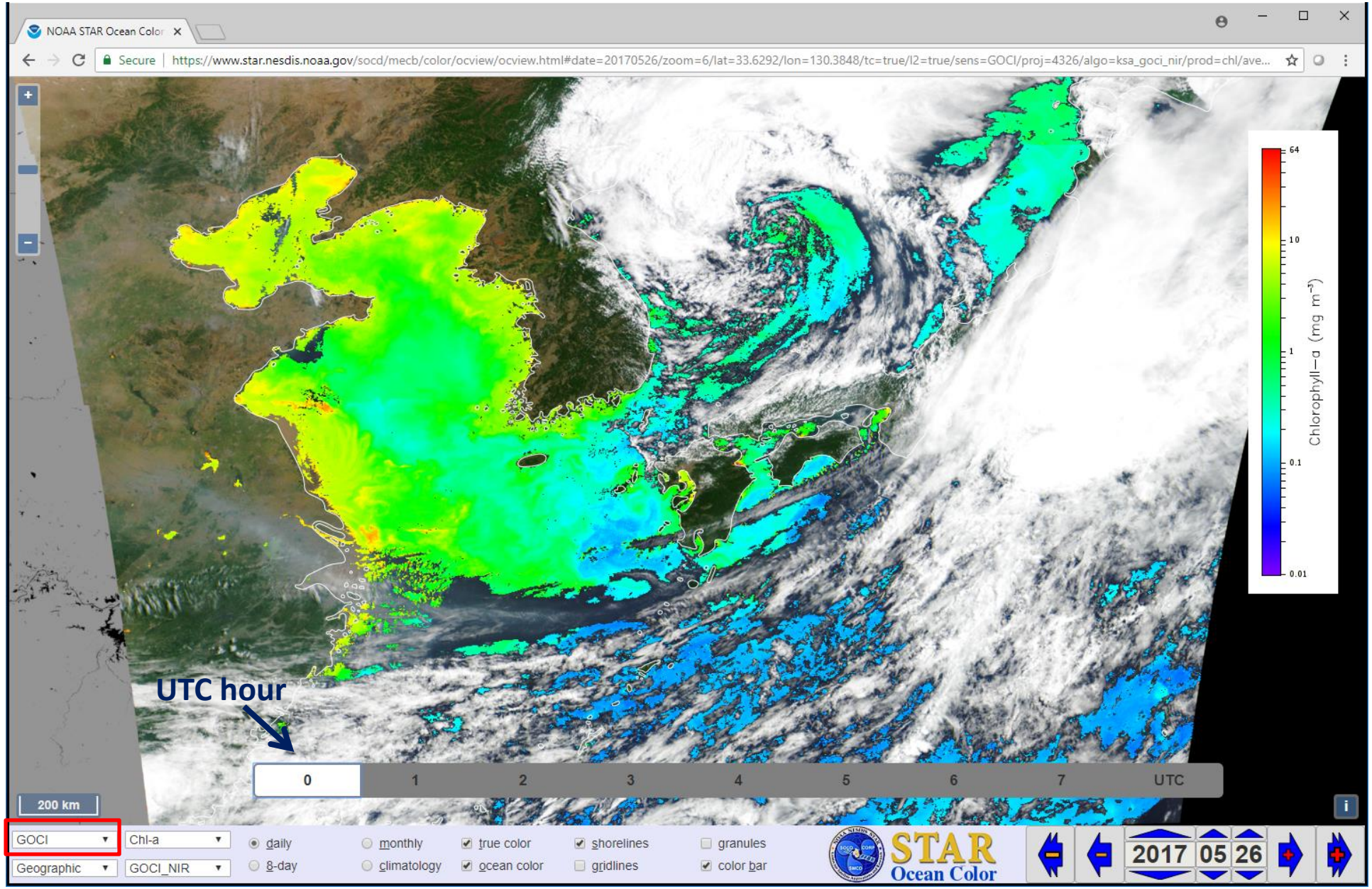


Sentinel-3A OLCI

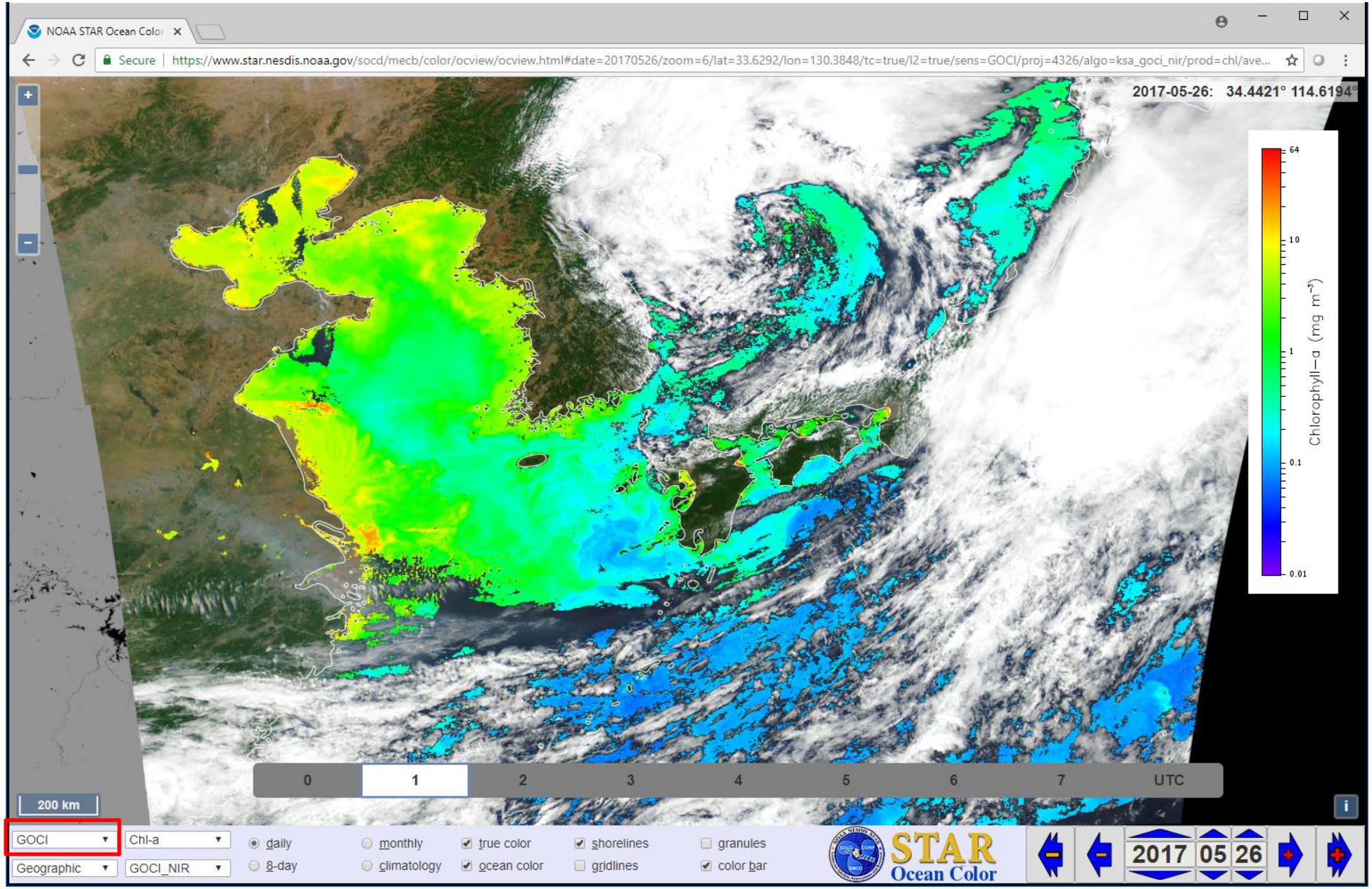


- Mission long imagery archive for S3A true color on OCView (and some ESA/EUMETSAT produced L2 data)
- Sentinel-3B launched on April 25, 2018 and is going to improve OLCI daily coverage

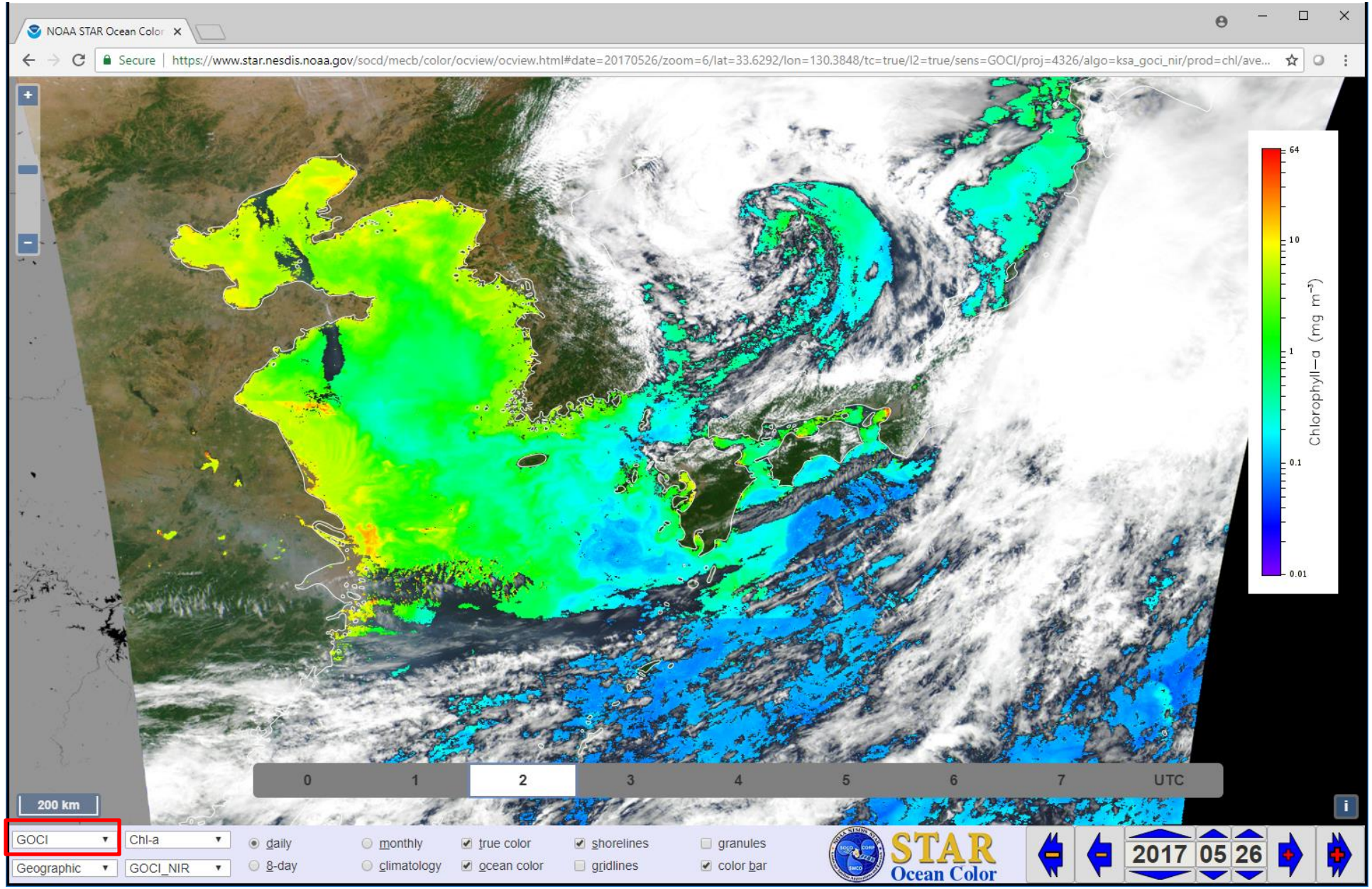
GOCI true color + NOAA MSL12 Chlor-a



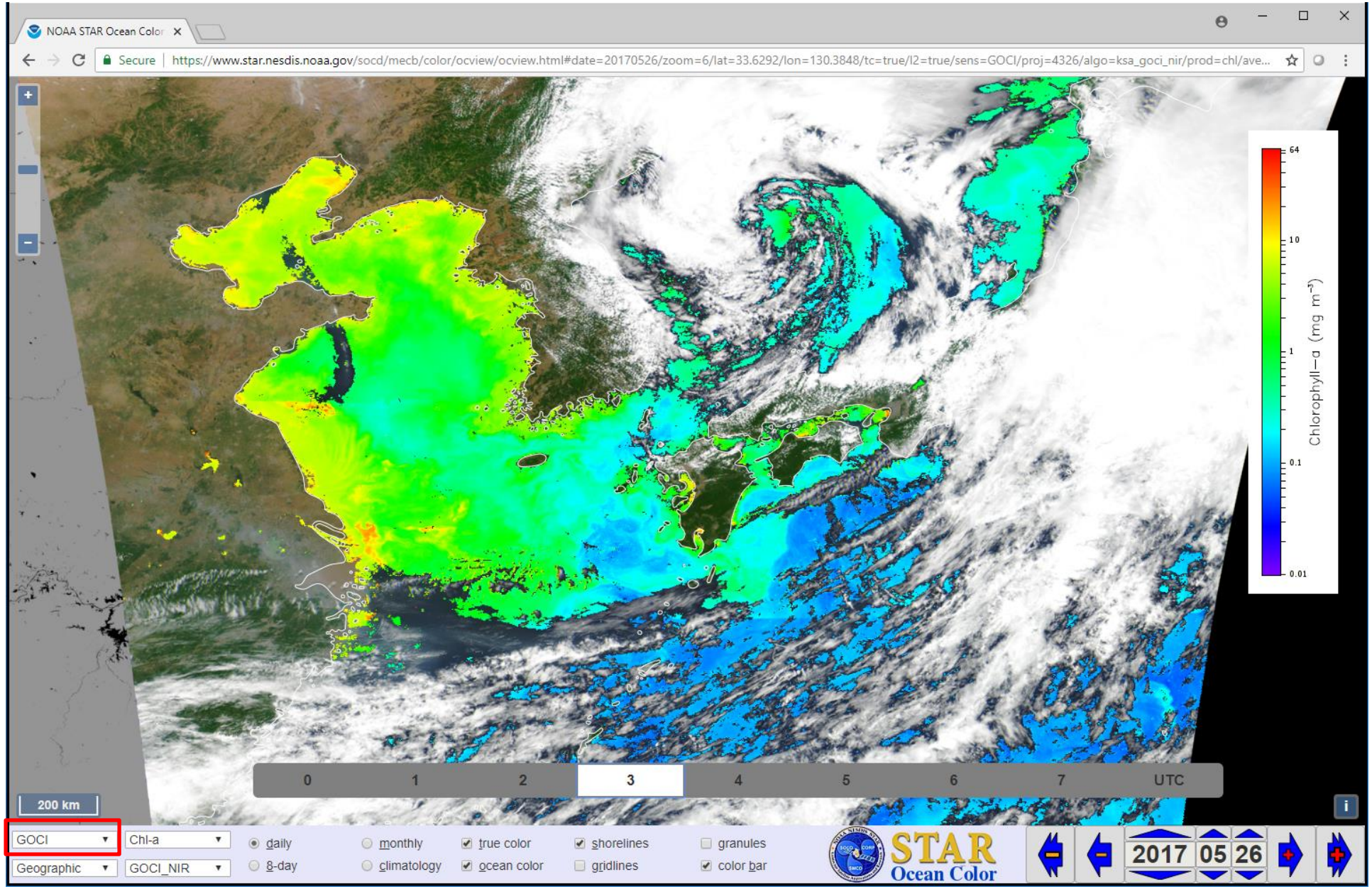
GOCI true color + NOAA MSL12 Chlor-a



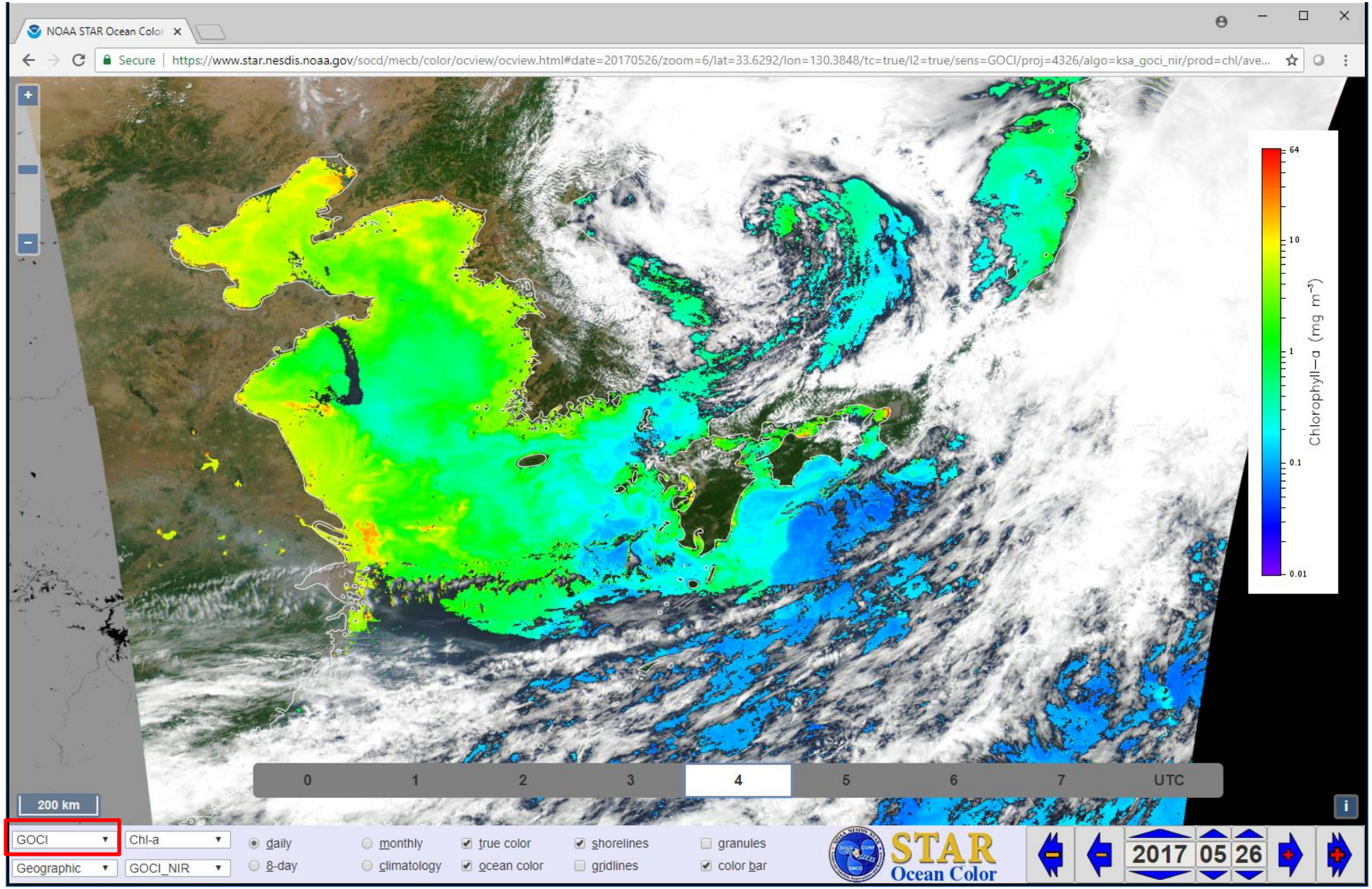
GOCI true color + NOAA MSL12 Chlor-a



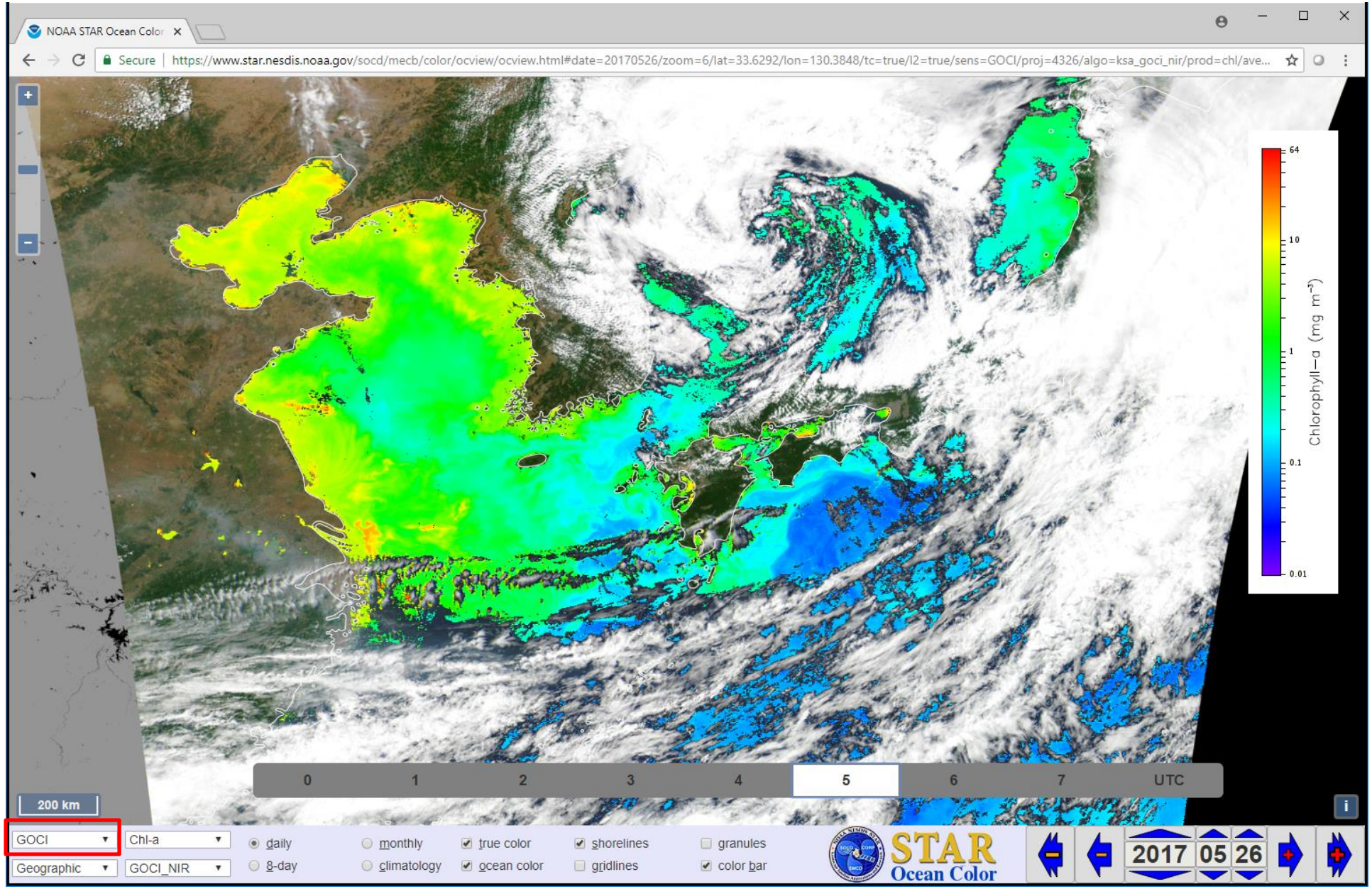
GOCI true color + NOAA MSL12 Chlor-a



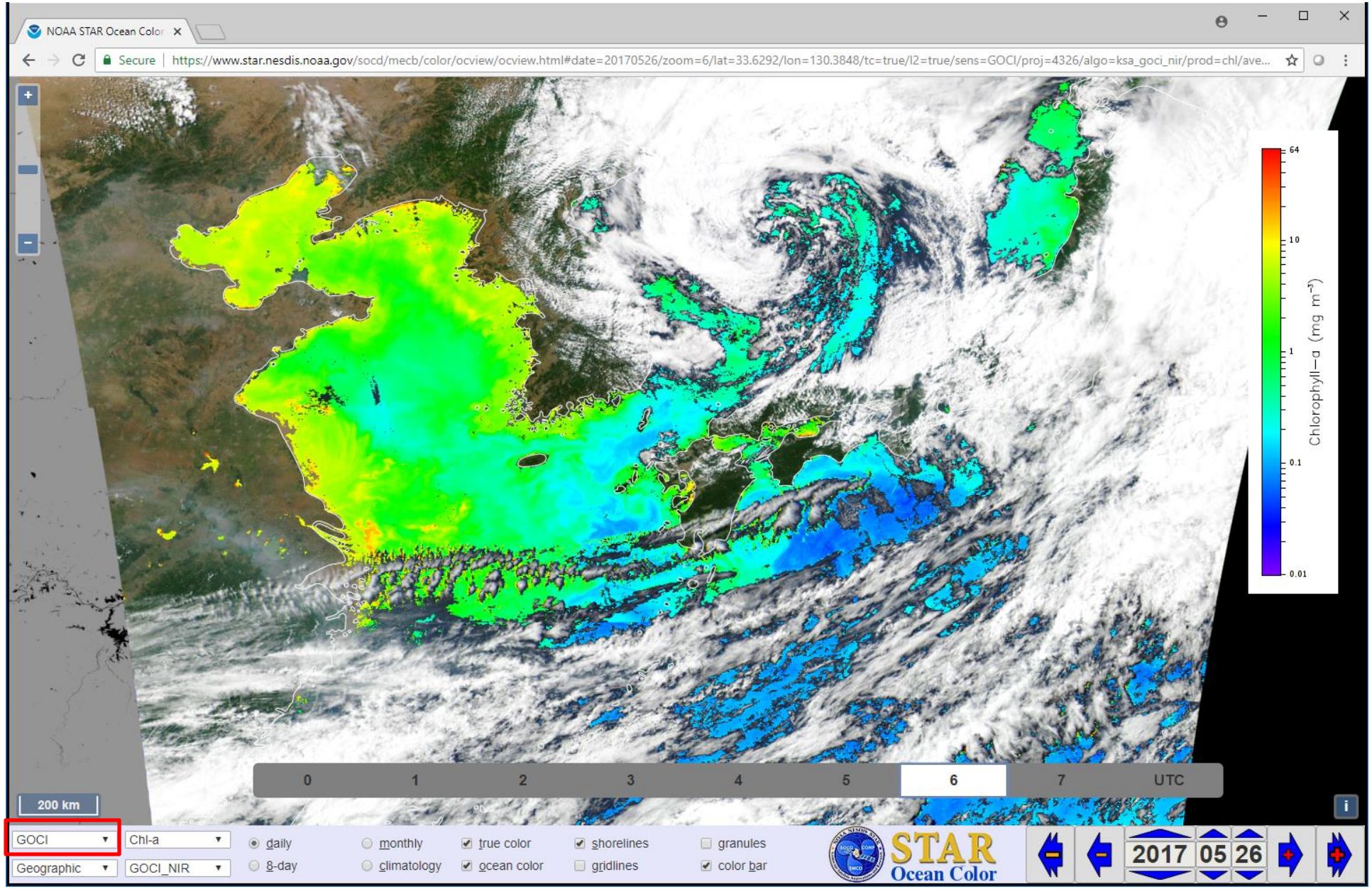
GOCI true color + NOAA MSL12 Chlor-a



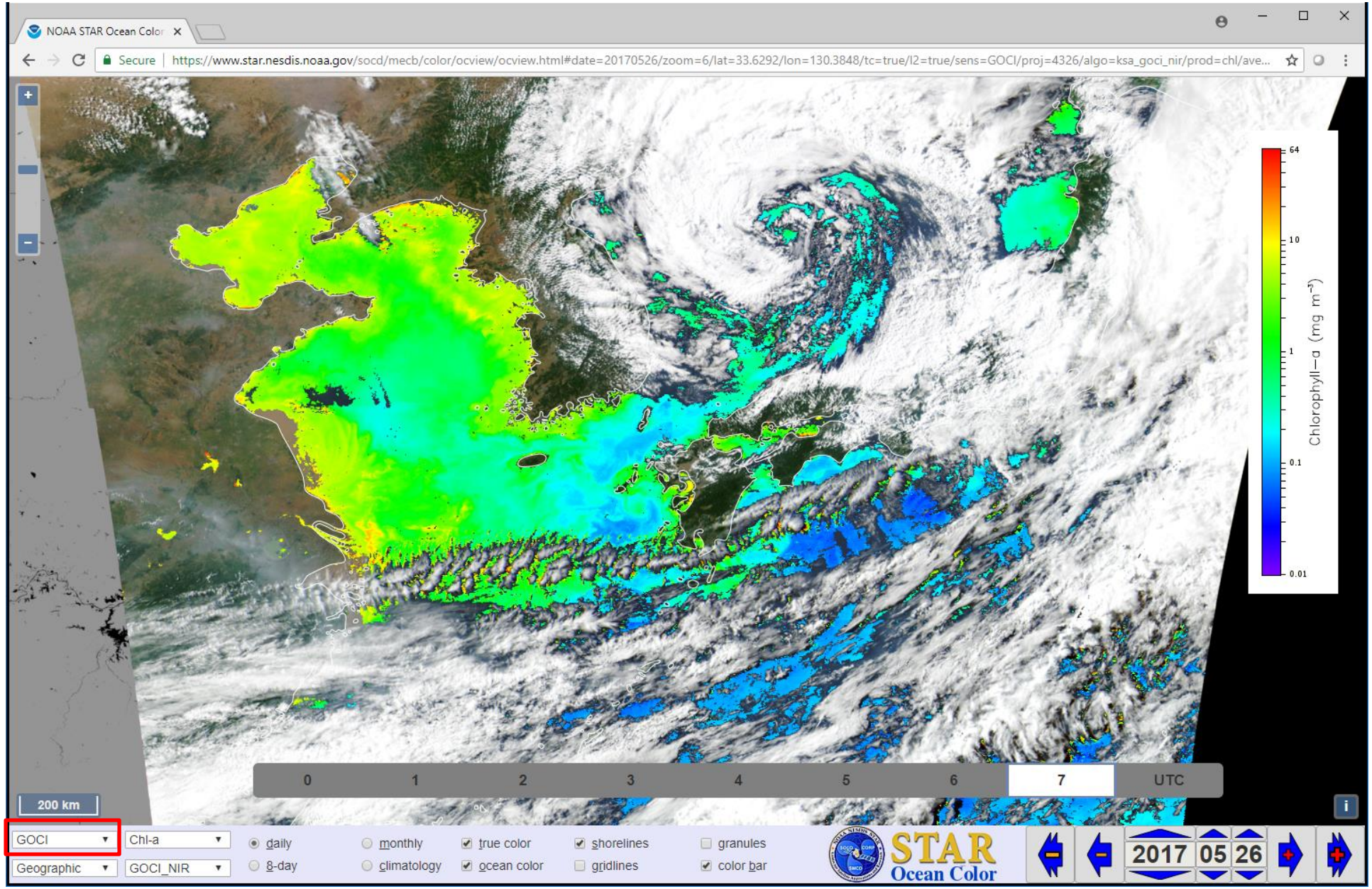
GOCI true color + NOAA MSL12 Chlor-a



GOCI true color + NOAA MSL12 Chlor-a



GOCI true color + NOAA MSL12 Chlor-a



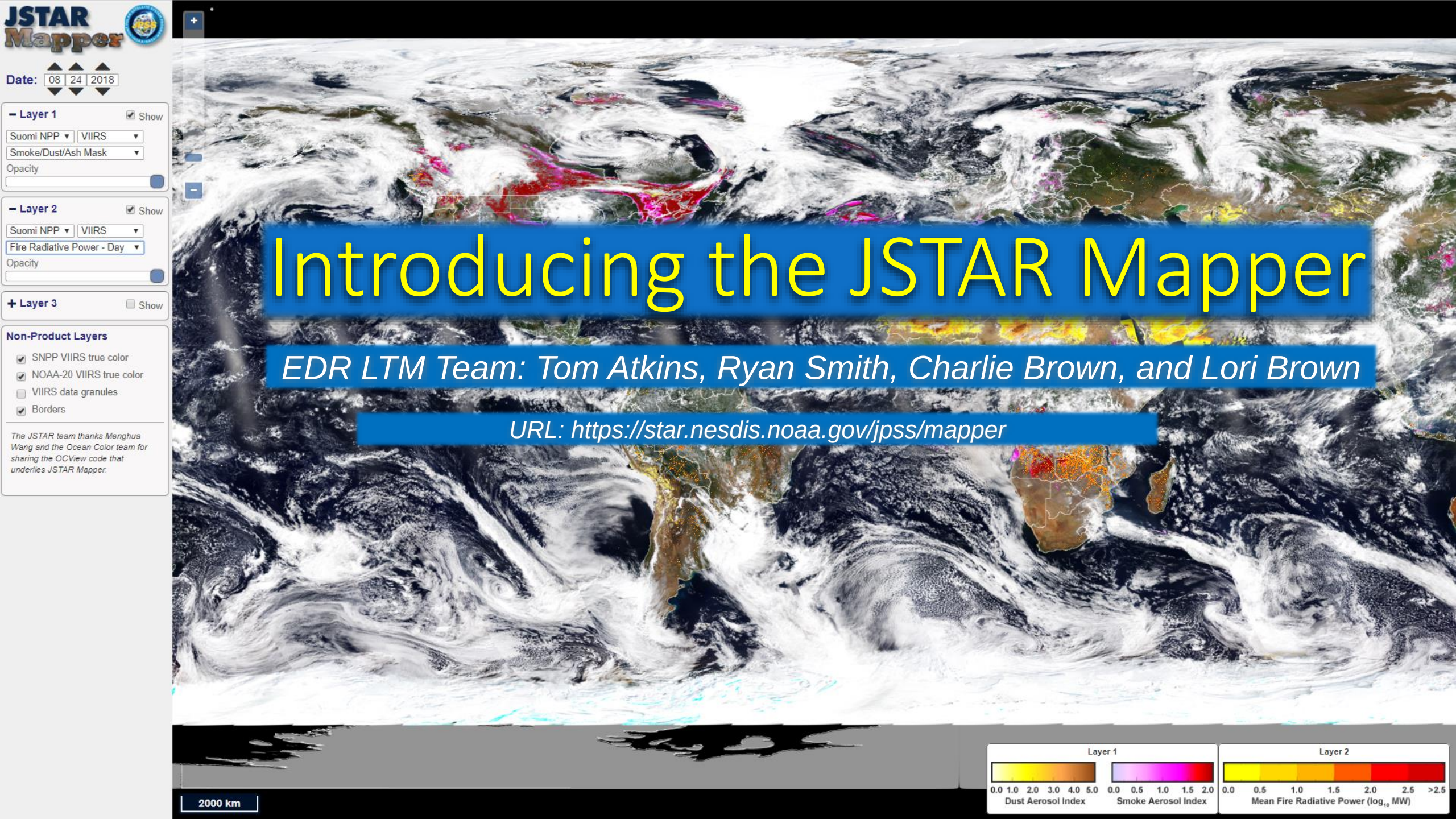
Summary

1. OCView is great, please use it, and send us your feedback!
2. It serves not only as interactive monitoring tool, but also for public engagement, and some quality control
3. IT support is important



Thank you!

https://www.star.nesdis.noaa.gov/socd/mecb/color/ocview/ocview.html


JSTAR Mapper
Date: 08 24 2018
Layer 1 Show
Suomi NPP VIIRS
Smoke/Dust/Ash Mask
Opacity
Layer 2 Show
Suomi NPP VIIRS
Fire Radiative Power - Day
Opacity
Layer 3 Show
Non-Product Layers
SNPP VIIRS true color
NOAA-20 VIIRS true color
VIIRS data granules
Borders
The JSTAR team thanks Menghua Wang and the Ocean Color team for sharing the OCView code that underlies JSTAR Mapper.
Introducing the JSTAR Mapper
EDR LTM Team: Tom Atkins, Ryan Smith, Charlie Brown, and Lori Brown
URL: https://star.nesdis.noaa.gov/jpss/mapper
2000 km
Layer 1
0.0 1.0 2.0 3.0 4.0 5.0
Dust Aerosol Index
0.0 0.5 1.0 1.5 2.0
Smoke Aerosol Index
Layer 2
0.0 0.5 1.0 1.5 2.0 2.5 >2.5
Mean Fire Radiative Power (log10 MW)

JPSS EDR LTM Team Background

- Success of ICVS and the need for consistent monitoring lead to a meeting in 2014 with each team presenting their current monitoring strategies and future plans.
- After the meeting, it was clear that a centralized team would be needed to create and maintain high quality monitoring for all teams.
- Previously JPSS product teams would host images of their operational EDR products on separate websites with varying display formats and availability.
- The EDR Long-Term Monitoring (LTM) team was established to construct a centralized location to host images of the EDR products in a consistent manner
- This site provides an avenue for product teams and users to monitor the long-term performance of JPSS EDR products

JPSS EDR LTM Website

- We currently produce 950+ images for Suomi-NPP daily
- NOAA-20 products are also being produced for select teams
- Includes global images as well as polar images depending on the product
- The website can be found at:

https://www.star.nesdis.noaa.gov/jpss/EDRs/
for Suomi NPP

https://www.star.nesdis.noaa.gov/jpss/EDRs/
for NOAA-20

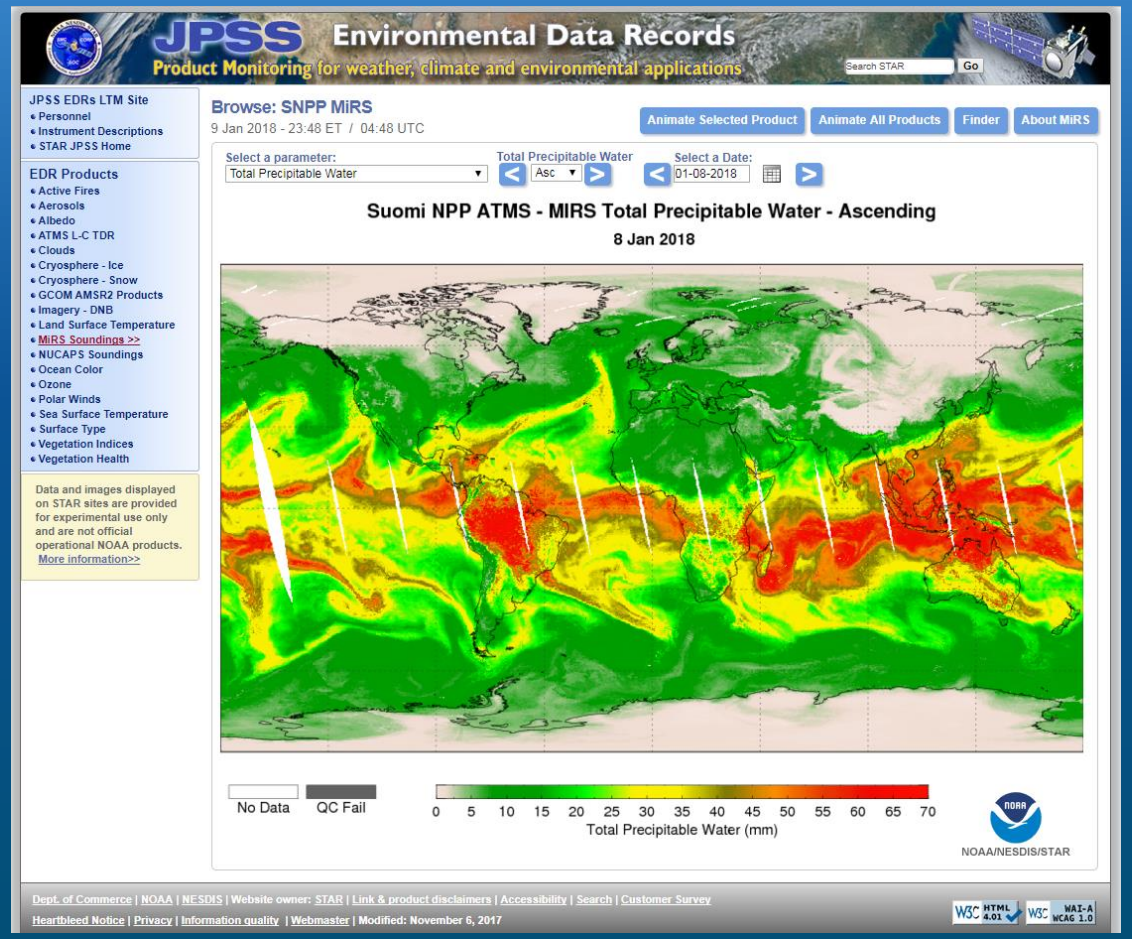


Figure: Screen capture of the JPSS EDR LTM website on Jan. 8, 2018. The product depicted is ATMS – MIRS Total Precipitable Water

Why JSTAR Mapper?

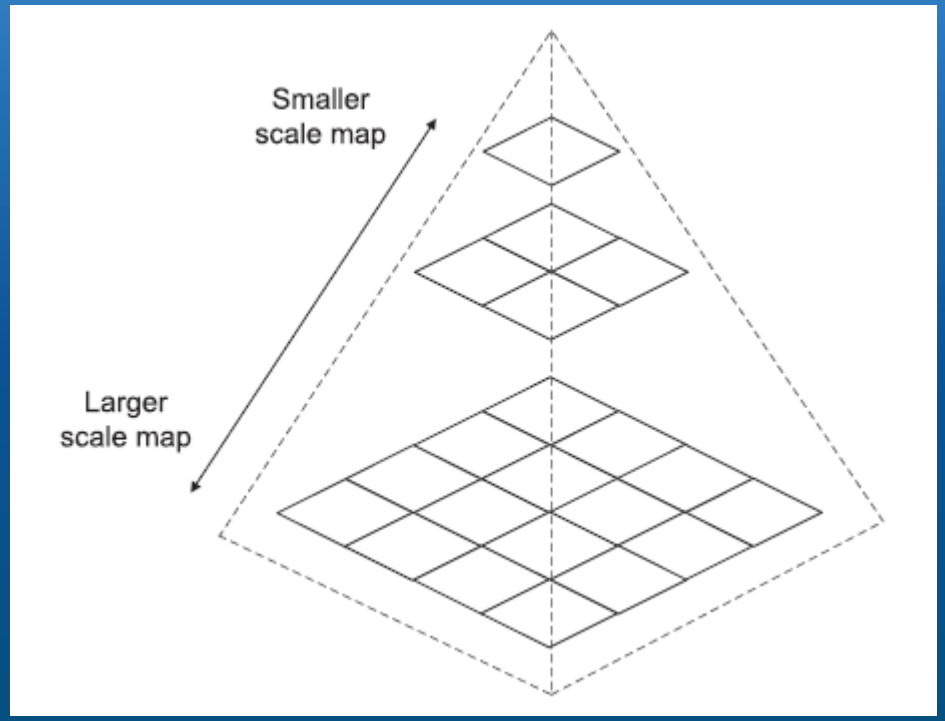
- The EDR LTM team noticed an increase in the volume of requests for images of specific events (e.g. hurricanes, fires, intense snow events).
- The current EDR LTM website is not capable of providing area-specific images of products, which limits our ability to meet these requests in a timely fashion.
- EDR LTM is uniquely situated to create this product because of access to data via SCDR or offline products, existing EDR LTM processing, and great relationships with the scientists
- **The solution**: an interface that will allow EDR products to be displayed in a high resolution fashion with multiple zoom levels

What is JSTAR Mapper?

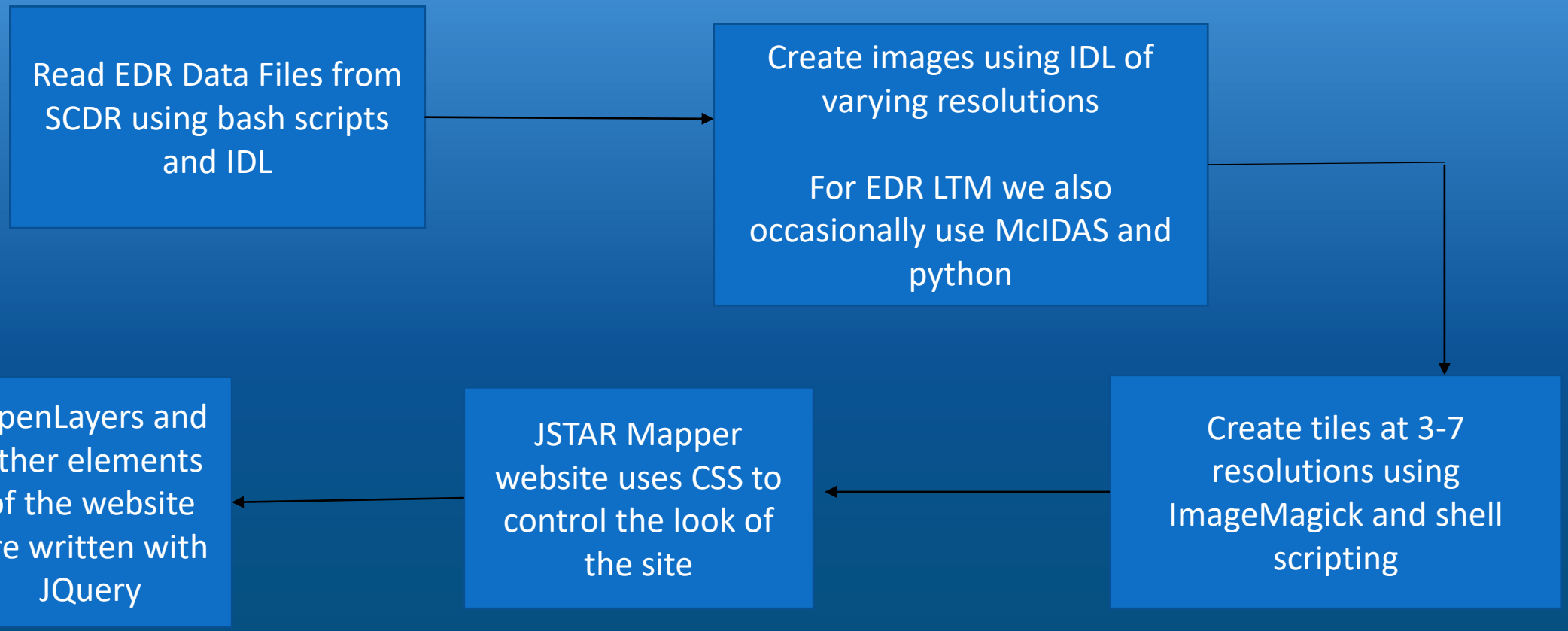
- JSTAR Mapper is built upon the interface already established and used by STAR's Ocean Color team, OCView
- Some features of JSTAR Mapper include:
  - Multiple zoom levels, allowing products to be shown at (or close to) their full resolution (up to 131072 x 65526 pixels - ~ 300 meters at the equator)
  - Up to three layers of products can be overlayed plus various preset backgrounds (blank map, VIIRS True Color during day or I5 Band at night, topographic map, national borders)
  - Optional granule layer to let users identify which data belong to which granule (SNPP VIIRS Only)
  - "Infinite" scrolling to allow a continuous view of global data over time
  - Display latitude, longitude, and measurement of a pixel by hovering the mouse over the desired pixel

How Do We Make The Maps

- Products come in a range of resolutions – from OMPS (50 km footprint) to VIIRS Imagery Band derived products (375 m at nadir)
- Each product is produced from the lowest resolution (1024x512 global map) to the highest possible for the product.
- Images saved as 512x512 pixel “tiles” in a pyramid format – each level is 2 times the resolution of the previous level.
- A free software tool – OpenLayers – is used to display the tiles on the JSTAR Mapper website.
- Most products made daily as of now – but we are beginning to produce some in Near-real time.



How Do We Make The Maps



A Closer Look at JSTAR Mapper

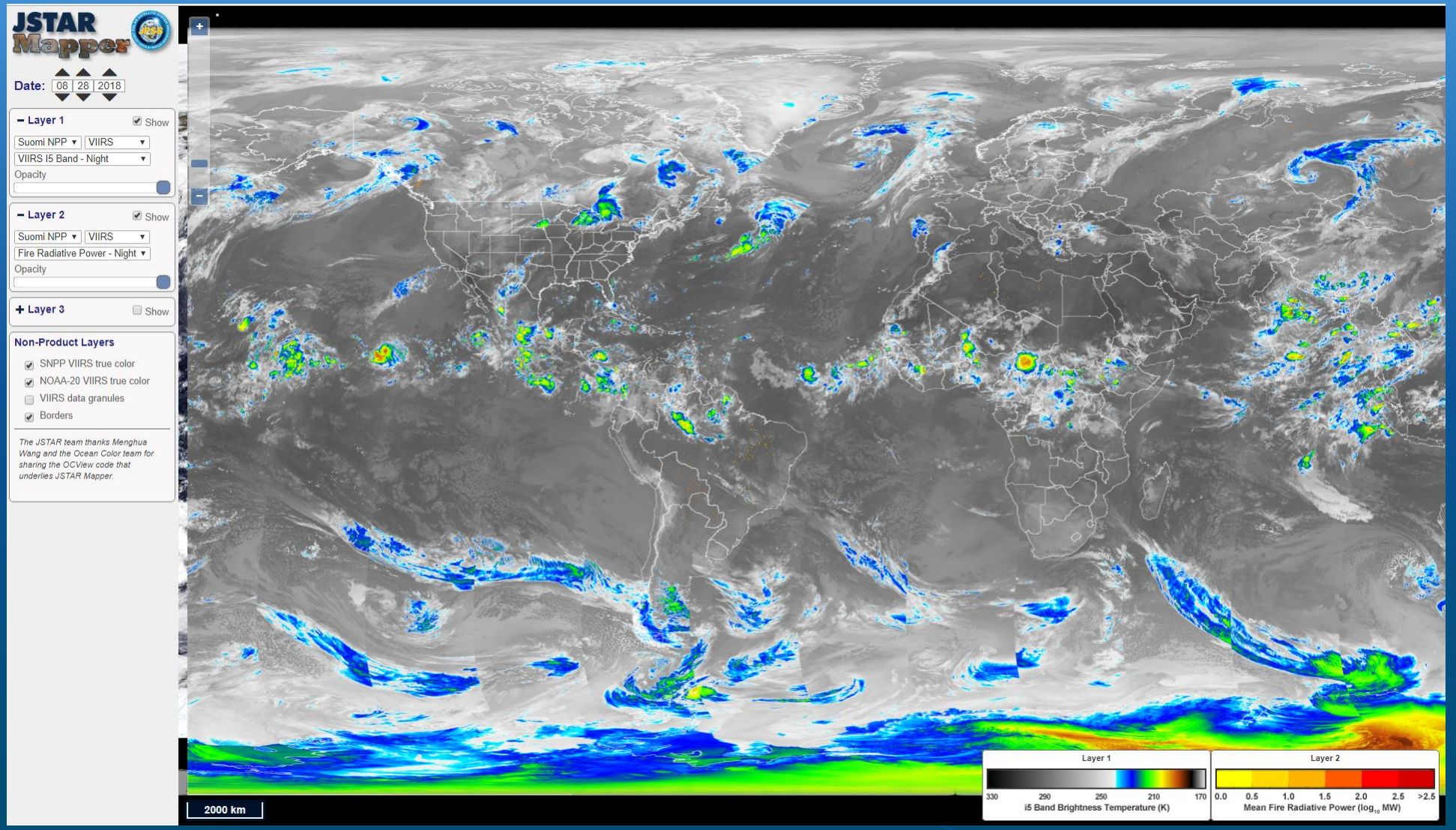
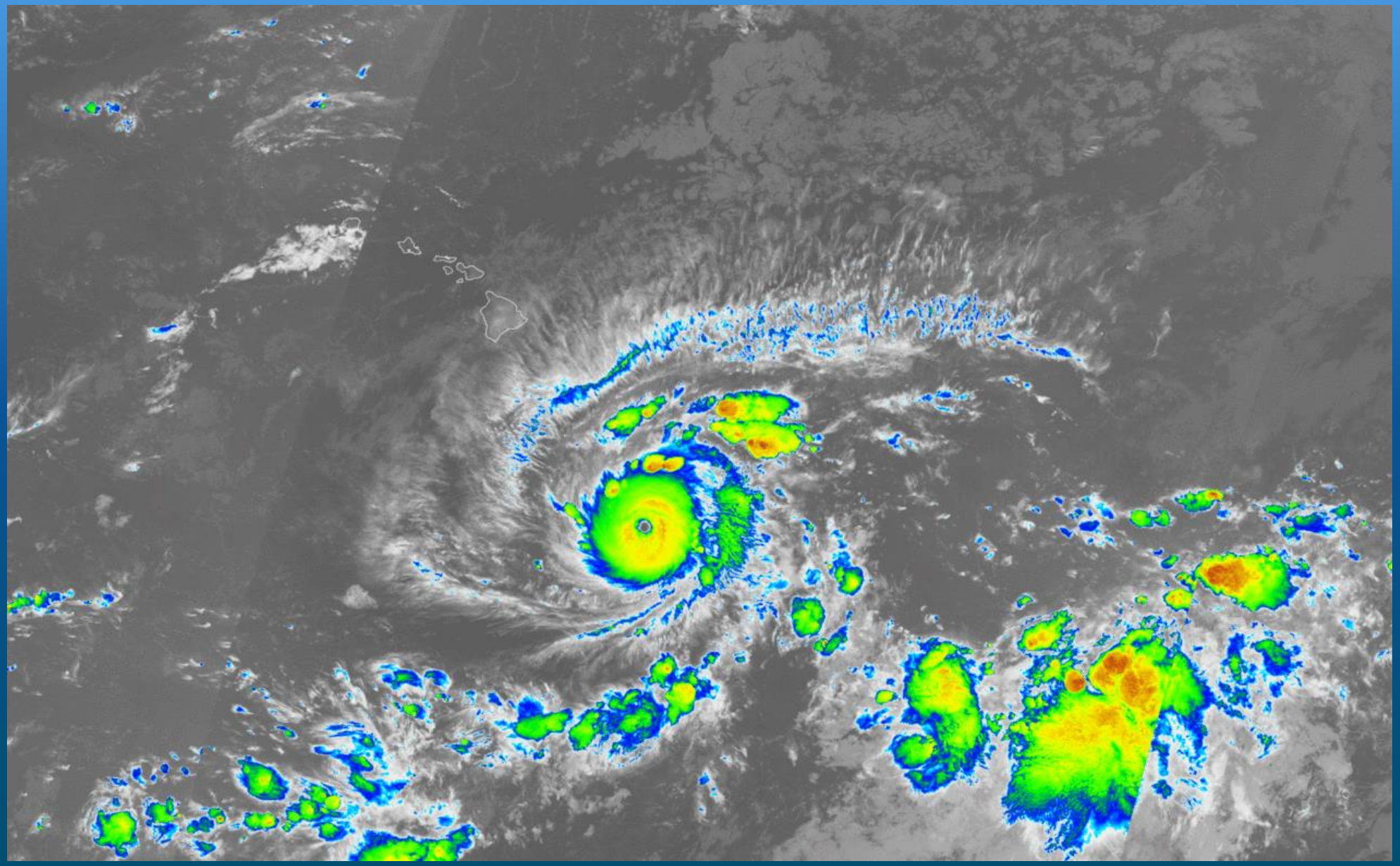
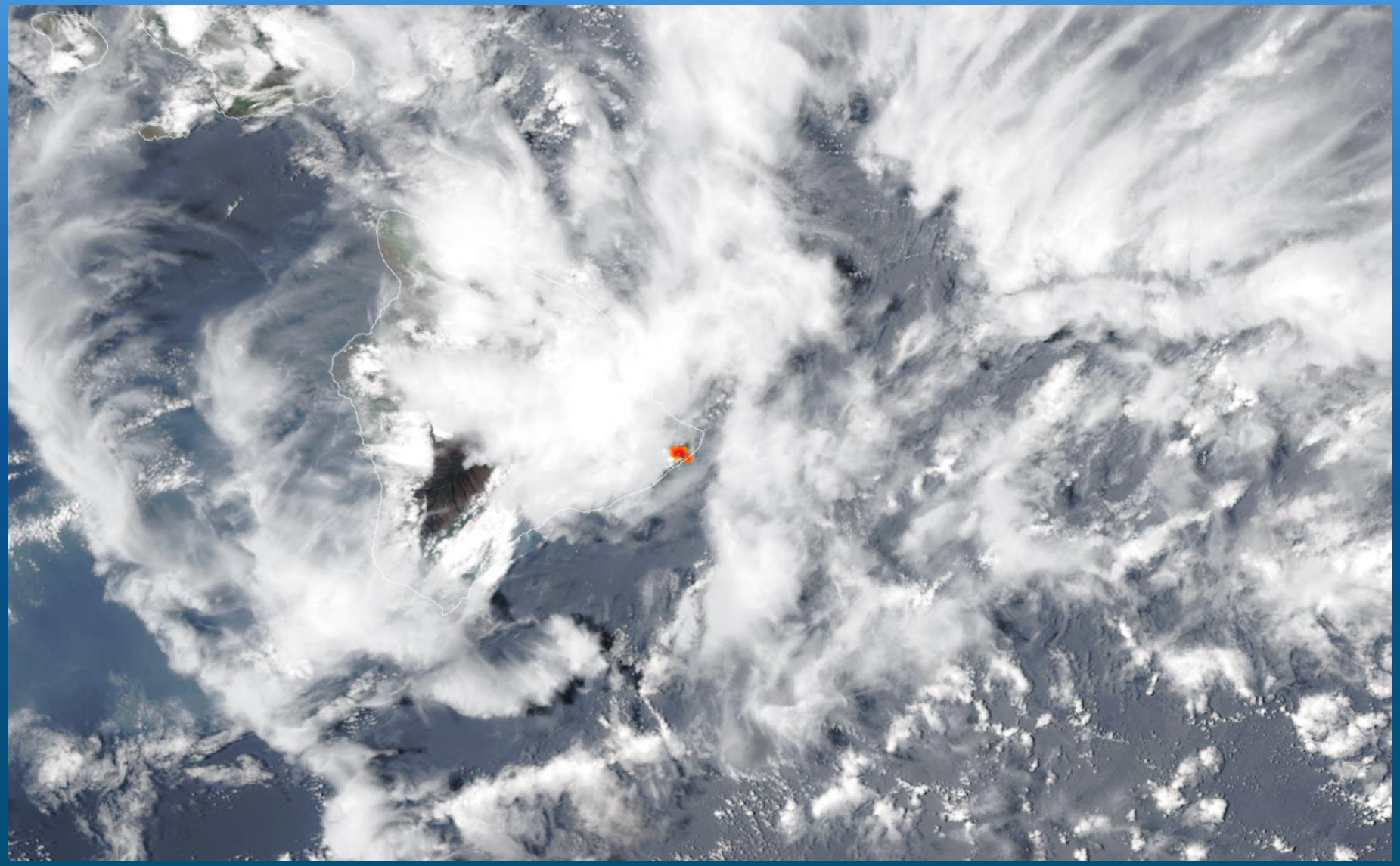


Figure: Screen capture of the JSTAR Mapper website on August 28, 2018. This is a map of VIIRS i5 Band and Fire Radiative Power at night. http://star.nesdis/noaa.gov/jpss/mapper/

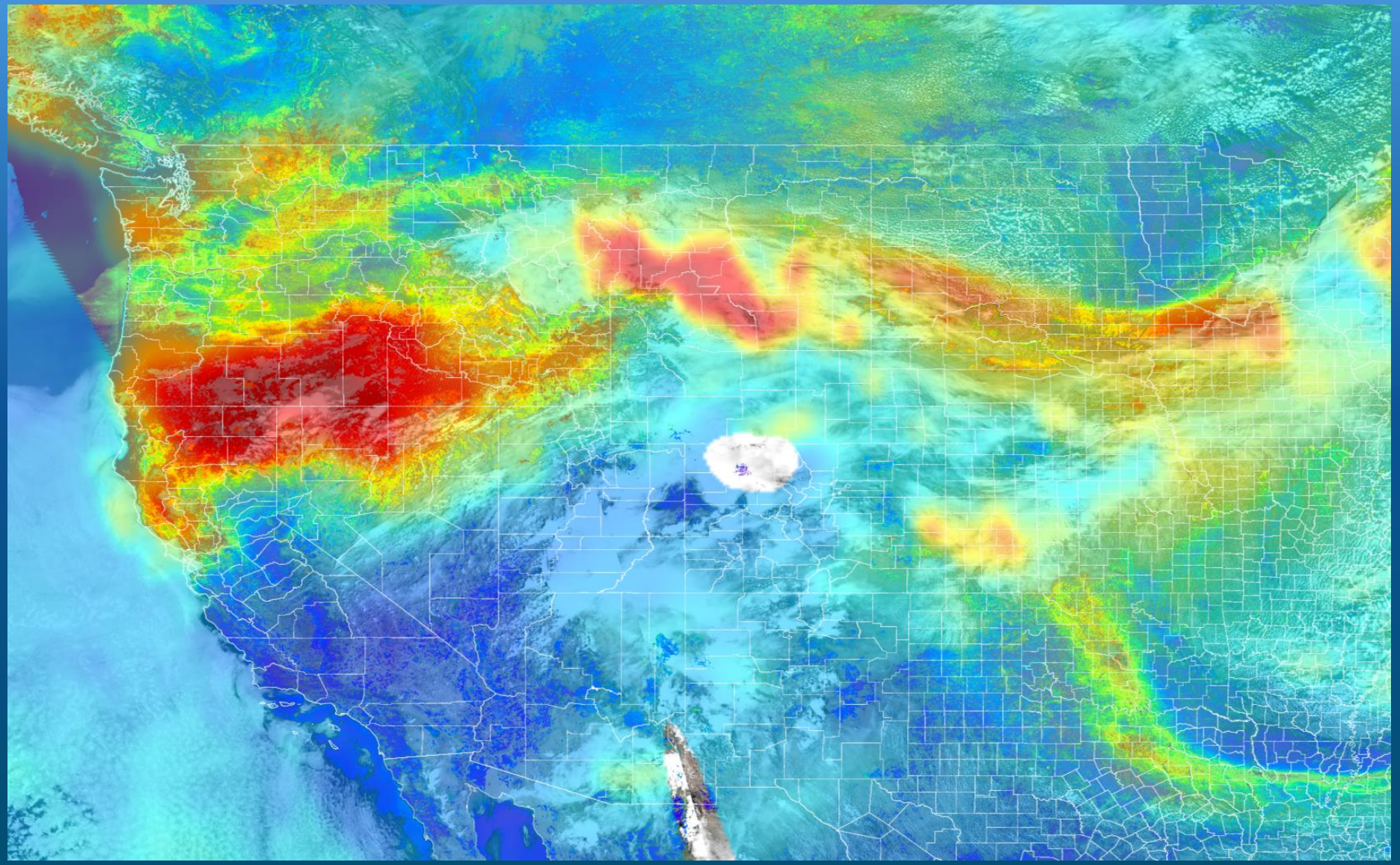
Hurricane Lane



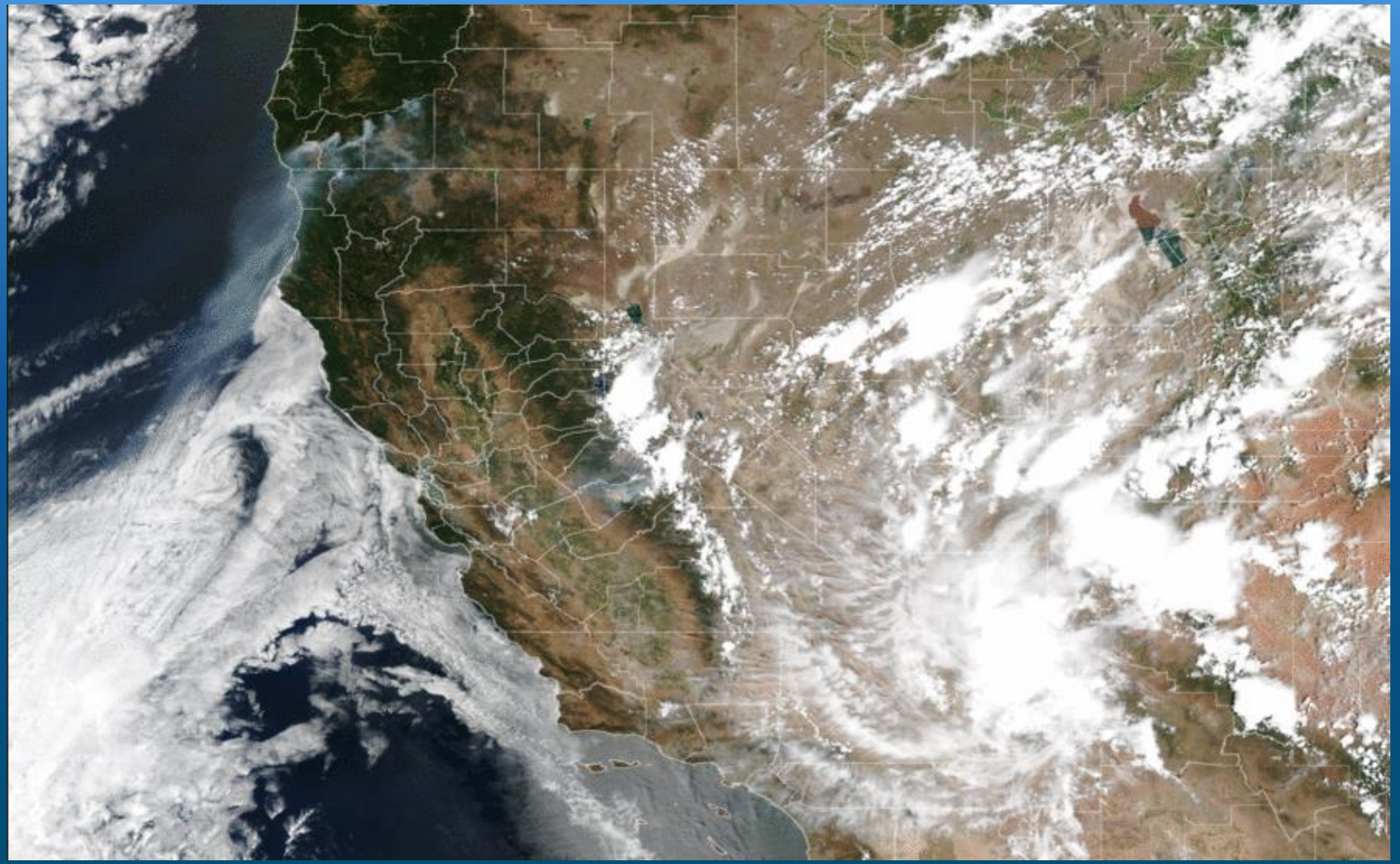
Kilauea Volcano



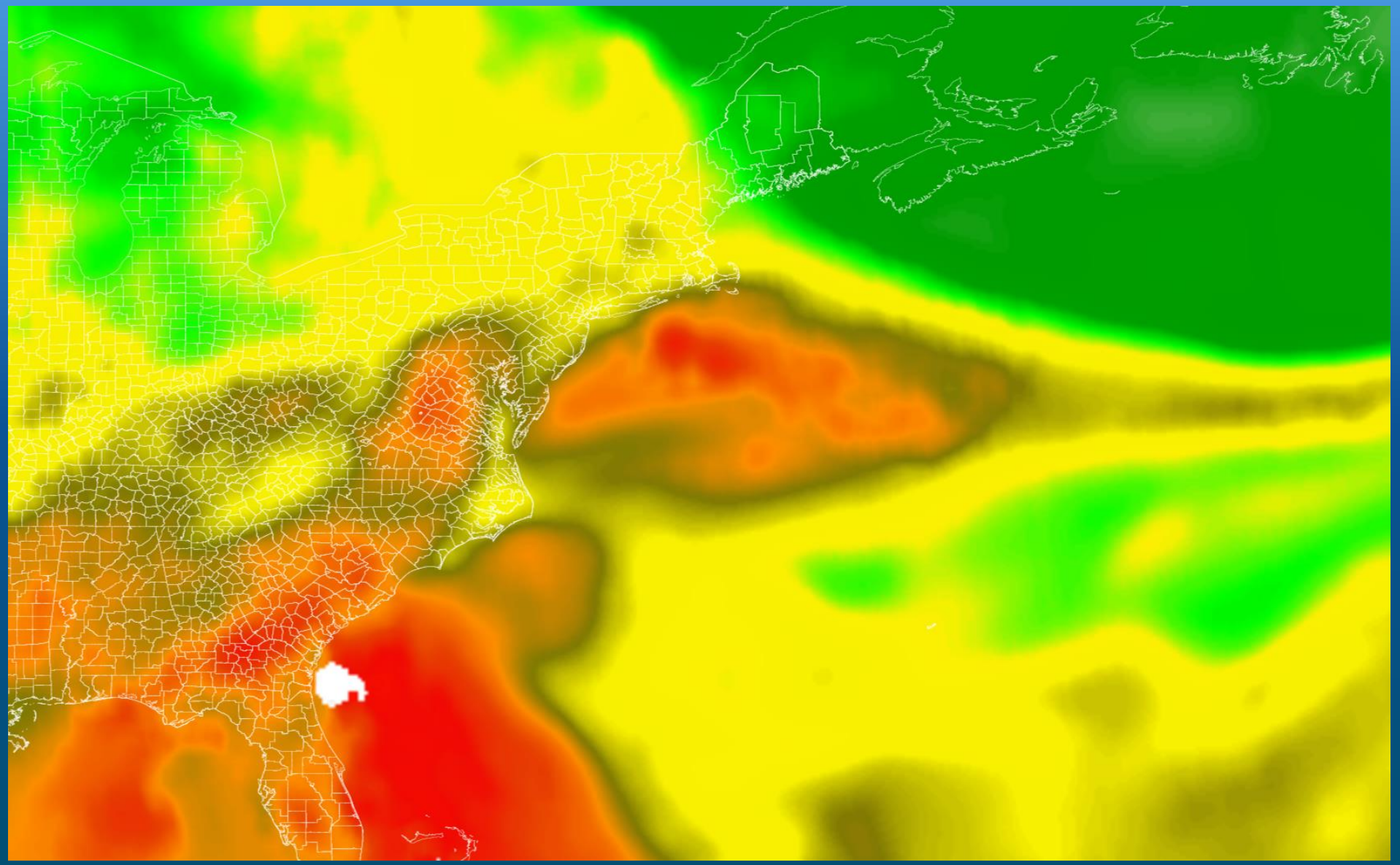
August 2018 Western Wildfires/Smoke



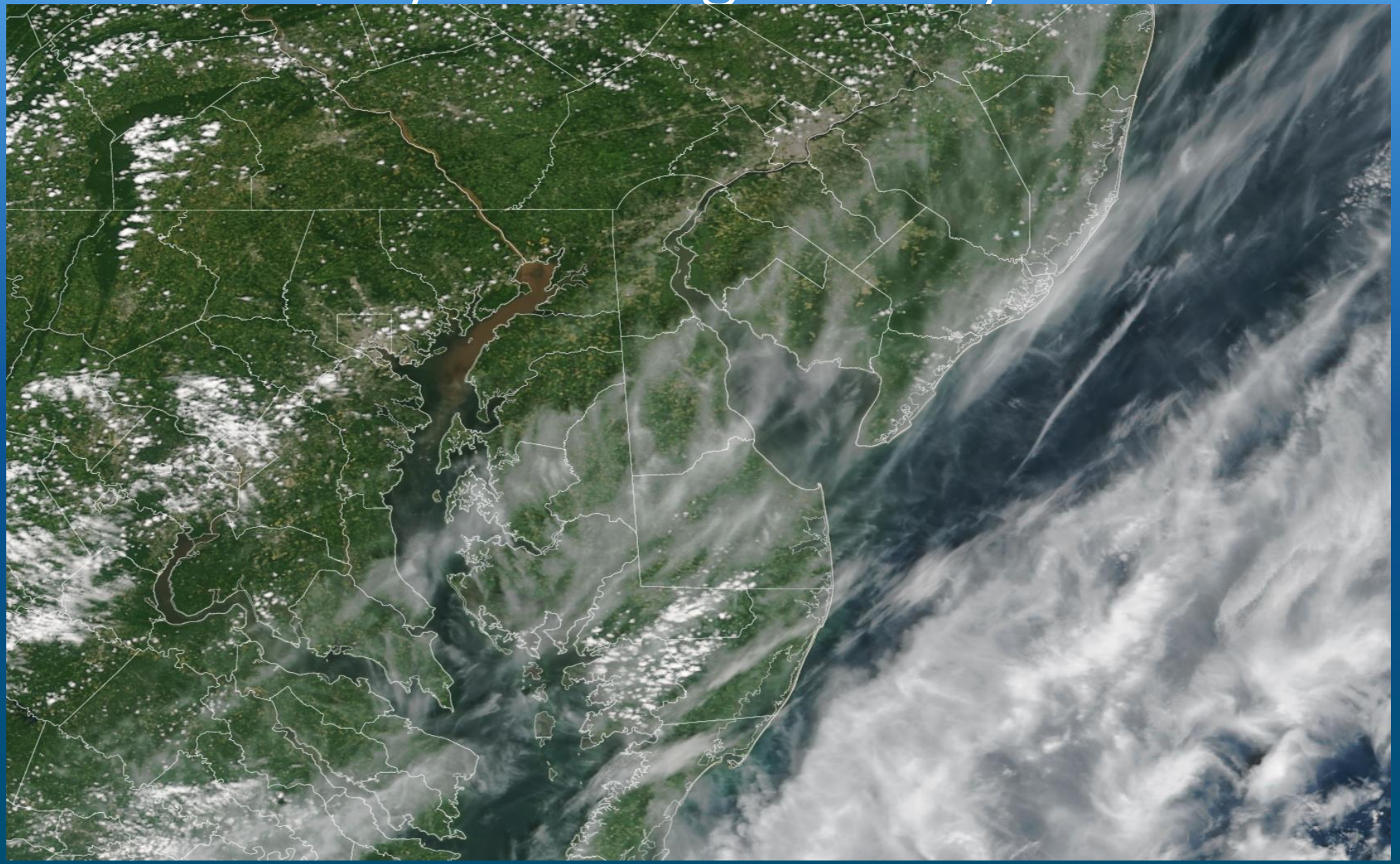
August 2018 Western Wildfires/Smoke



May 27 Ellicott City Flood



July Flooding in Maryland



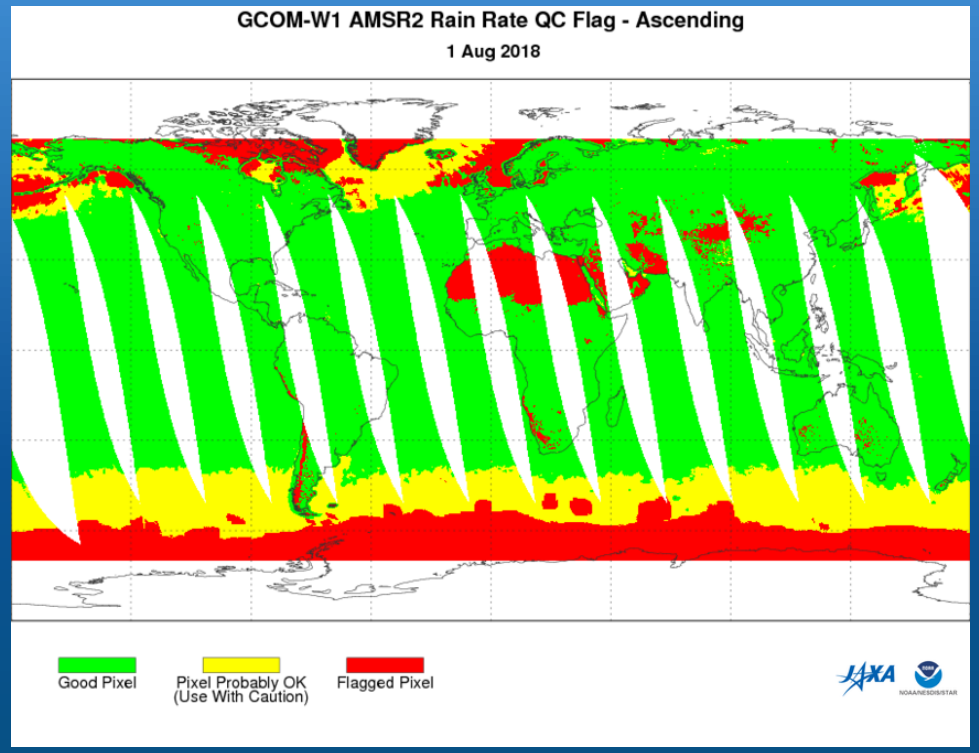
Path Forward: JSTAR Mapper

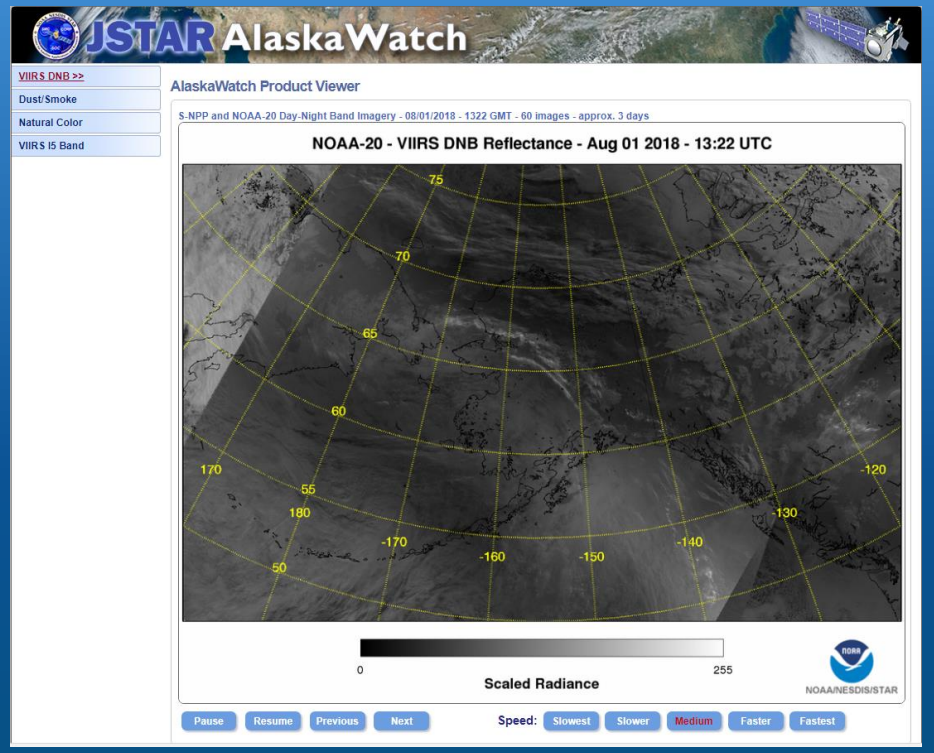
- Near-term improvements
  - Add all available JPSS EDRs initially on a daily basis, then more frequently.
  - Add VIIRS Single Band and RGB images with help of ICVS team – including DNB, Fire Temperature RGB, Snow/Cloud RGB and Natural Color RGB.
  - Add a separate ascending and descending view for appropriate products.
  - Have a polar stereographic site for appropriate products (e.g. Sea Ice Concentration, Snow Cover, etc)
  - Make NOAA-20 products available as they reach provisional status.
  - Create mouse hover function to allow users to obtain data values from map
  - Create granule map for all instruments

Path Forward: JSTAR Mapper

- Create mouse hover function to allow users to obtain data values from map
- Create granule map for all instruments for all 3 satellites.
- User interface changes to make the website better for smaller screens.
- Allow users to easily download single map images or animations of multiple days.
- Allow users to add custom layers for user specific demands.

New Products from EDR LTM team





- Improvements to the EDR LTM site include the consistent addition of new products from Suomi NPP and NOAA-20. We are also adding Quality Flag maps and product Quality charts.
- In addition to the mapper, we have created a new site – AlaskaWatch for meterologists to view JPSS products in near real time to aid forecasting. https://www.star.nesdis.noaa.gov/jpss/alaskawatch/

Thank You

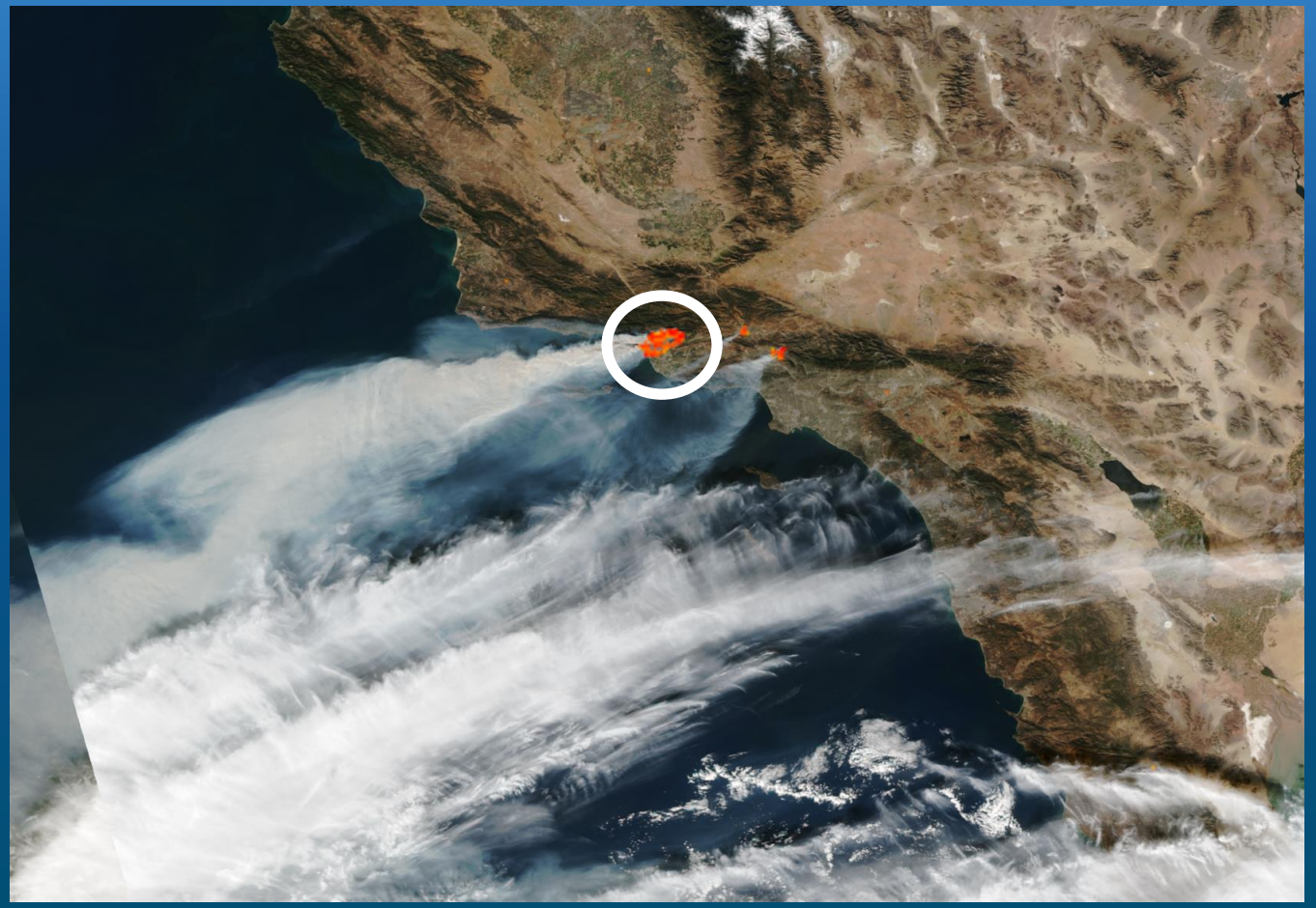
Acknowledgements

- JPSS Program
- Lihang Zhou
- STAR's Ocean Color Team
- All JPSS EDR product teams

Thomas Fire

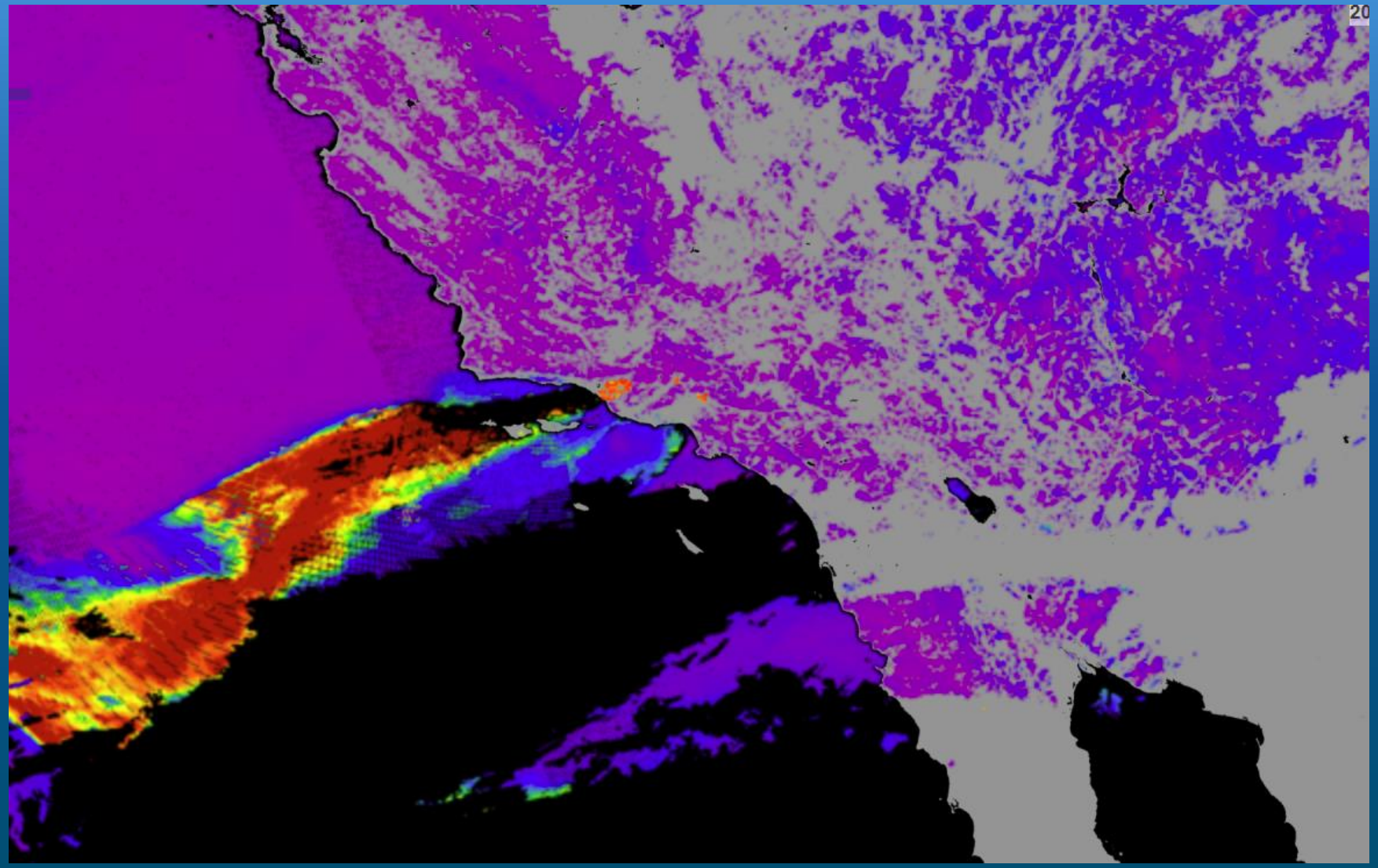
- **VIIRS NDE Fire Radiative Power**

December 5, 2017



Thomas Fire December 5, 2017

- VIIRS NDE Fire Radiative Power
- VIIRS Aerosol Optical Depth at 550 nm EPS



Atlas Fire October 9, 2017

- **VIIRS NDE Fire Radiative Power**

