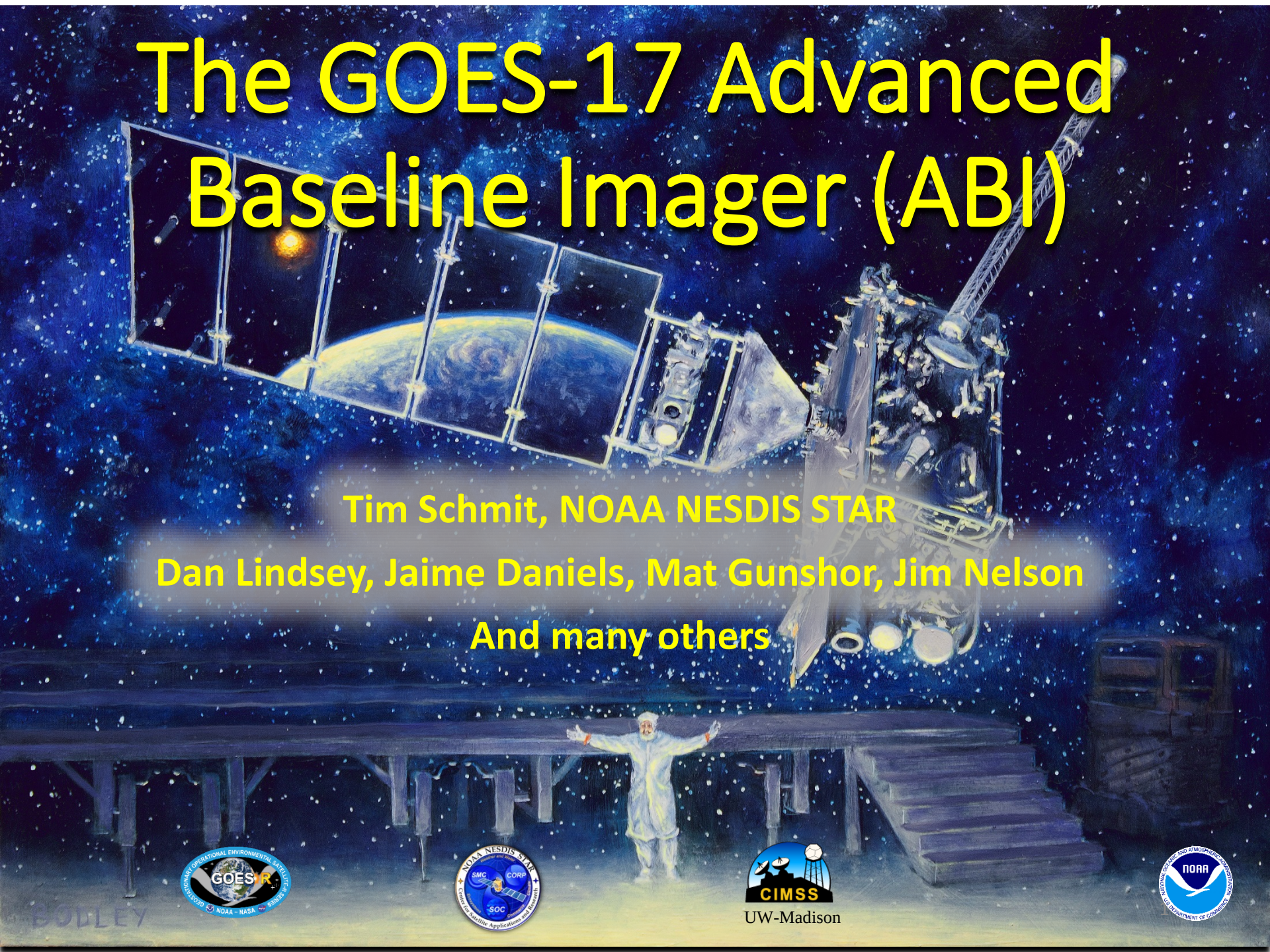
The GOES-17 Advanced Baseline Imager (ABI)



Tim Schmit, NOAA NESDIS STAR

Dan Lindsey, Jaime Daniels, Mat Gunshor, Jim Nelson

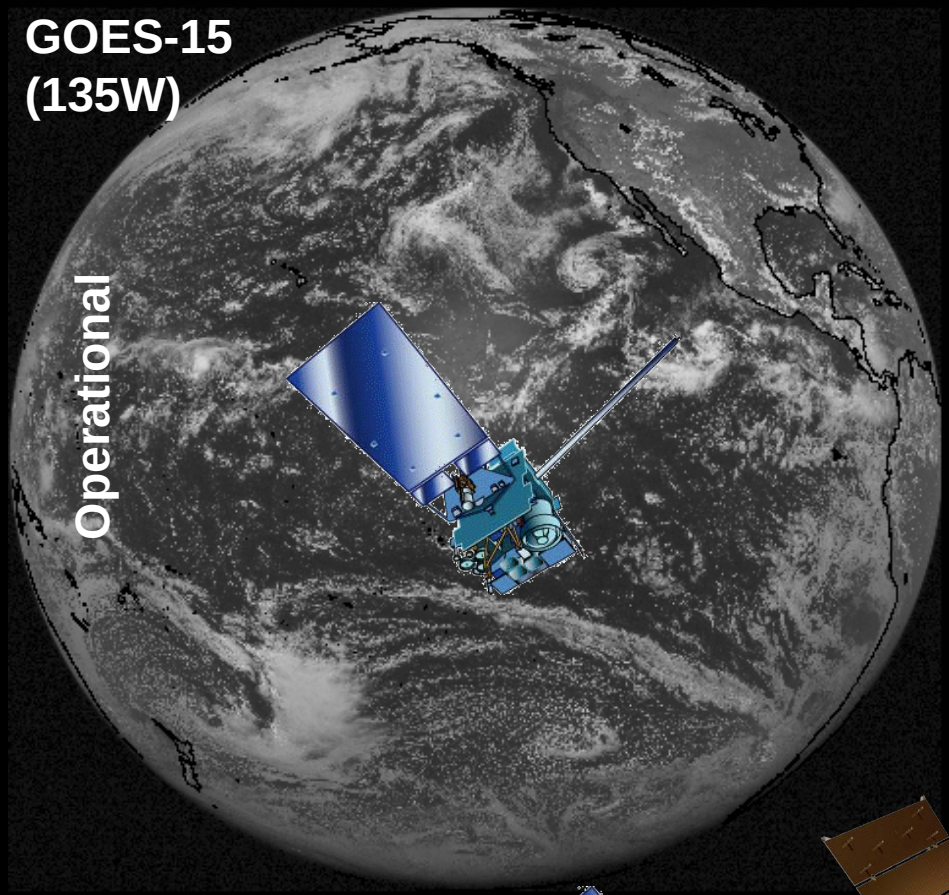
And many others

UW-Madison

NOAA GOES Constellation (2018)

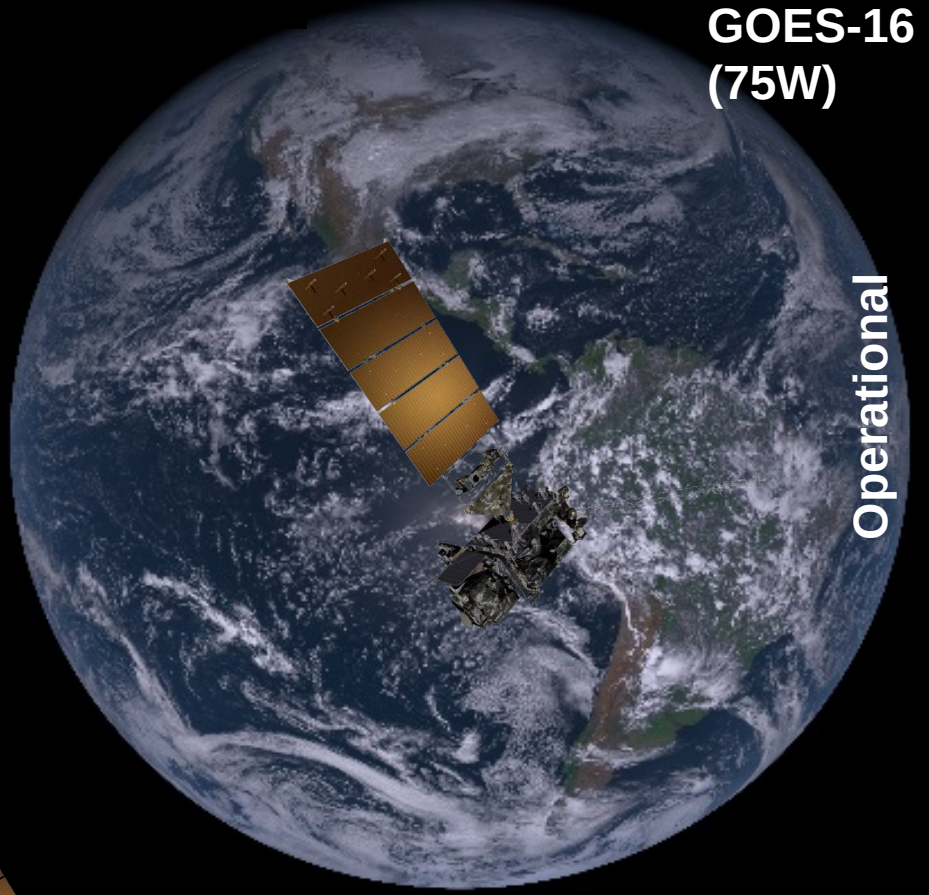
GOES-15
(135W)

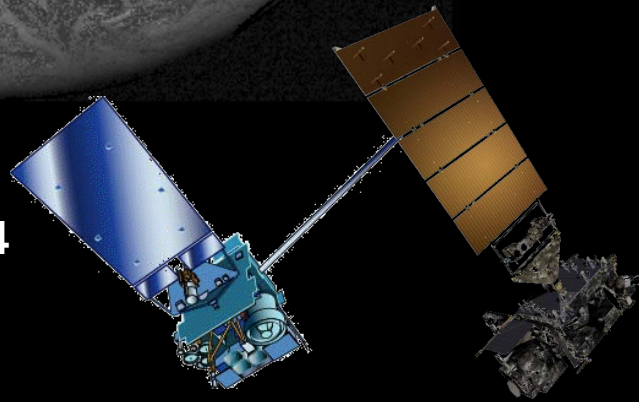
Operational



GOES-16
(75W)

Operational





GOES-14
(105W)
Back-up

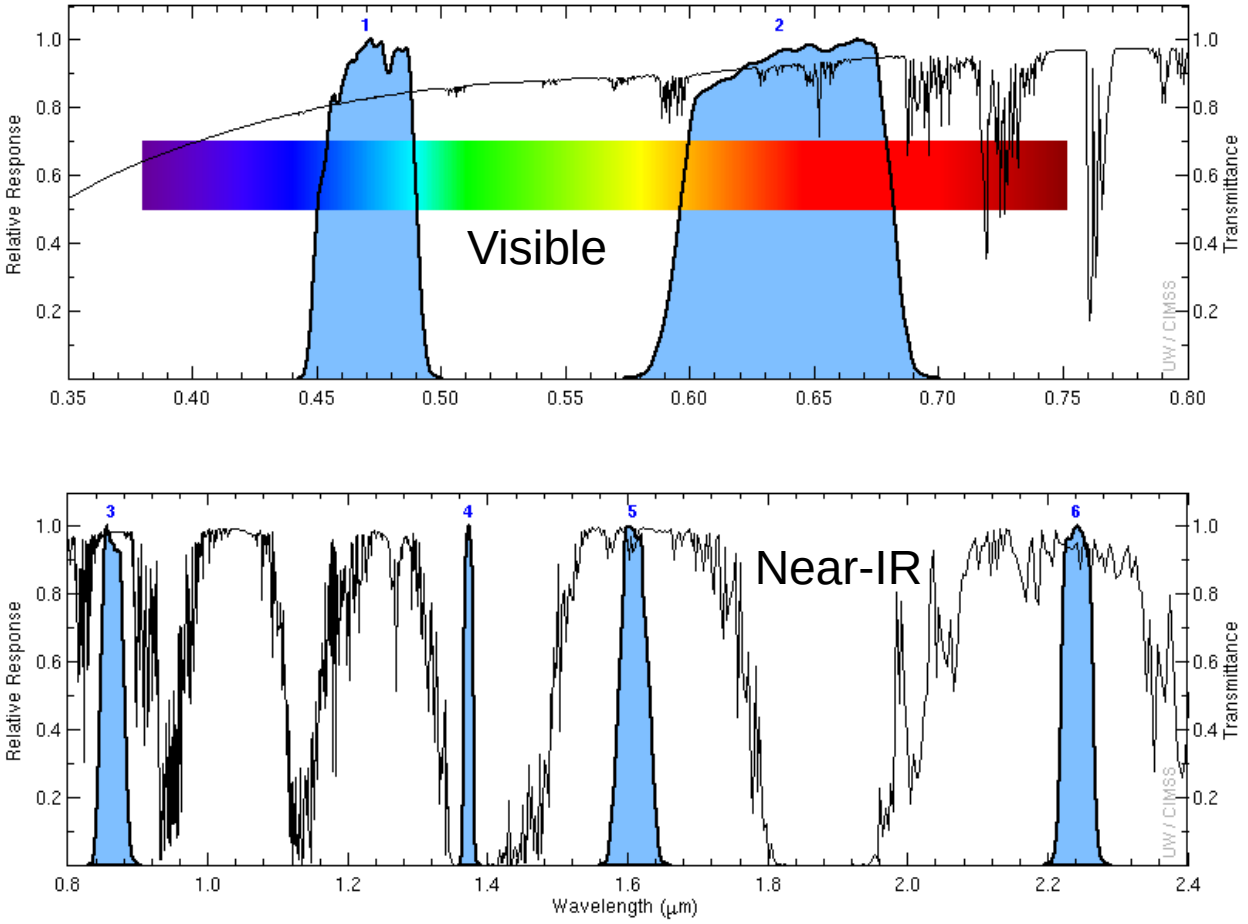
GOES-17
(90W)
Testing
(Will move to 137W)

ABI: Bands 1-6 (Visible / NearIR)

ABI Band	Wavelength (μm)	Wavelength range (μm)	Sub-point pixel spacing (km)	Descriptive Name
1	0.47	0.45 - 0.49	1	“Blue”
2	0.64	0.60 - 0.68	0.5	“Red”
3	0.864	0.847 - 0.882	1	“Veggie”
4	1.373	1.366 - 1.380	2	“Cirrus”
5	1.61	1.59 - 1.63	1	“Snow/Ice”
6	2.24	2.22 -2.27	2	“Cloud Particle Size”

Six visible or near visible bands on ABI, one on heritage imager

ABI Spectral Bands (1-6)

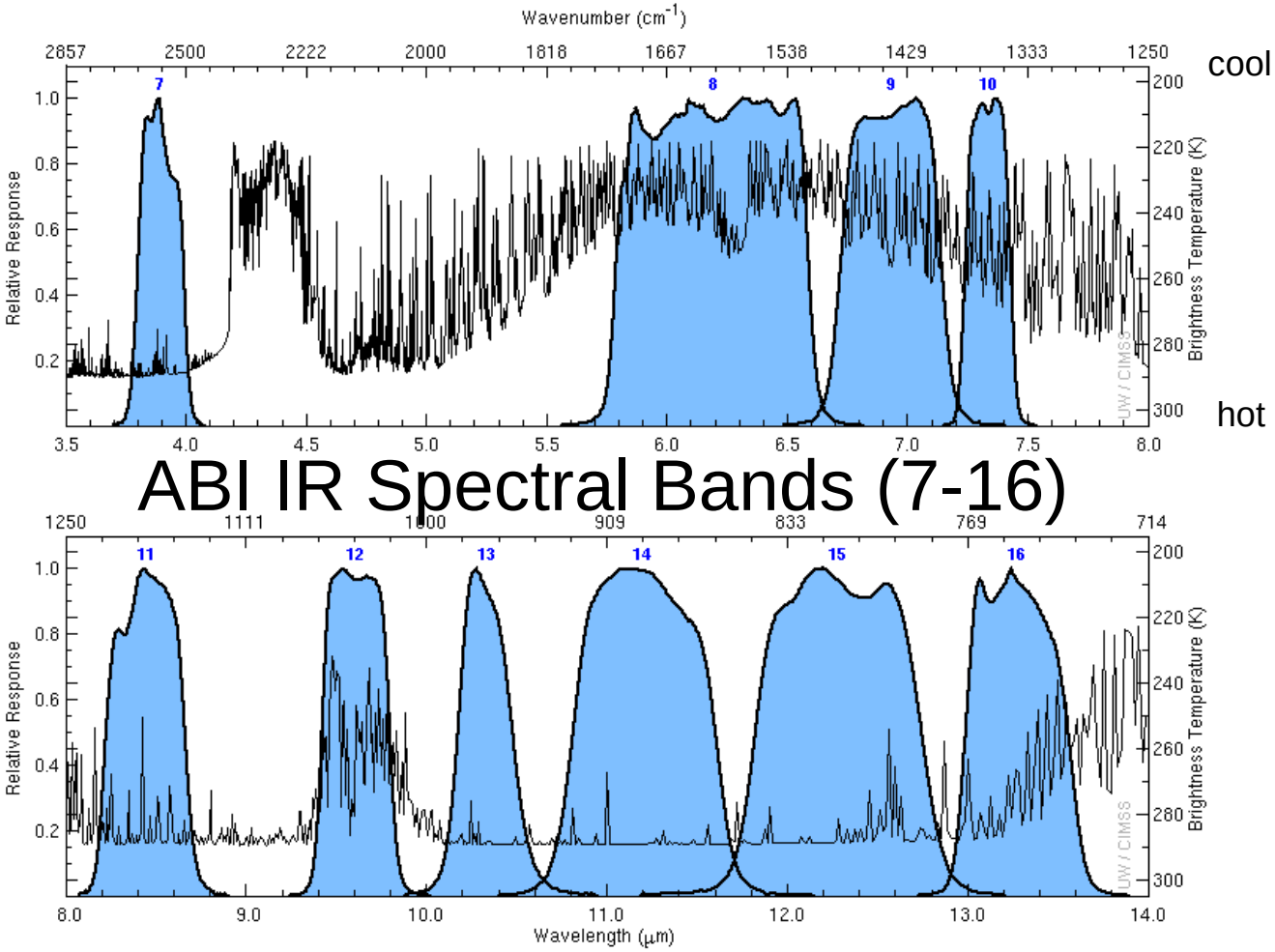


ABI: Bands 7-16 (Infrared)

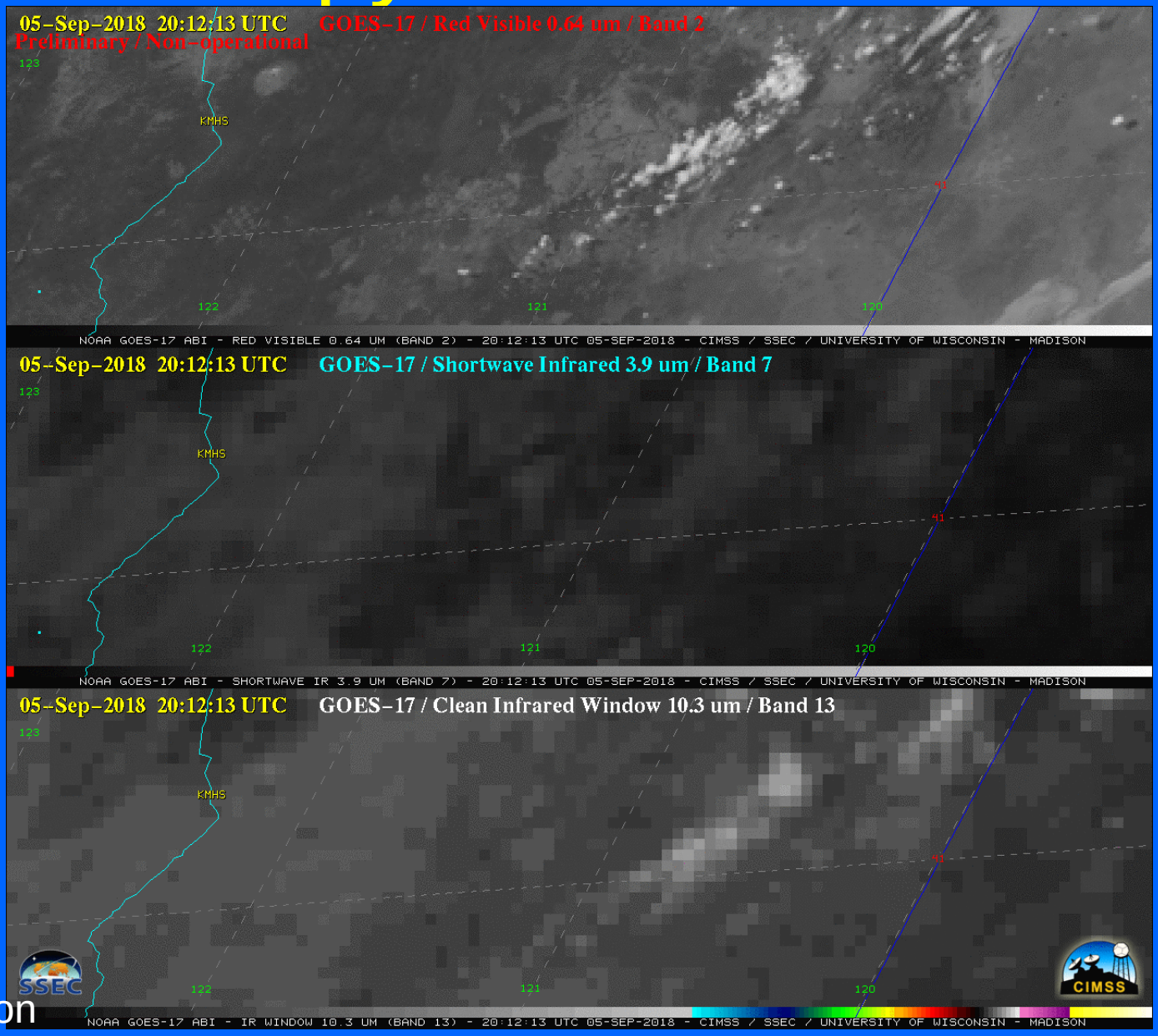
ABI Band	Wavelength (μm)	Wavelength range (μm)	Sub-point pixel spacing (km)	Descriptive Name
7	3.90	3.80 - 3.99	2	“Shortwave window”
8	6.19	5.79 - 6.59	2	“Upper-level Water Vapor”
9	6.93	6.72 - 7.14	2	“Mid-Level Water Vapor”
10	7.34	7.24 - 7.43	2	“Lower/Mid-level Water Vapor”
11	8.44	8.23 - 8.66	2	“Cloud-top Phase”
12	9.61	9.42 - 9.80	2	“Ozone”
13	10.33	10.18 - 10.48	2	“Clean longwave window”
14	11.21	10.82 - 11.60	2	“Longwave window”
15	12.29	11.83 - 12.75	2	“Dirty longwave window”
16	13.28	12.99 - 13.56	2	“CO_2”

10 infrared bands on the ABI, four on heritage imager

ABI IR Spectral Bands (7-16)



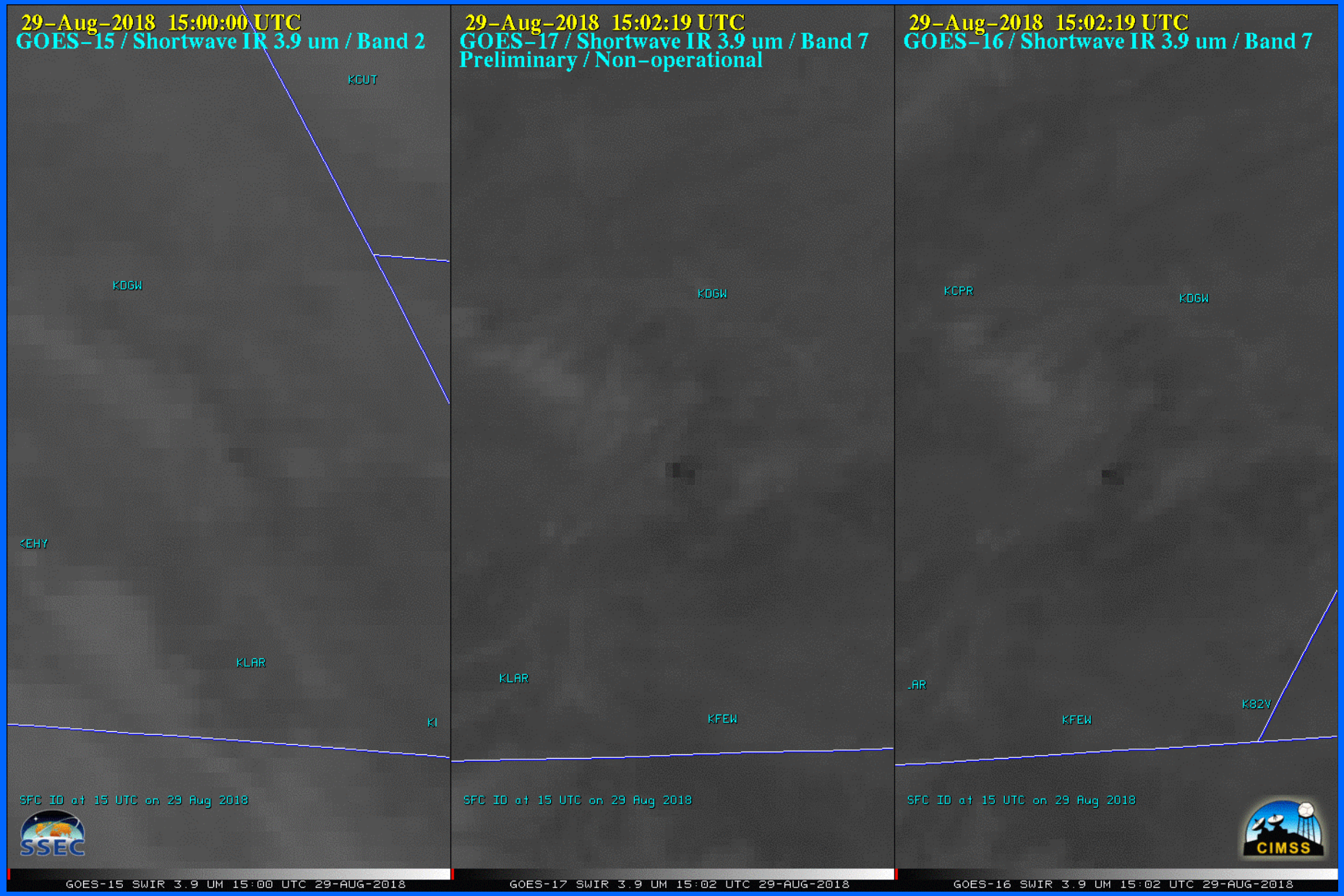
Delta Fire pyroCumulonimbus in CA



Scott Bachmeier, CIMSS

Animation

WY Wildfire (GOES-15/17/16)



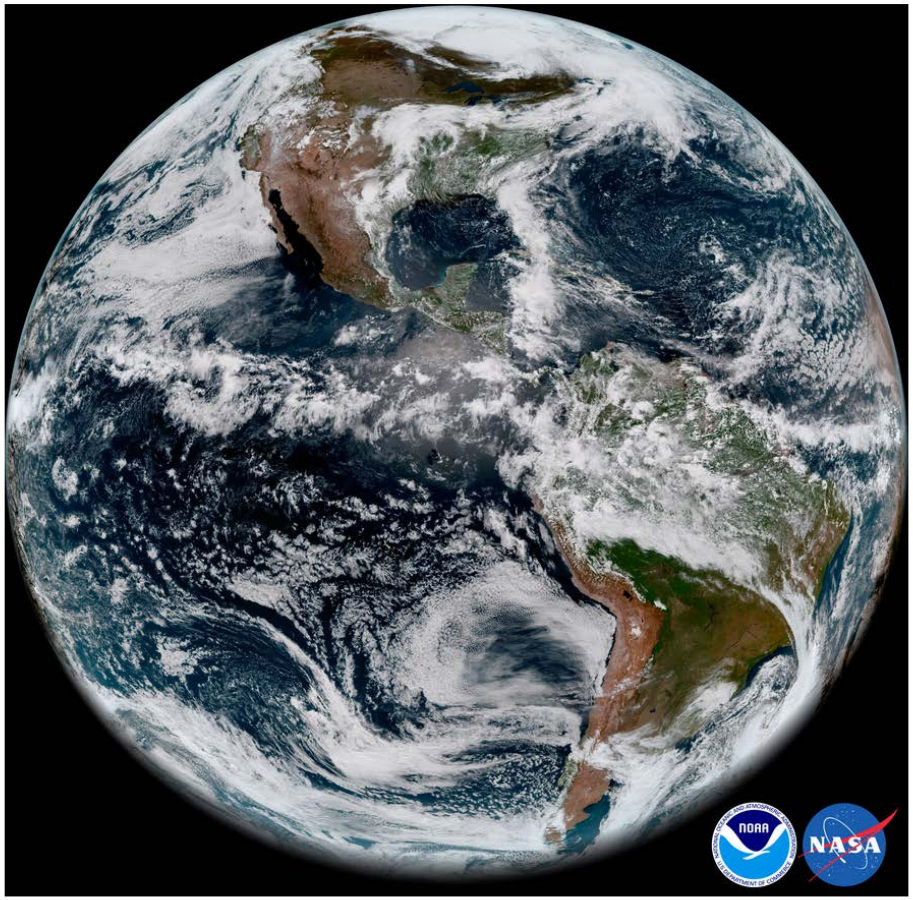
Animation

Scott Bachmeier, CIMSS

GOES-17 ABI First Light Release

- Visible bands:
- May 31, 2018
- Data: May 20

The first imagery from NOAA's GOES-17 Advanced Baseline Imager (ABI) made its public debut today.

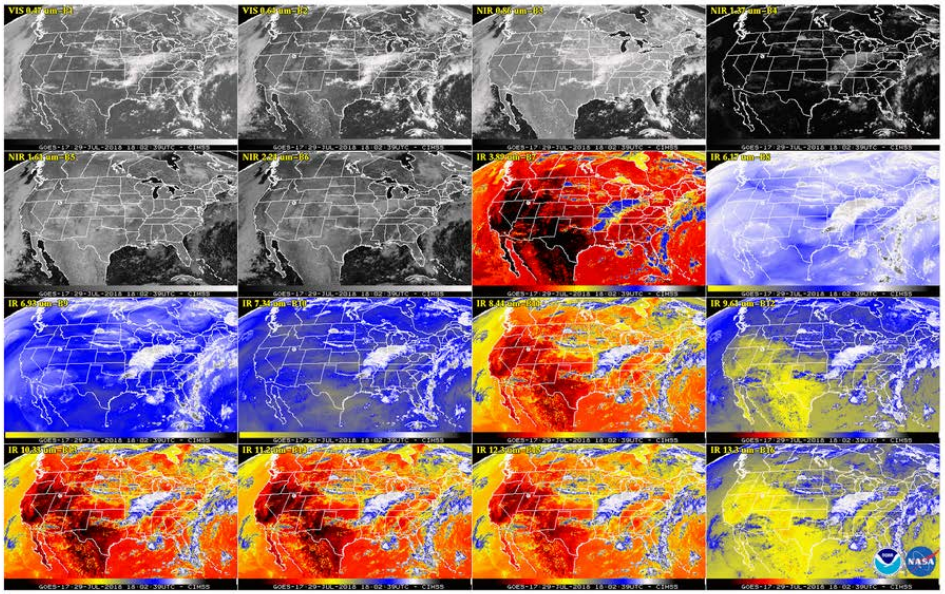


GOES-17 took this stunning, full-disk snapshot of Earth's Western Hemisphere from its checkout position at 12:00 p.m. EDT on May 20, 2018, using the Advanced Baseline Imager (ABI) instrument. GOES-17 observes Earth from an equatorial vantage point approximately 22,300 miles above the surface. Credit: NOAA/NASA

GOES-17 ABI IR First Light Release

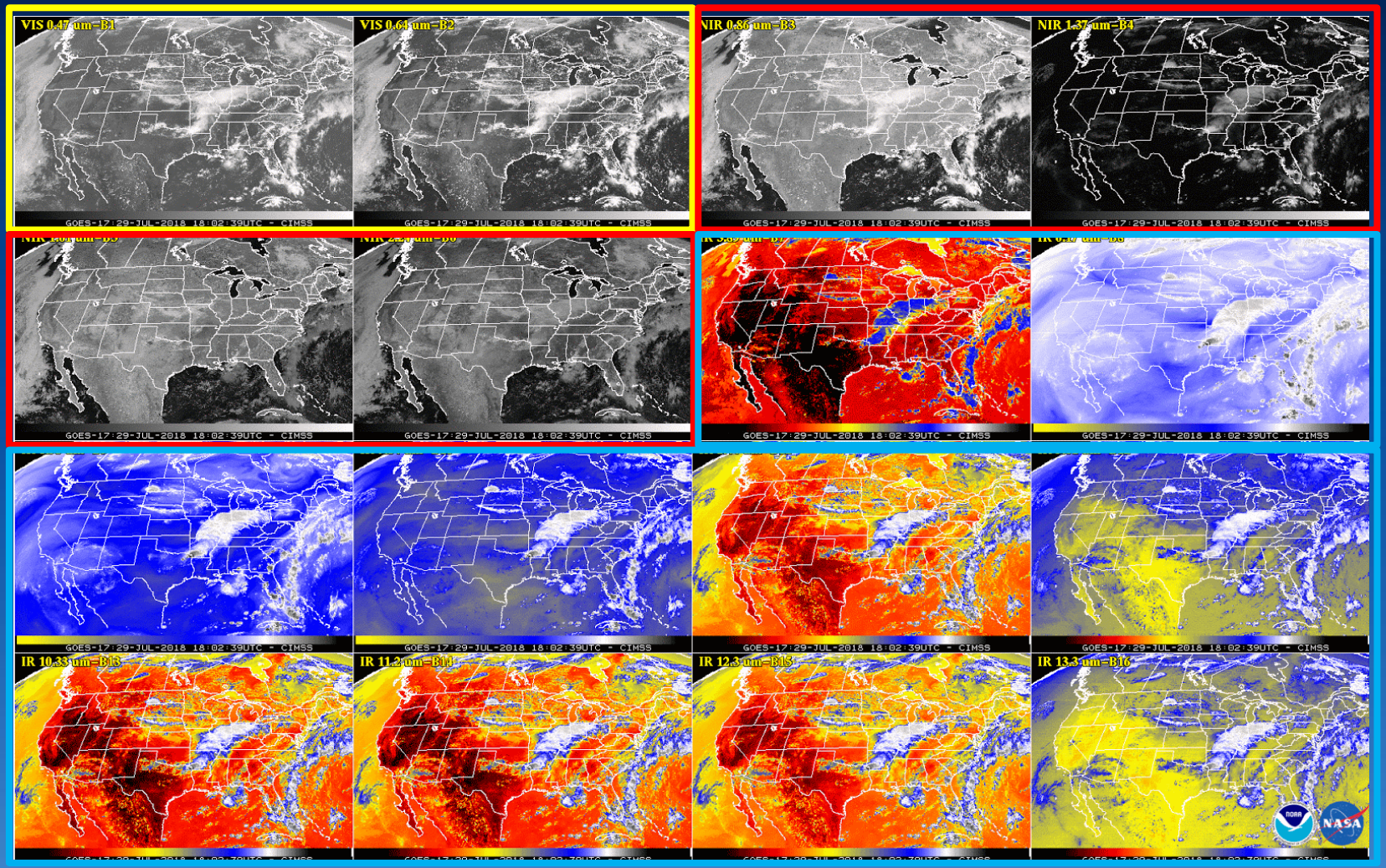
- All bands,
- including infrared
- August 8, 2018
- Data: July 29

While experts continue addressing an issue with the cooling system of GOES-17's Advanced Baseline Imager (ABI), they have made progress in increasing the available observing time of the affected infrared channels. Due to adjustments in operating procedures, the ABI is demonstrating improved performance from initial observations.



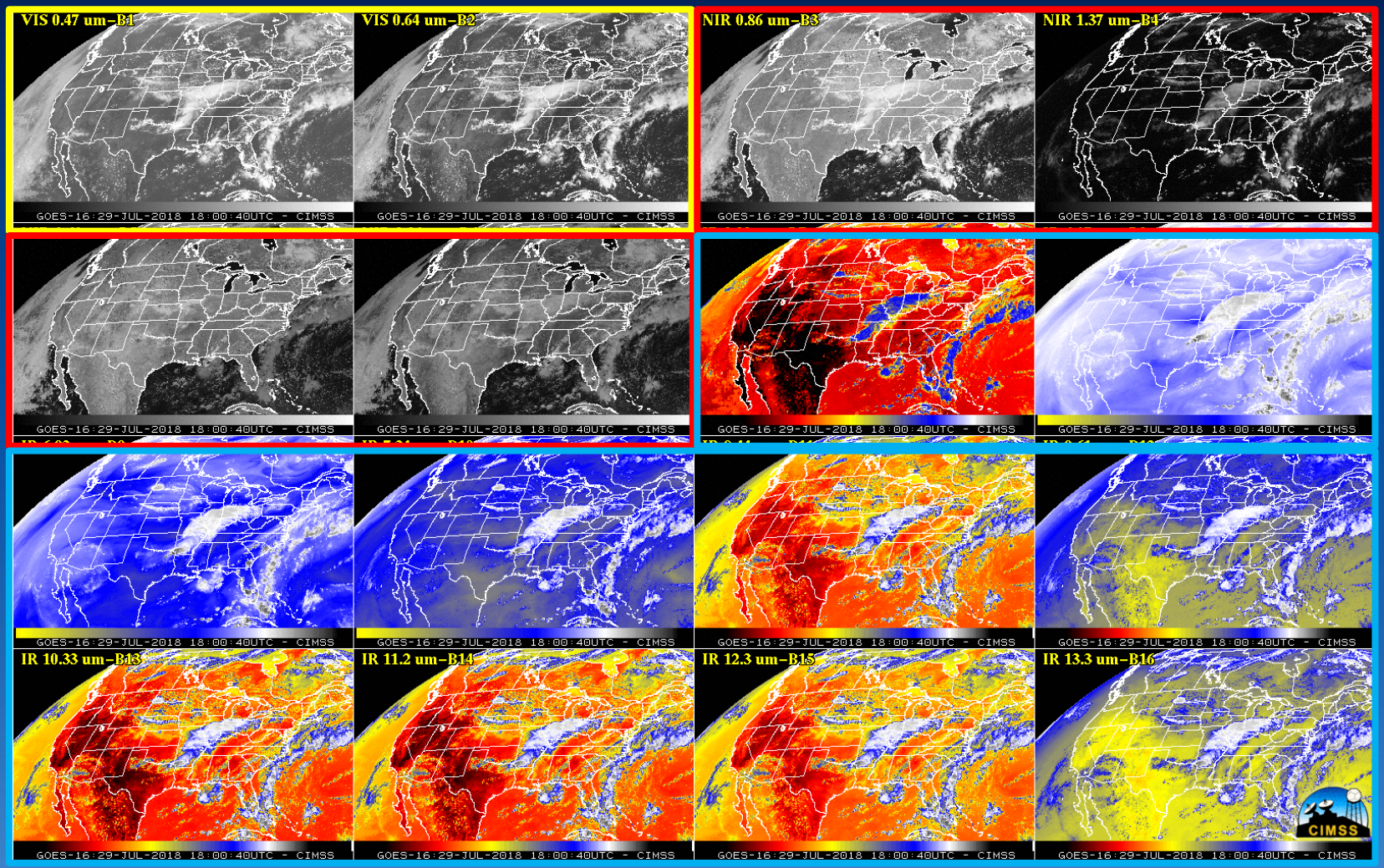
This 16-panel image shows a snapshot of the continental U.S. and surrounding oceans from each of the Advanced Baseline Imager channels at 2:02 p.m. EDT on July 29, 2018. This includes, from top left to bottom right, two visible channels, four near-infrared channels, and ten infrared channels. Each channel has a specific purpose in discerning meteorological and environmental features. A number of features can be seen in this image, including clouds over the mid-Mississippi region and off both coasts, the warm land temperatures over the Western U.S., and atmospheric moisture. This imagery was captured between the instrument's "cool" and "warm" season, when all 16 channels are available 24 hours per day. During the instrument's "warm" seasons, varied data outages are expected for 9 of the channels during nighttime hours. The ABI's increased channels provide three times more spectral information than the previous GOES imager. Credit: NOAA/NASA

ABI GOES-17 Spectral Bands (16)

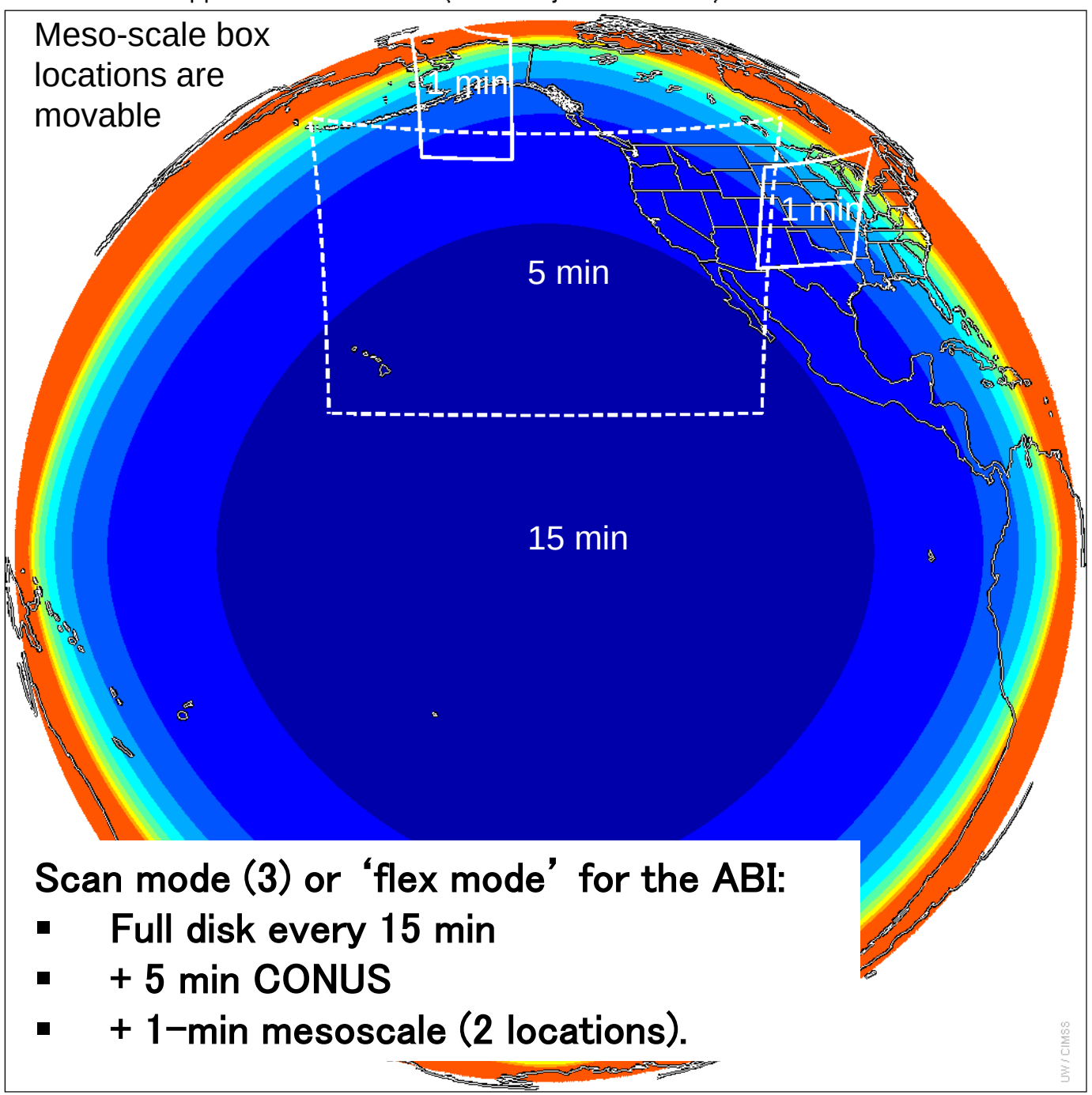


2 VIS **4 NIR** **10 IR**

ABI GOES-16 Spectral Bands (16)



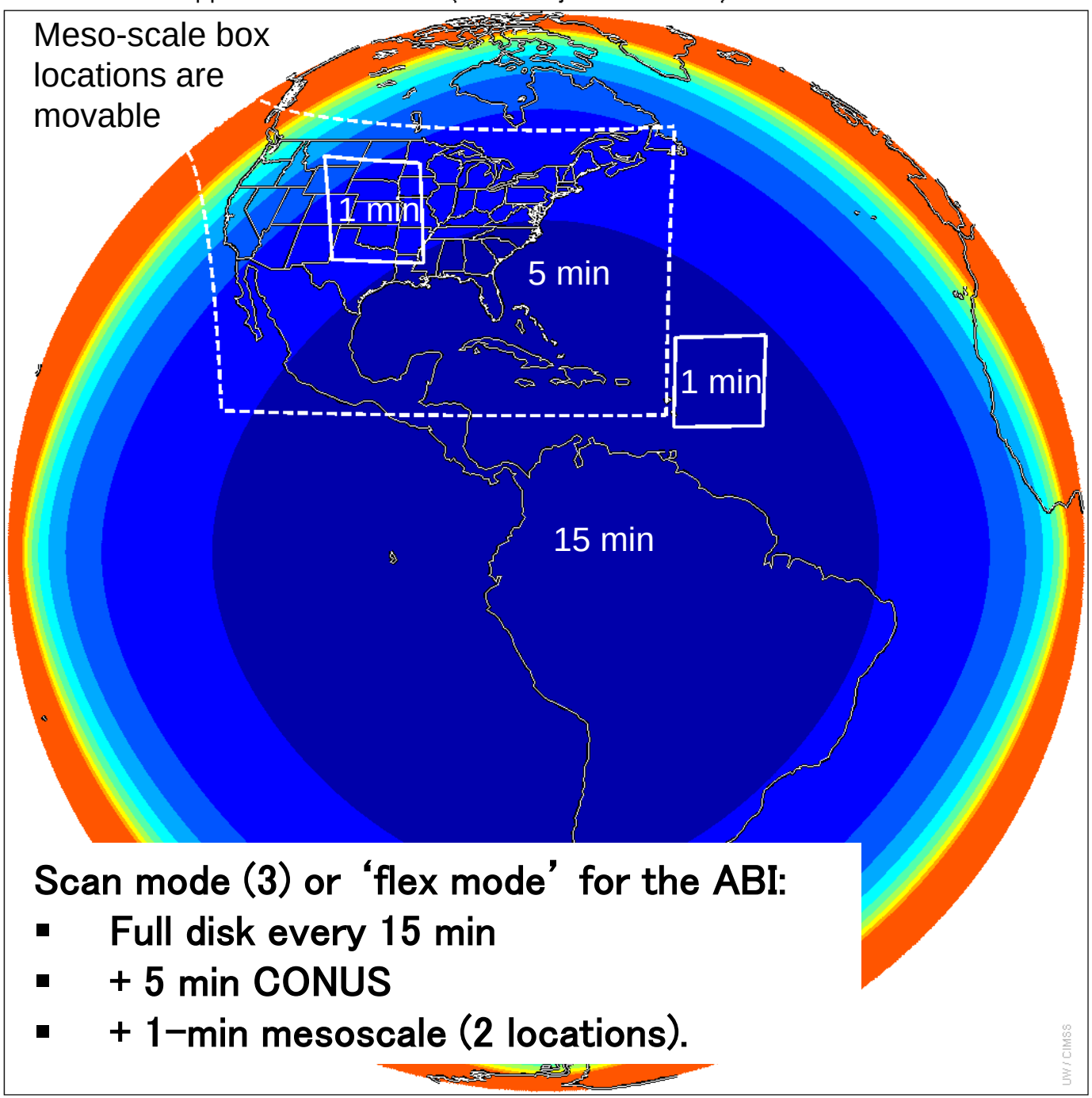
2 VIS **4 NIR** **10 IR**



Scan mode (3) or 'flex mode' for the ABI:

- **Full disk every 15 min**
- **+ 5 min CONUS**
- **+ 1–min mesoscale (2 locations).**

Mat Gunshor, CIMSS

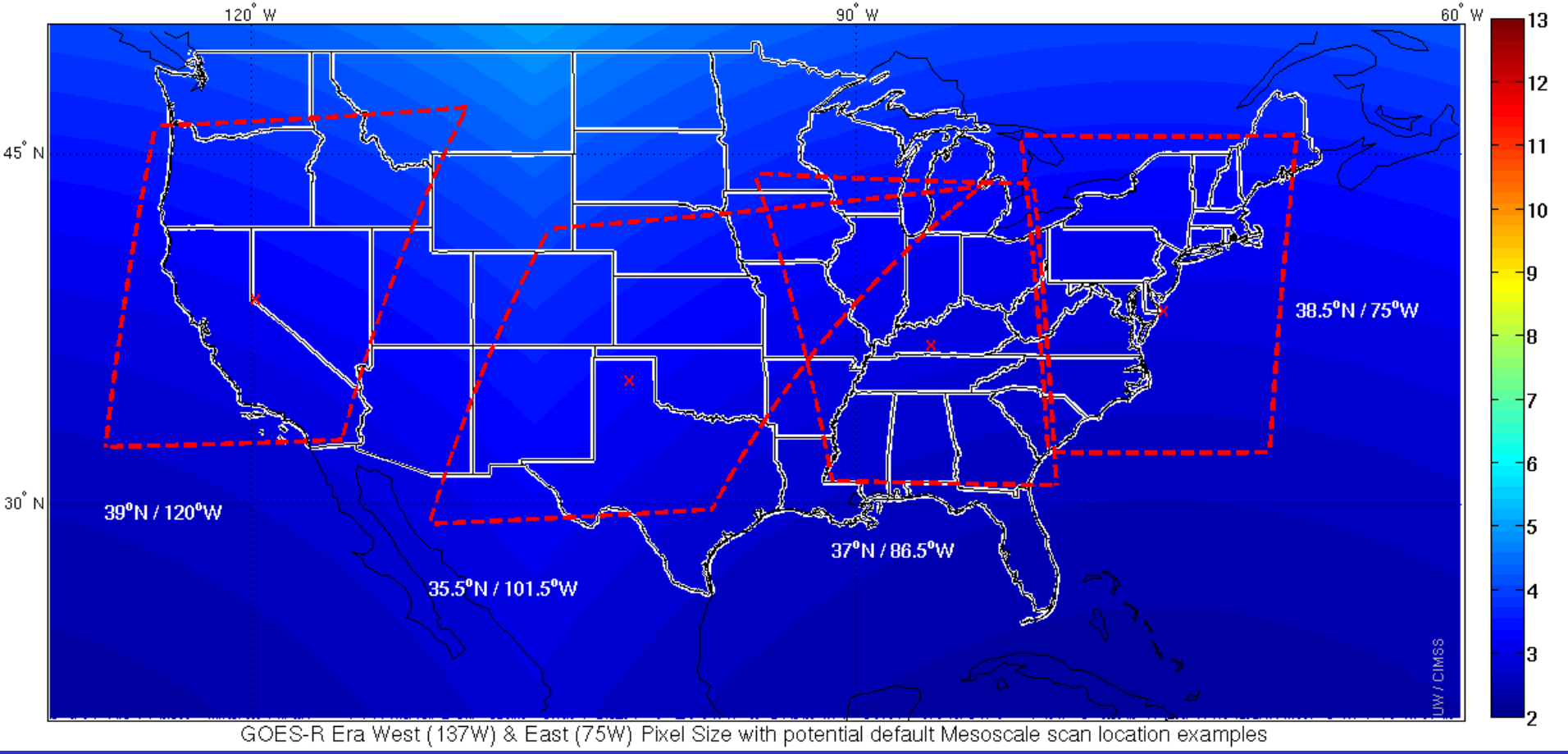


Scan mode (3) or 'flex mode' for the ABI:

- **Full disk every 15 min**
- **+ 5 min CONUS**
- **+ 1–min mesoscale (2 locations).**

Mat Gunshor, CIMSS

Default Meso Locations

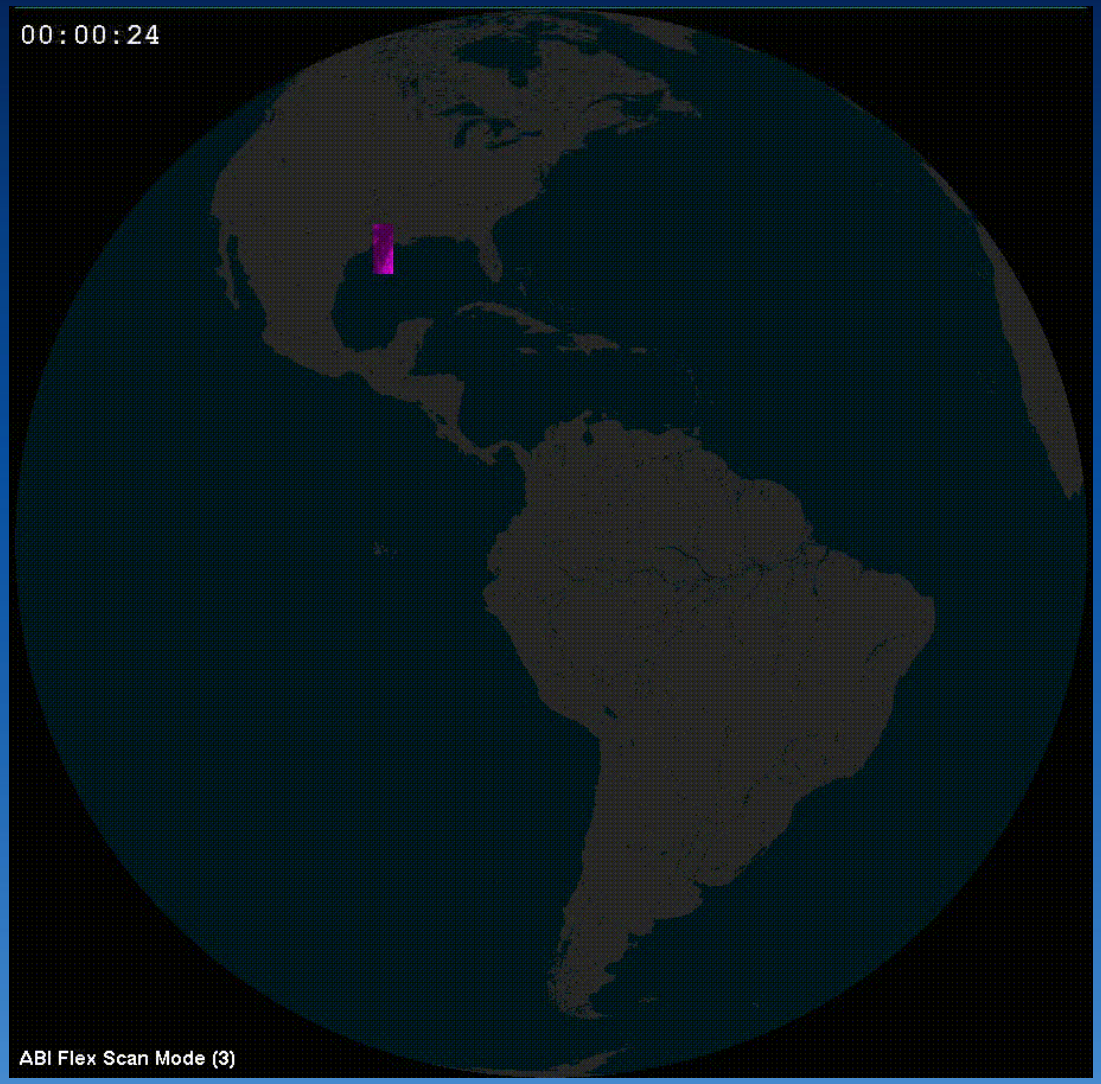


GOES-R Era West (137W) & East (75W) Pixel Size with potential default Mesoscale scan location examples

Two meso from GOES-West and two from GOES-East

Mat Gunshor, CIMSS

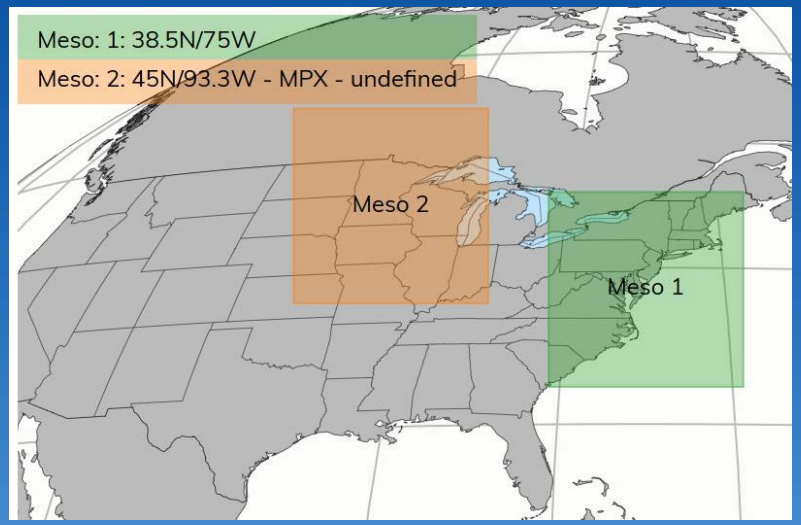
ABI - 5 times faster coverage



Animation

	GOES-16: *Flex Mode*	Previous: Routine
Full Disk:	15 min	3-hr
CONUS:	5 min	15-min
Mesoscale:	1-min *or* 30-sec	n/a

PLUS – Flex mode scanning!

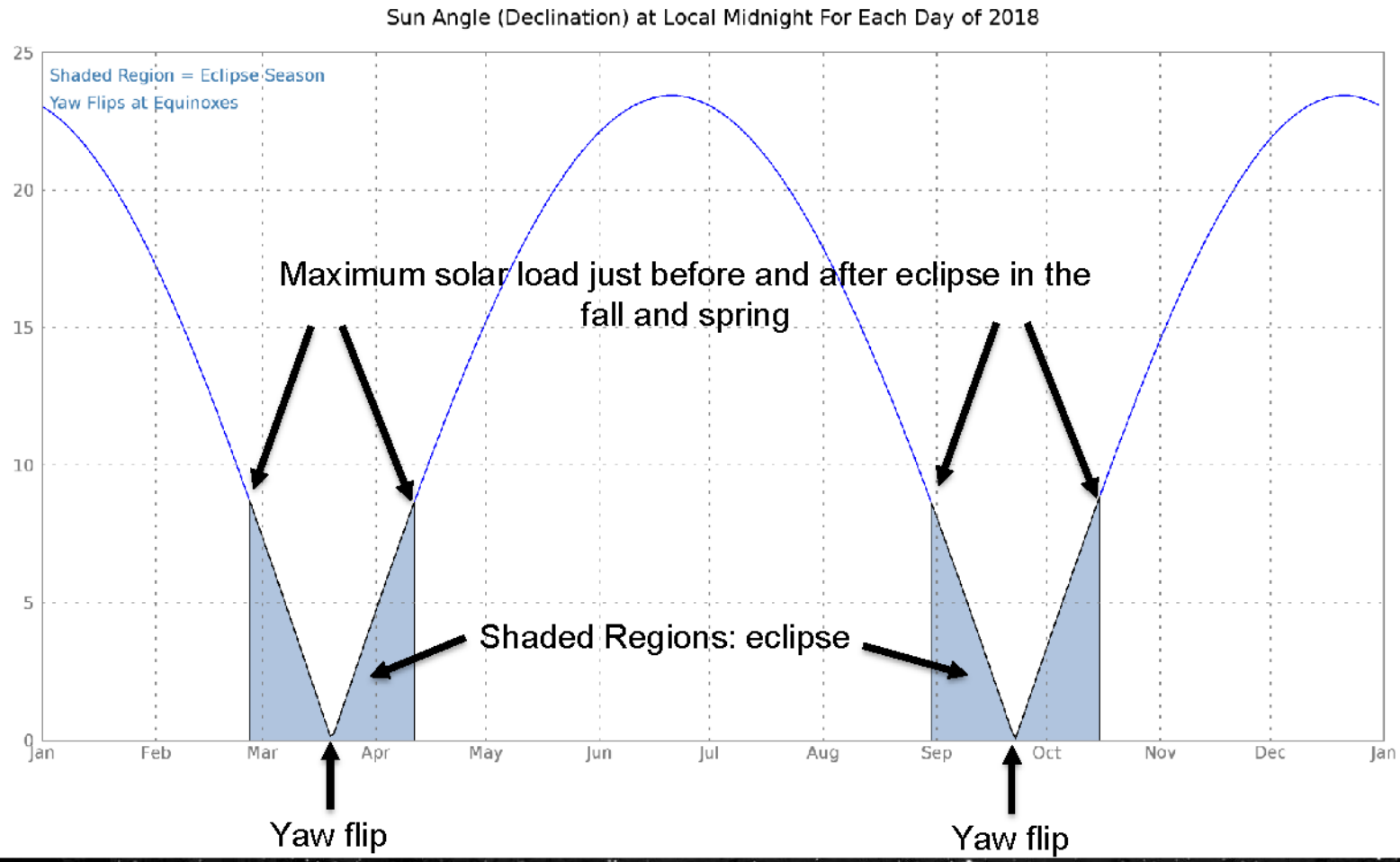


Credit: Rick Kohrs and Margaret Mooney, CIMSS

Loop Heat Pipe Anomaly

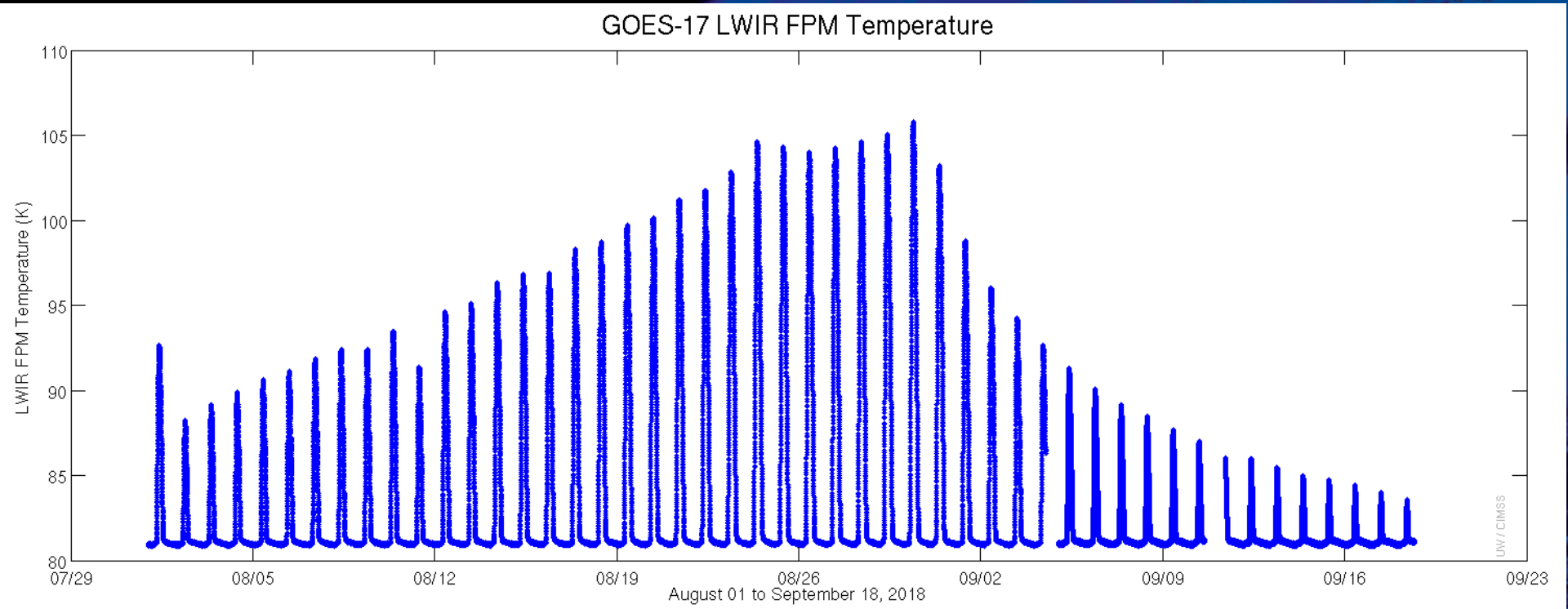
- Loop Heat Pipes on G-17 ABI not functioning properly
- During nighttime hours, the sun heats up the ABI detectors faster than we can cool them
- Detectors become warmer than they're designed to operate, and they begin to radiate at temperatures closer to the wavelengths they're attempting to detect from the Earth
- Eventually, local emission and dark current noise overwhelm the signal from the Earth, and the channels saturate, meaning there's no useful signal at all
- The longer wavelengths, i.e., the IR channels, are generally affected first, and the shorter wavelengths (VIS and near-IR) not at all

Seasonal Dependence



Lower angles generally mean larger solar load, except for the shaded eclipse times where the Earth blocking the sun provides for nighttime cooling

GOES-17 LWIR Focal Plane Module Temperature



These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

Current Assessment of Channel

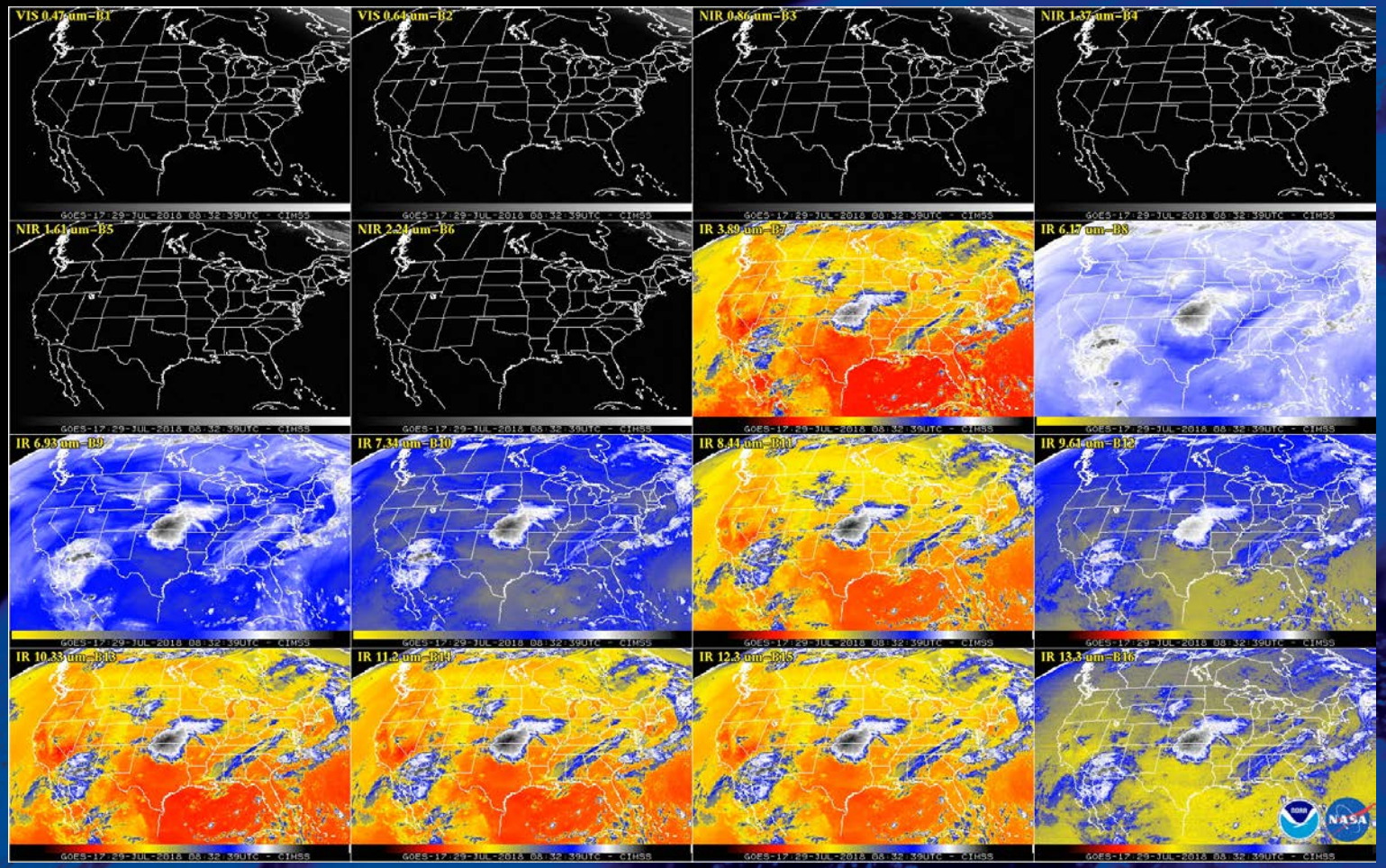
Band	Channel (μm)	Function	GOES-15	GOES-17 Availability (Hours)		
				Initial Estimate (5/6/18)	Current Estimate (Cold Season) (1)	Current Estimate (Warm Season)(2)
1	0.47	Blue		24	24	24
2	0.64	Red	Yes (0.63μm)	24	24	24
3	0.86	Green (Veggie)		24	24	24
4	1.38	Cirrus		22	24	24
5	1.61	Snow/Ice		22	24	24
6	2.25	Cloud Particle Size		22	24	24
7	3.90	Shortwave Window	Yes	14	24	24
8	6.18	Upper-Level Water Vapor	Yes (6.48μm)	14	24	18-20
9	6.95	Mid-Level Water Vapor		14	24	18-20
10	7.34	Lower-Level Water Vapor		14	24	18.20
11	8.50	Cloud Top Phase		14	24	21
12	9.61	Ozone		12	24	18-20
13	10.35	Clean IR Longwave Window		12	24	24 *
14	11.20	IR Longwave Window	Yes (10.7μm)	12	24	24 *
15	12.30	Dirty Longwave Window		12	24	21
16	13.30	CO_2 Longwave Infrared	Yes	12	24	18-20

NOTE: **Preliminary estimate** of channel availability at best/worst season; subject to change.

***** = data may be noisy and striped and biased for up to 4 hours per day (TBR)

GOES-17 ABI: "Cool" Part of the Year

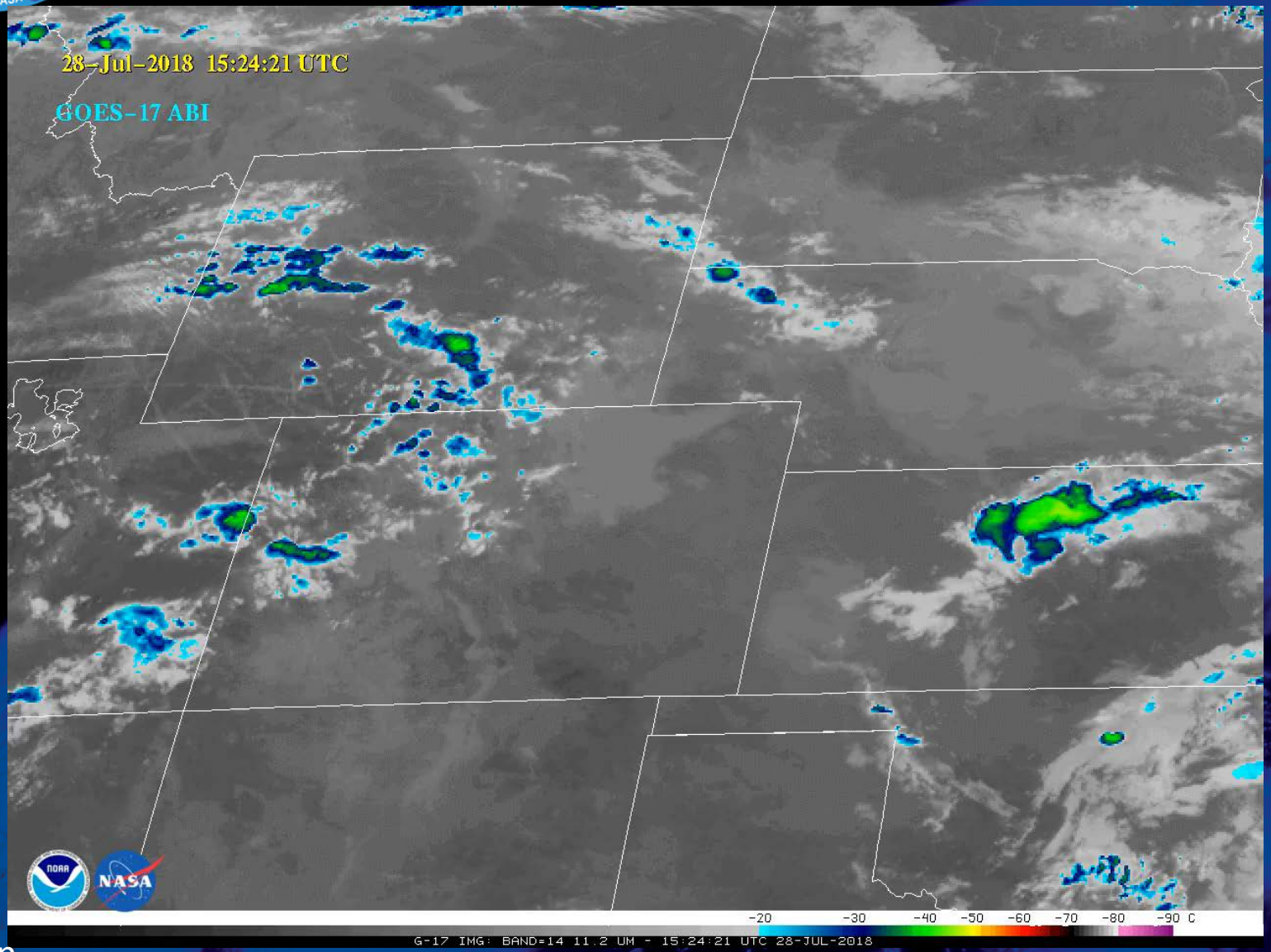
(first light day)



Animation

These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

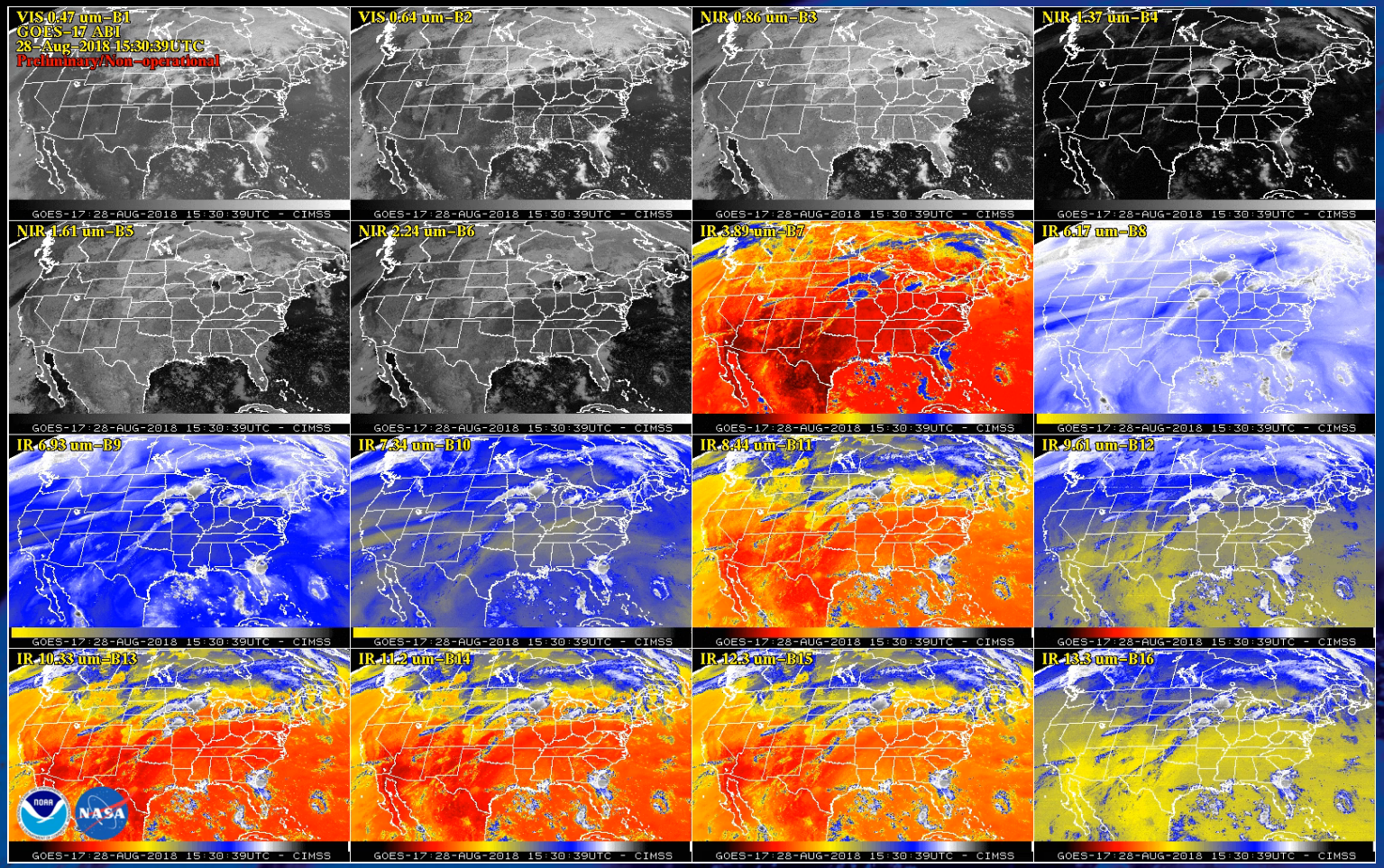
Infrared Window



Animation

These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

GOES-17 ABI: “Hot” Part of the Year
(Aug 28/29)

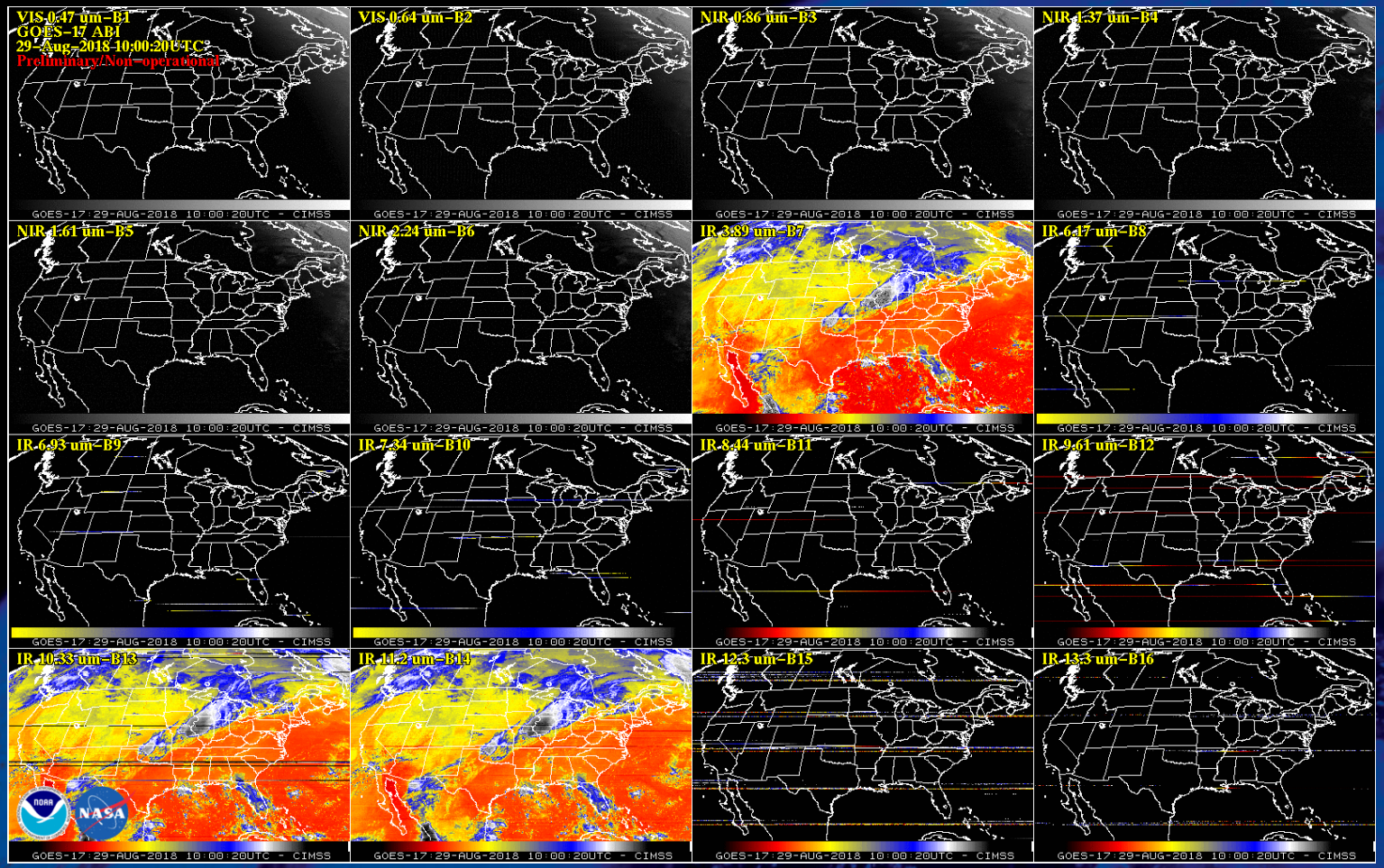


Animation

These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

GOES-17 ABI: "Hot" Part of the Year

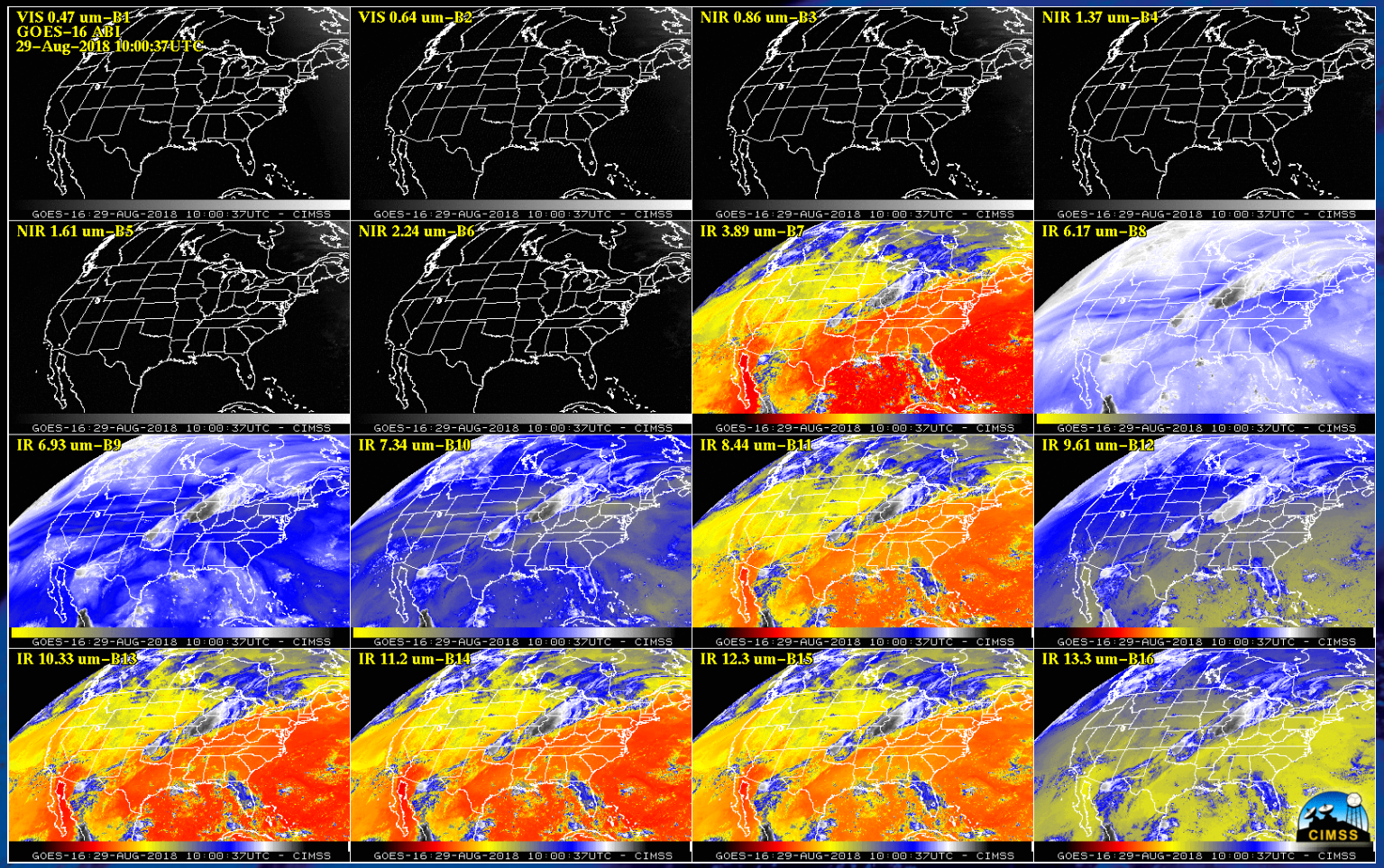
(Aug 29 10 UTC)



These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

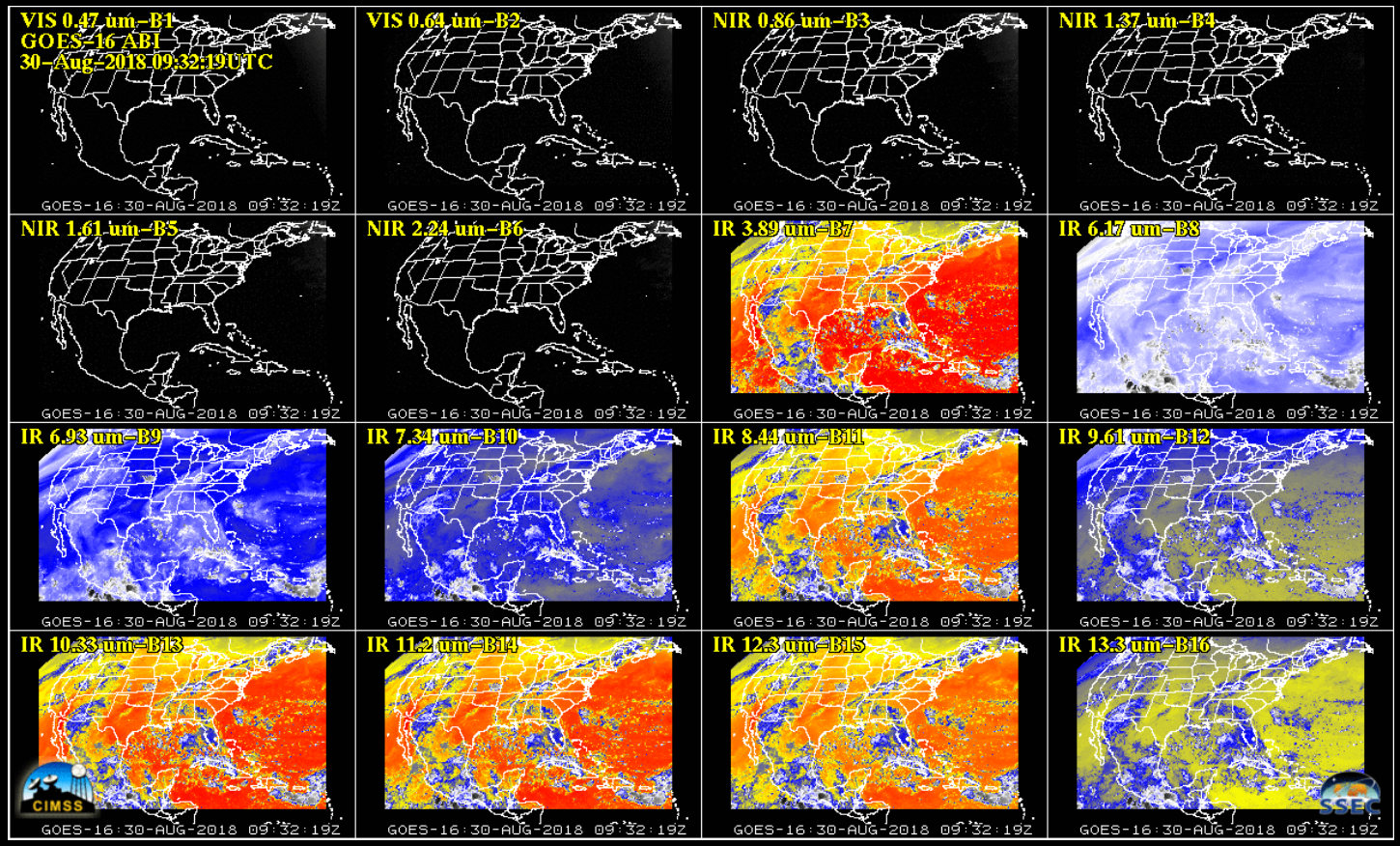
GOES-16 ABI

(Aug 29: 10 UTC)

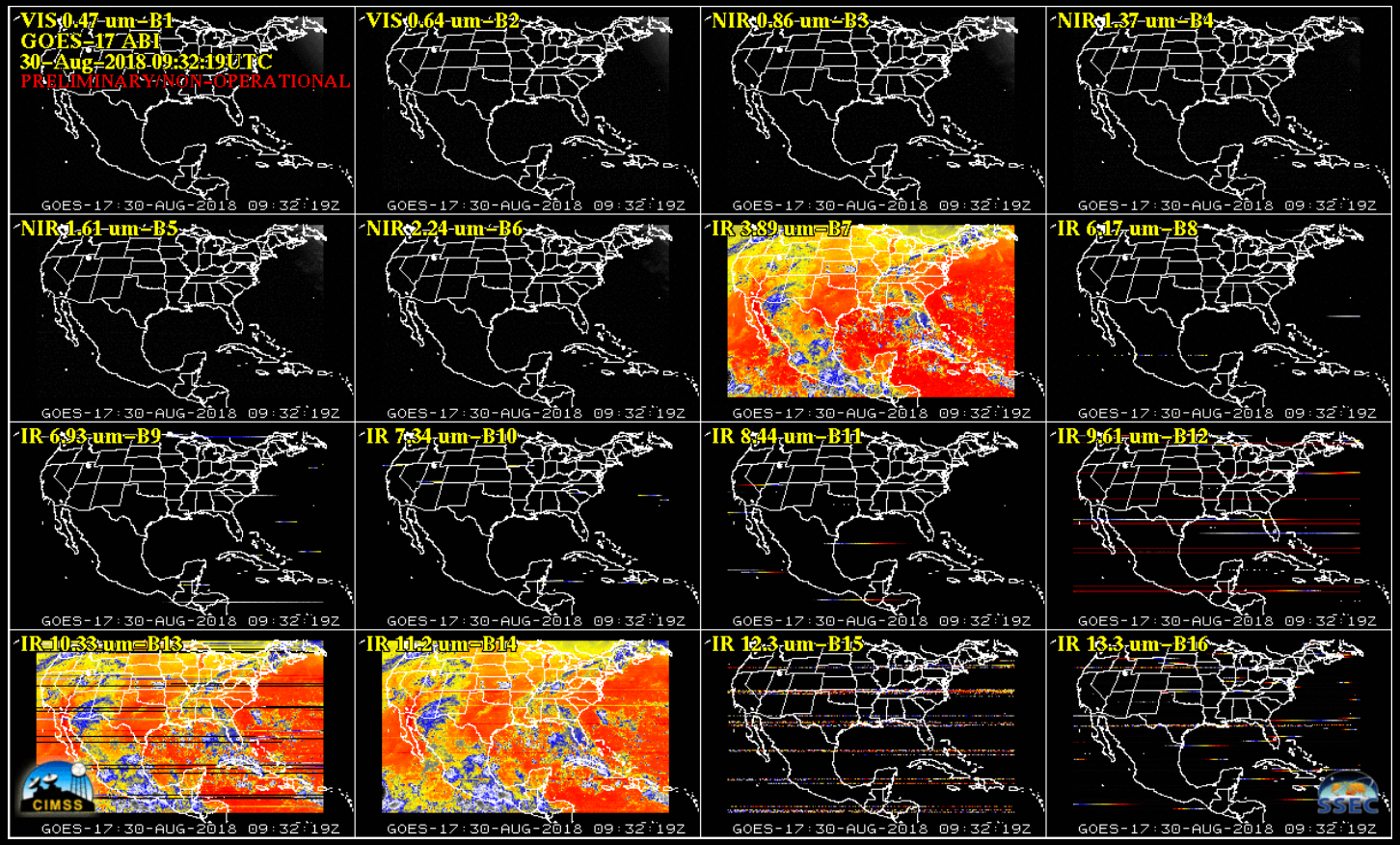


These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

GOES-16 ABI CONUS at 09:32 UTC on August 30, 2018 – for comparison, “worst time” for FPM Temp

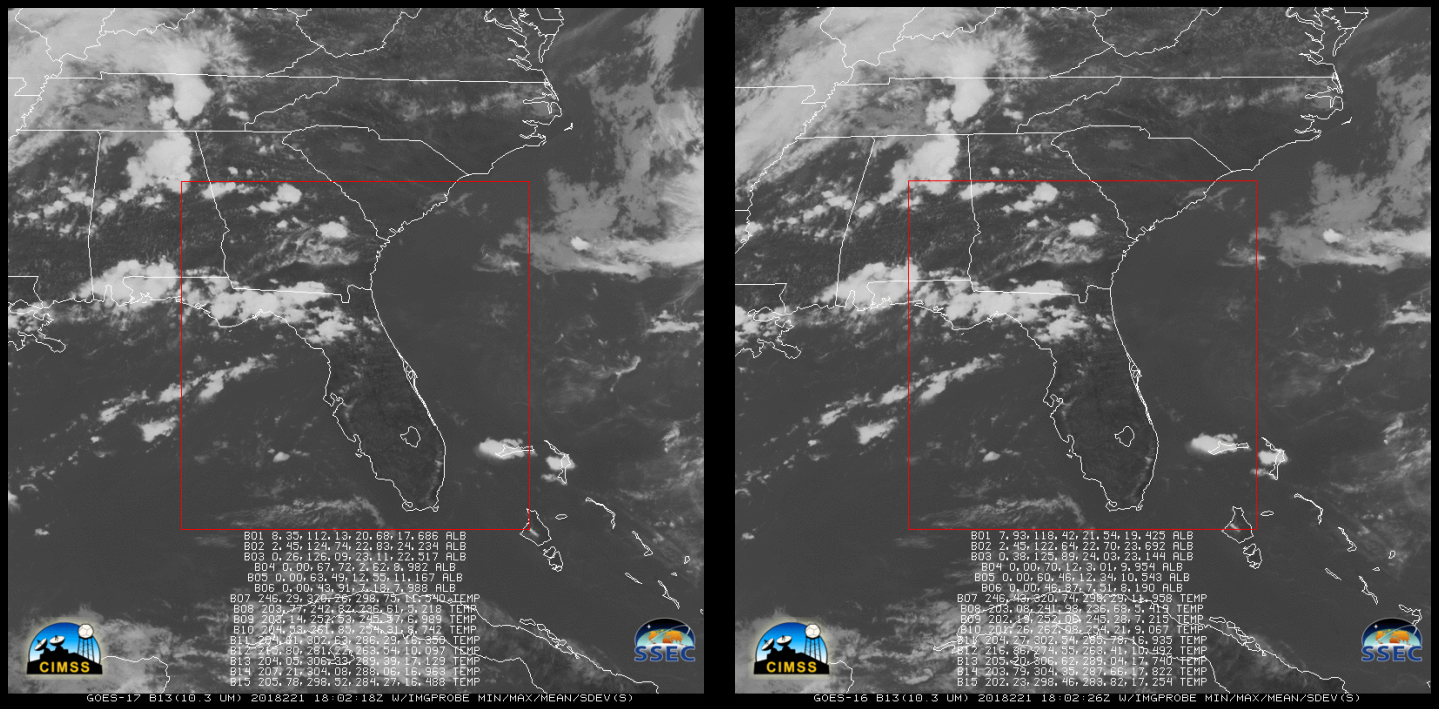


GOES-17 ABI CONUS at 09:32 UTC on August 30, 2018 – "worst time" for FPM Temp



Disclaimer: GOES-17 ABI data at this time are preliminary and non-operational.

FPM Temperature Analysis

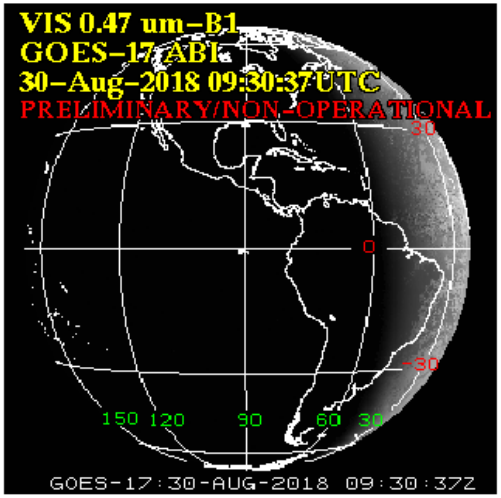


GOES-17 (left) vs GOES-16 (right) comparison area.

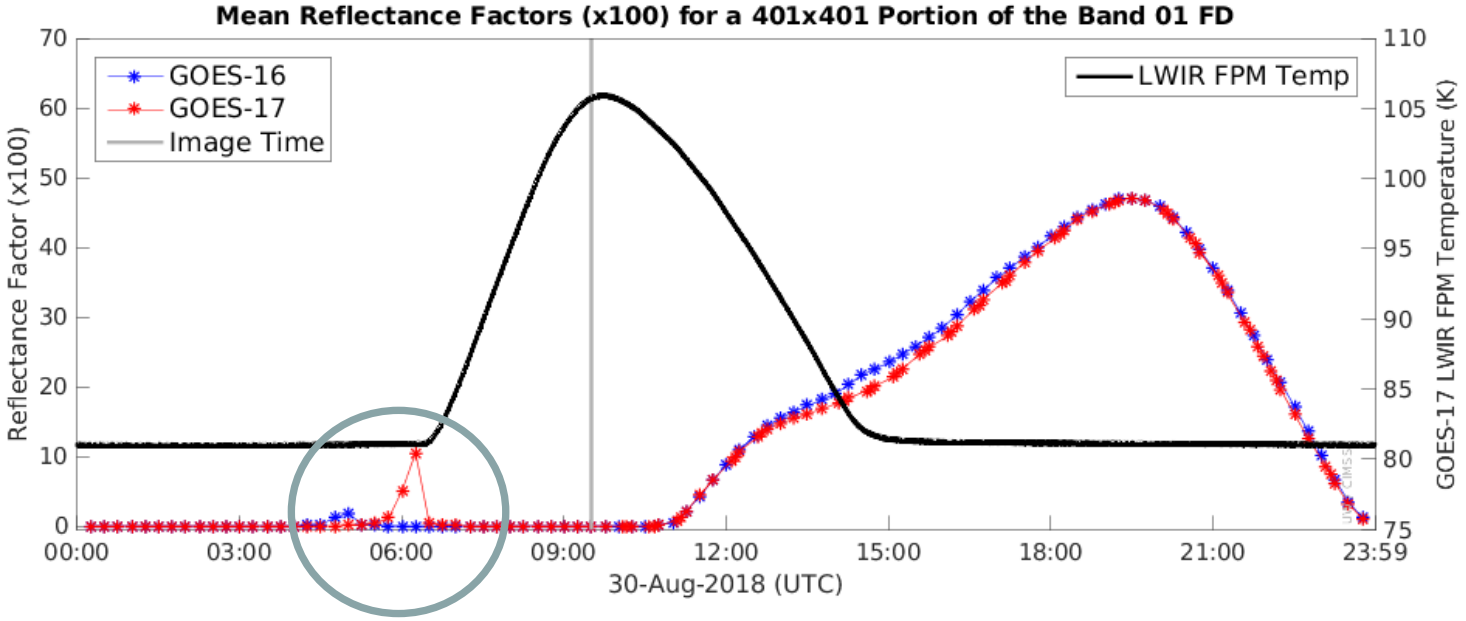
To compare: Mean CMI GOES-16, Mean CMI GOES-17, & FPM Temperature

These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

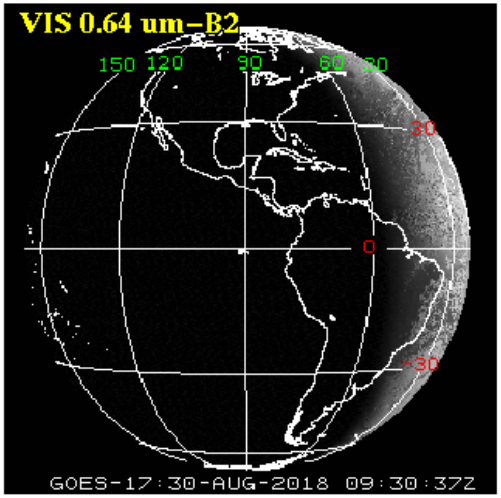
GOES-17 ABI Band 01 (0.47 μm) 30-Aug-2018 09:30:37 UTC



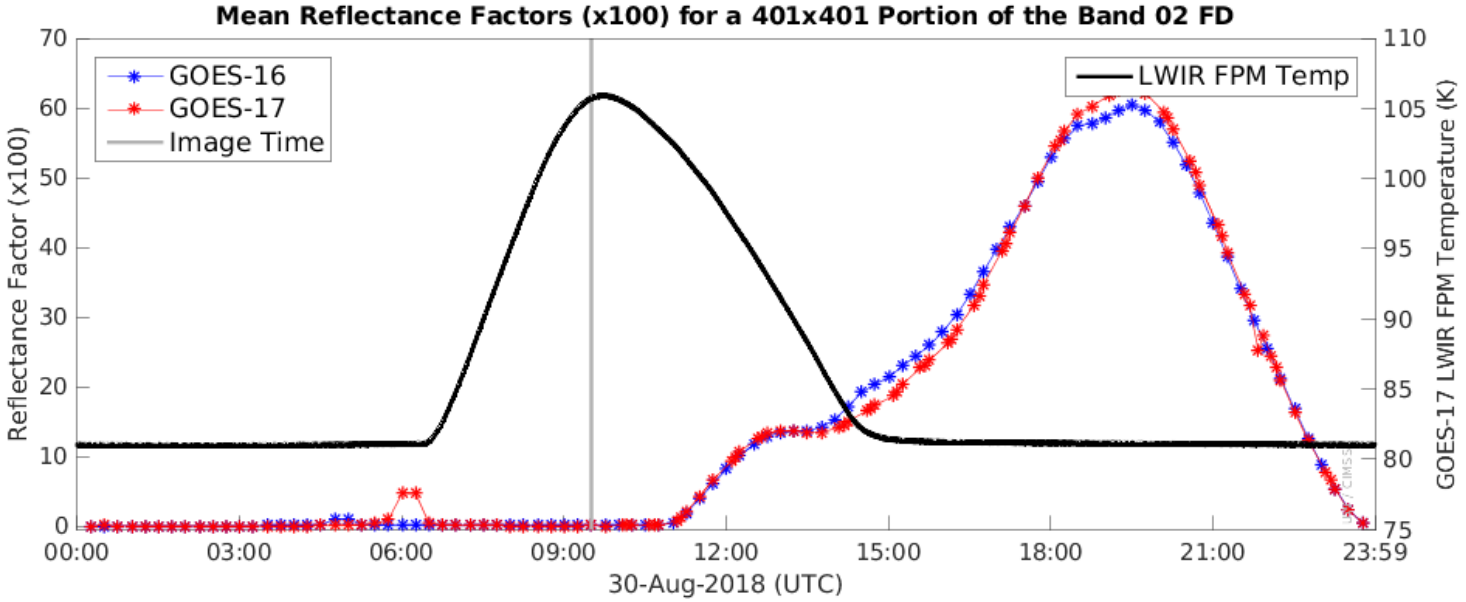
GOES-17 Preliminary / Non-Operational



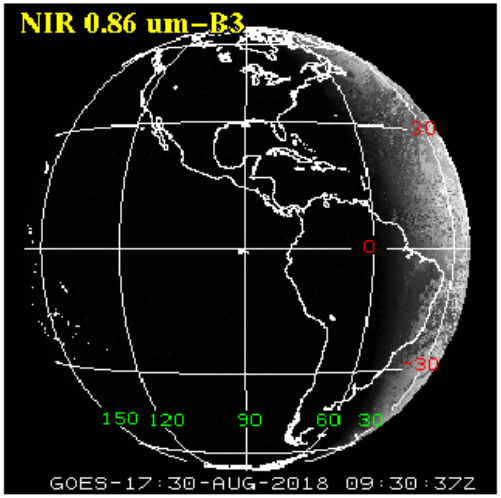
GOES-17 ABI Band 02 (0.64 μm) 30-Aug-2018 09:30:37 UTC



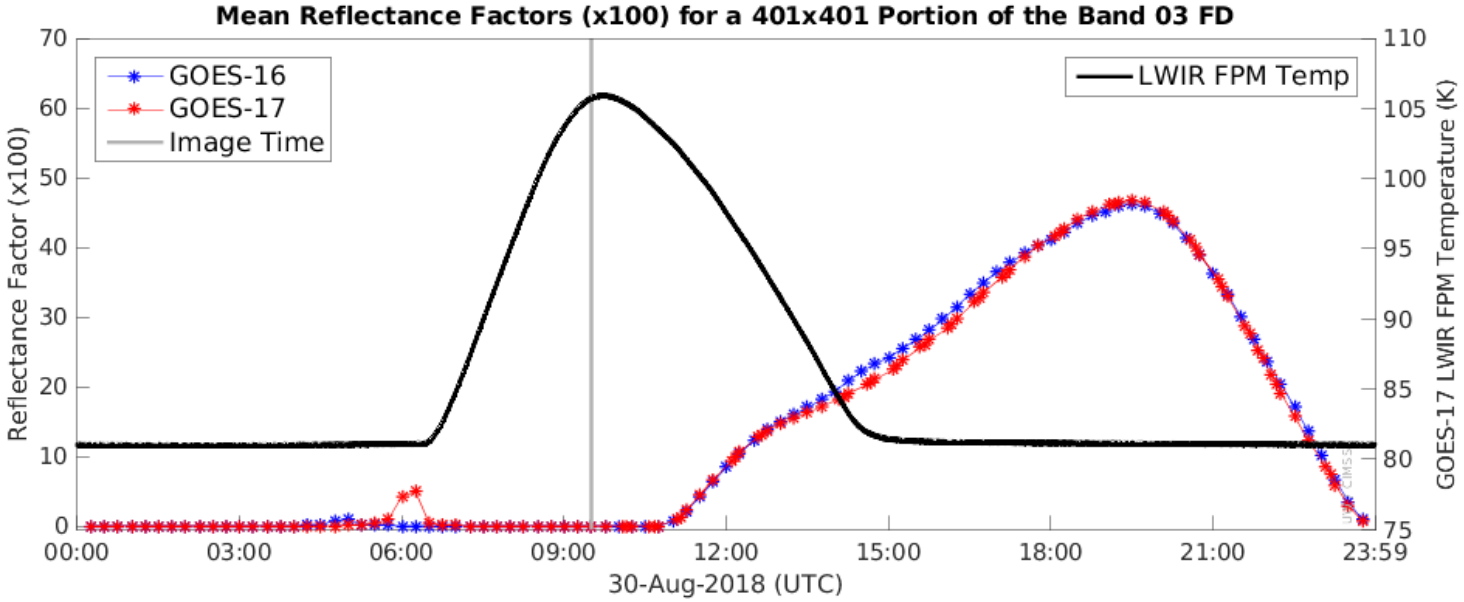
GOES-17 Preliminary / Non-Operational



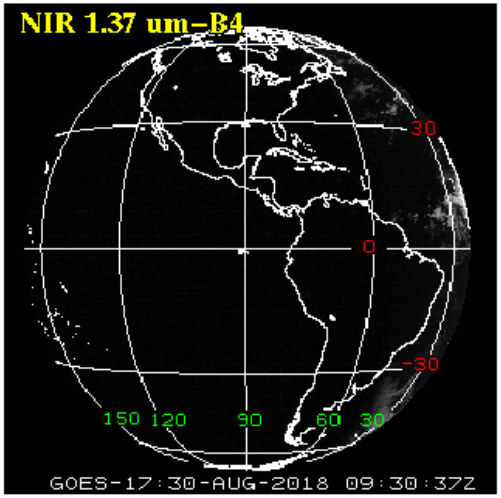
GOES-17 ABI Band 03 (0.86 μm) 30-Aug-2018 09:30:37 UTC



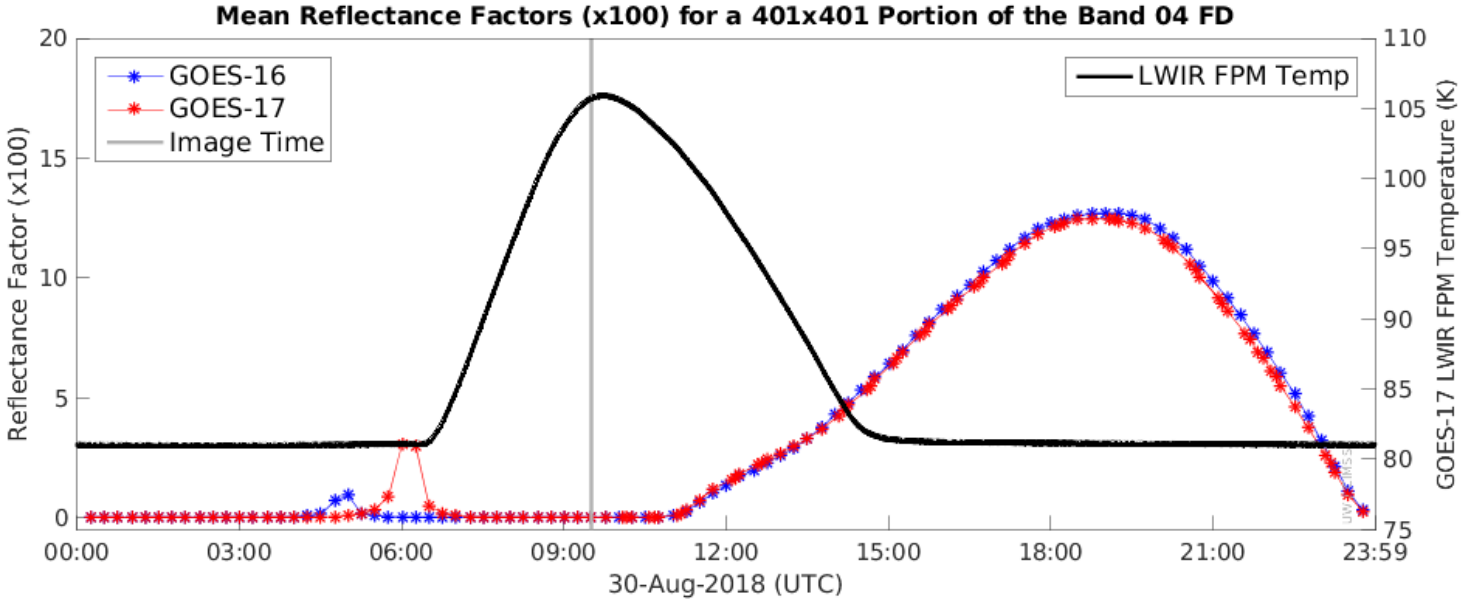
GOES-17 Preliminary / Non-Operational



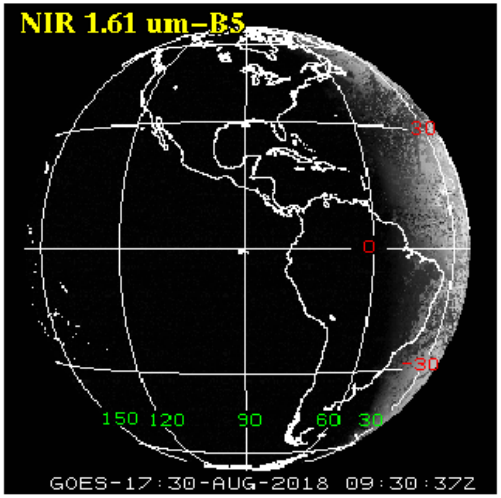
GOES-17 ABI Band 04 (1.37 μm) 30-Aug-2018 09:30:37 UTC



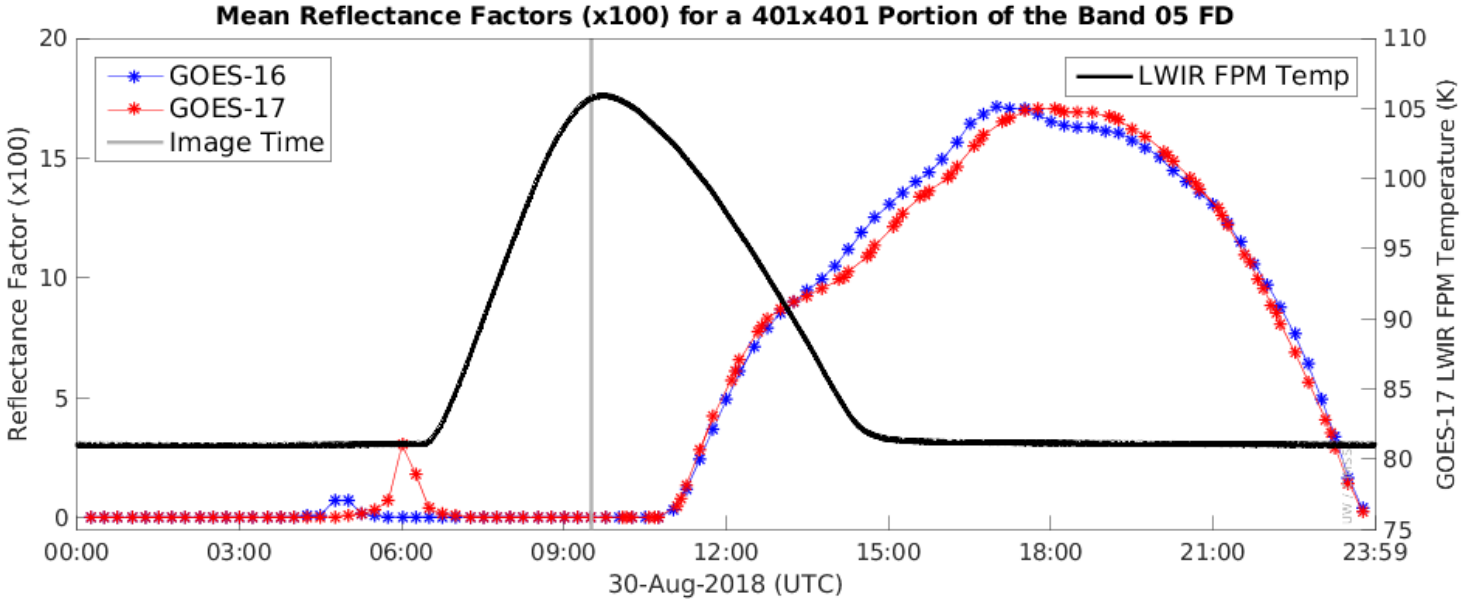
GOES-17 Preliminary / Non-Operational



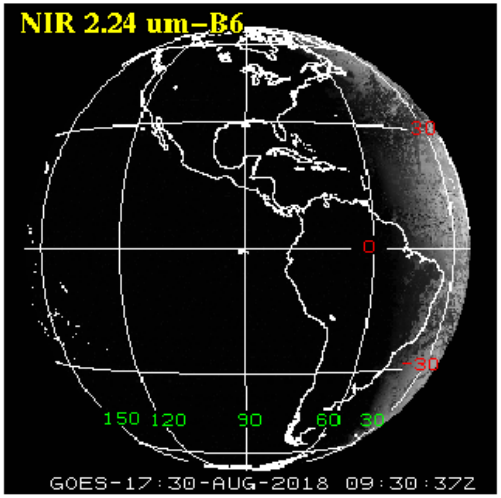
GOES-17 ABI Band 05 (1.61 μm) 30-Aug-2018 09:30:37 UTC



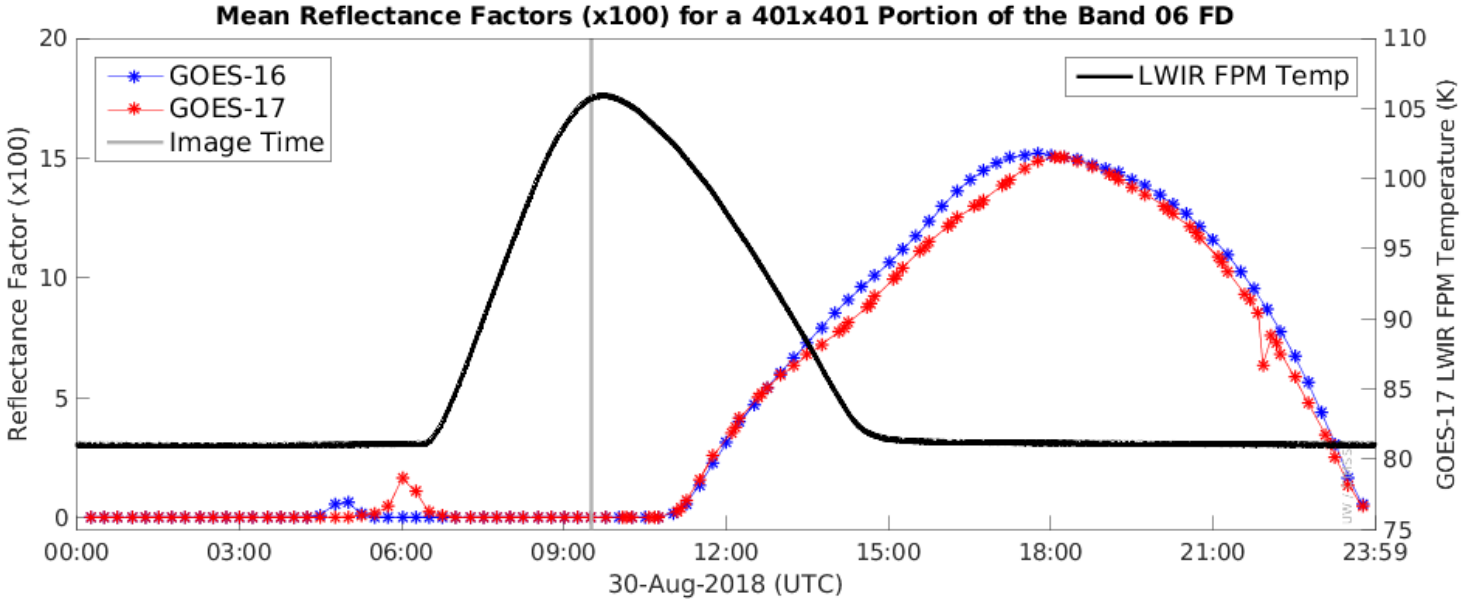
GOES-17 Preliminary / Non-Operational



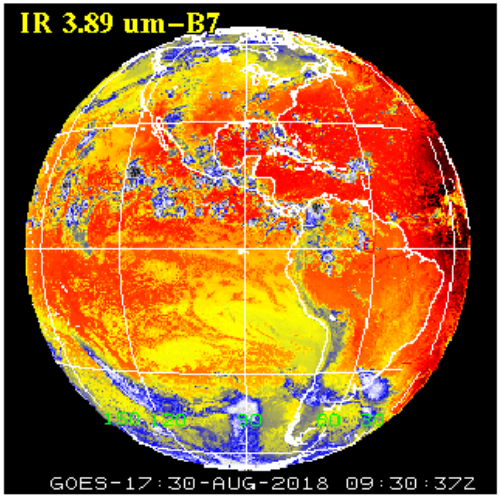
GOES-17 ABI Band 06 (2.24 μm) 30-Aug-2018 09:30:37 UTC



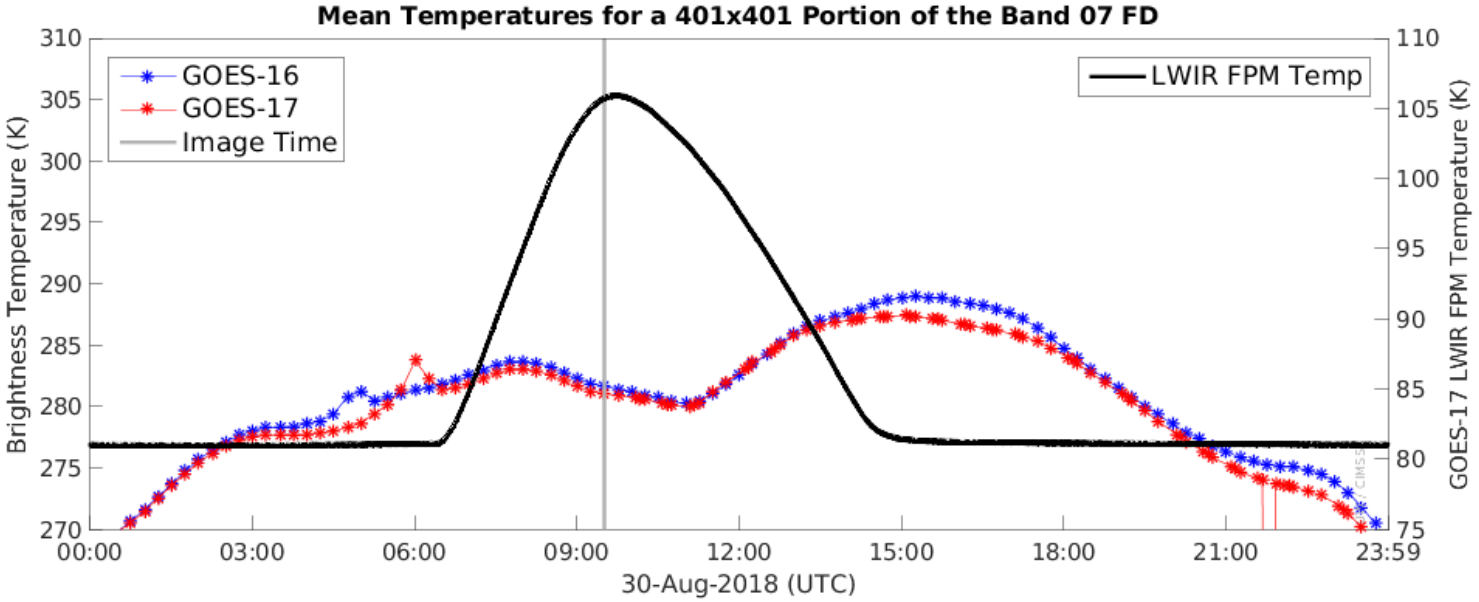
GOES-17 Preliminary / Non-Operational



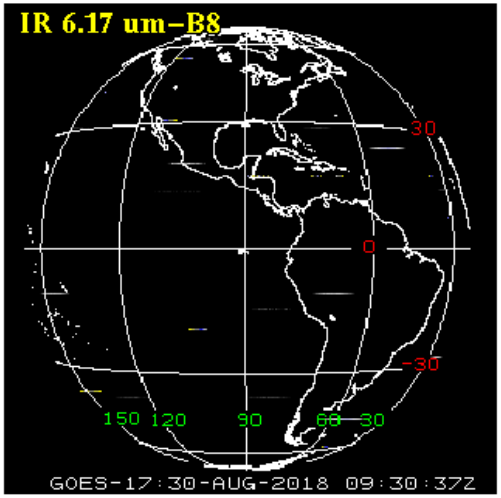
GOES-17 ABI Band 07 (3.89 μm) 30-Aug-2018 09:30:37 UTC



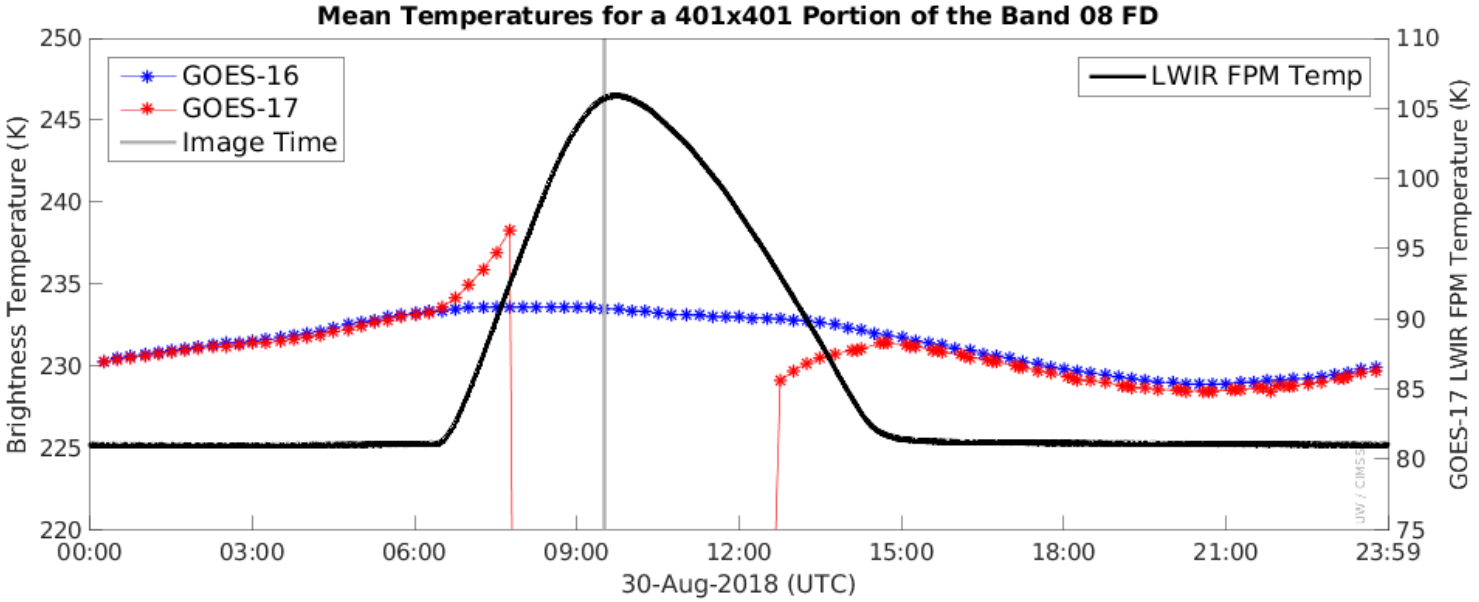
GOES-17 Preliminary / Non-Operational



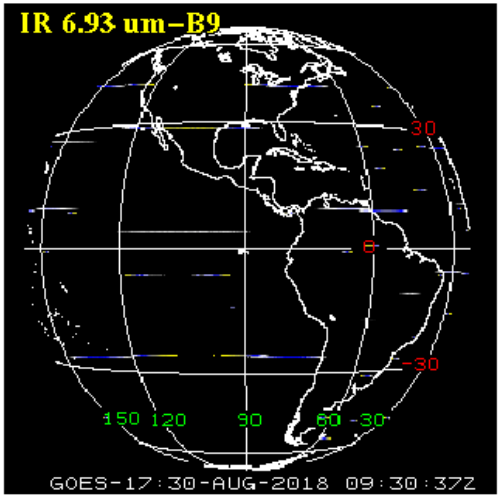
GOES-17 ABI Band 08 (6.17 μm) 30-Aug-2018 09:30:37 UTC



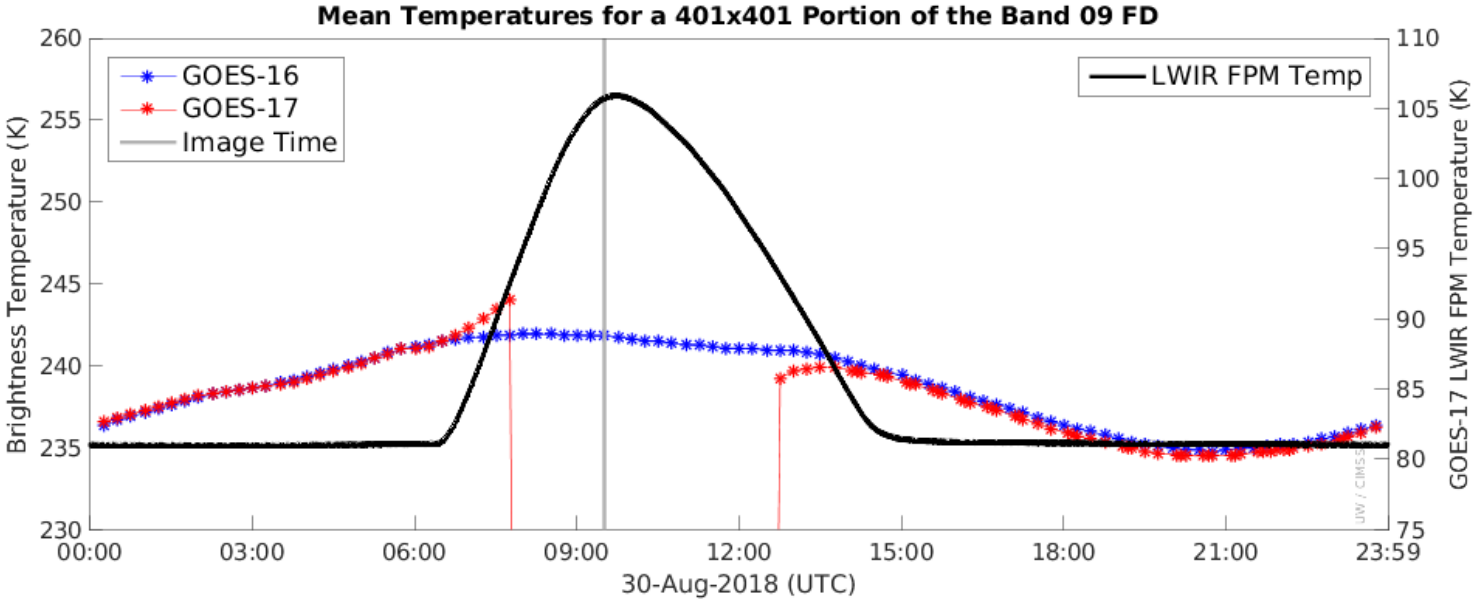
GOES-17 Preliminary / Non-Operational



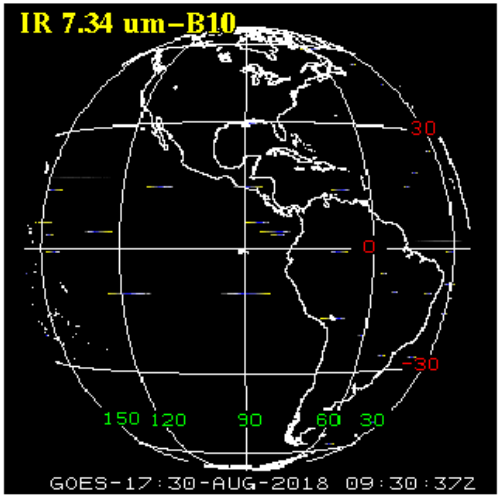
GOES-17 ABI Band 09 (6.93 μm) 30-Aug-2018 09:30:37 UTC



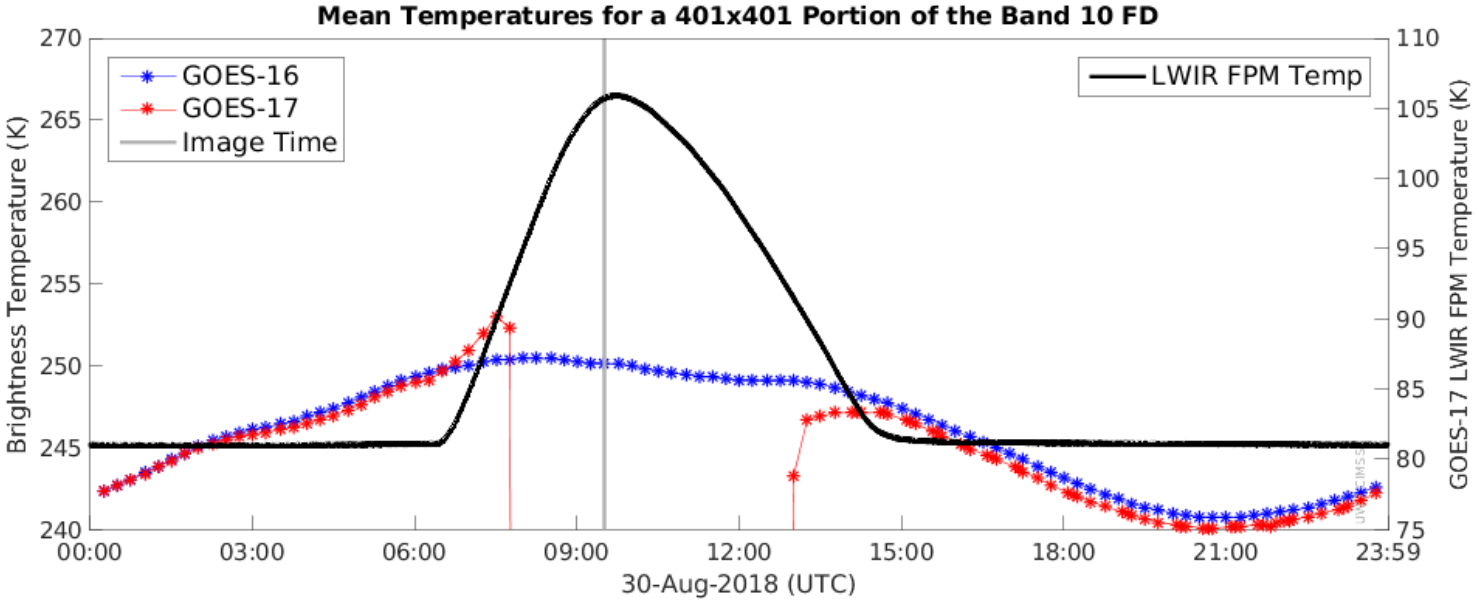
GOES-17 Preliminary / Non-Operational



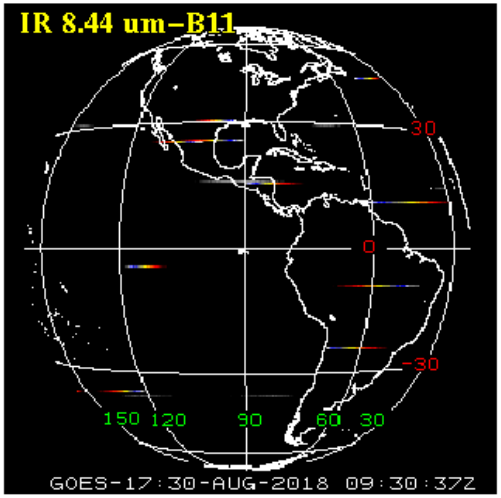
GOES-17 ABI Band 10 (7.34 μm) 30-Aug-2018 09:30:37 UTC



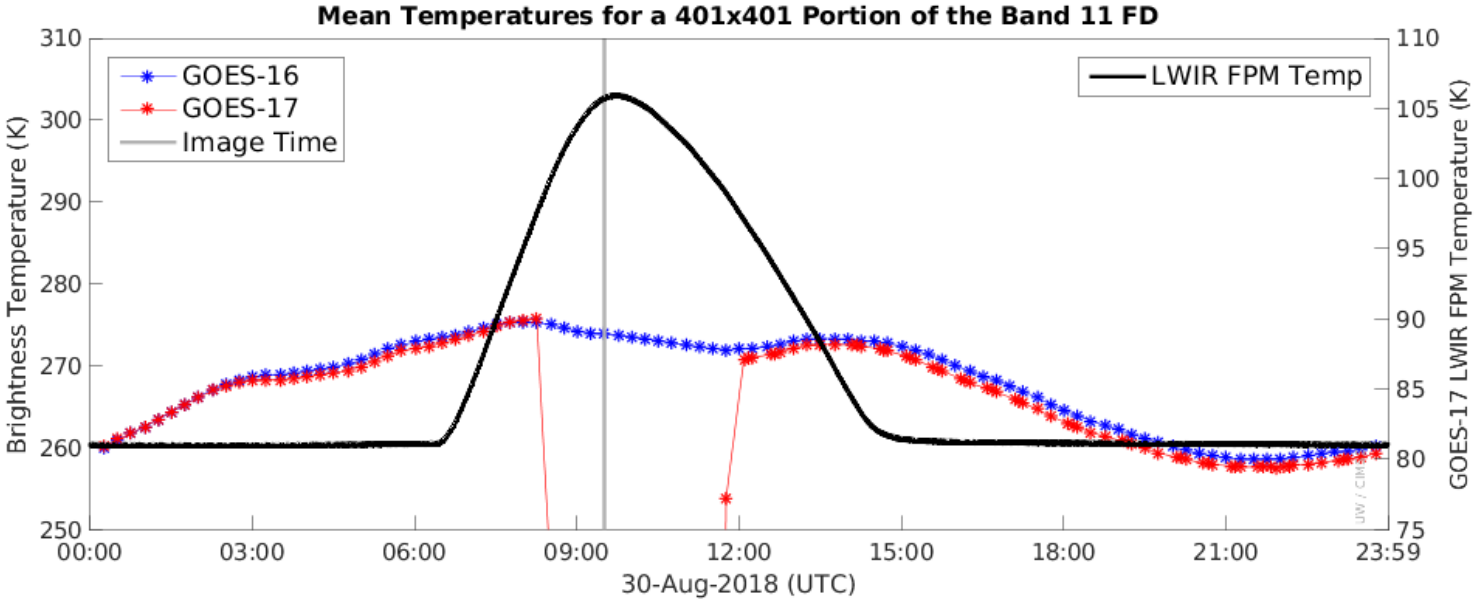
GOES-17 Preliminary / Non-Operational



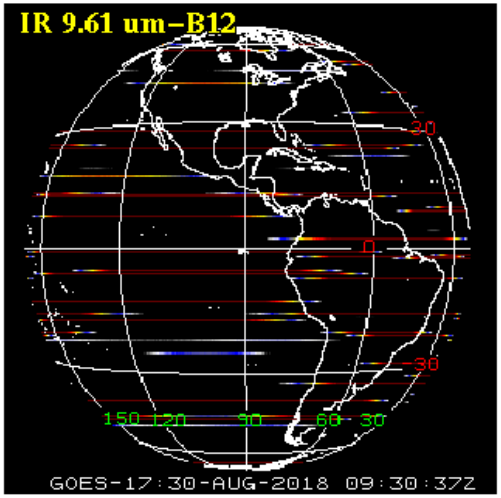
GOES-17 ABI Band 11 (8.44 μm) 30-Aug-2018 09:30:37 UTC



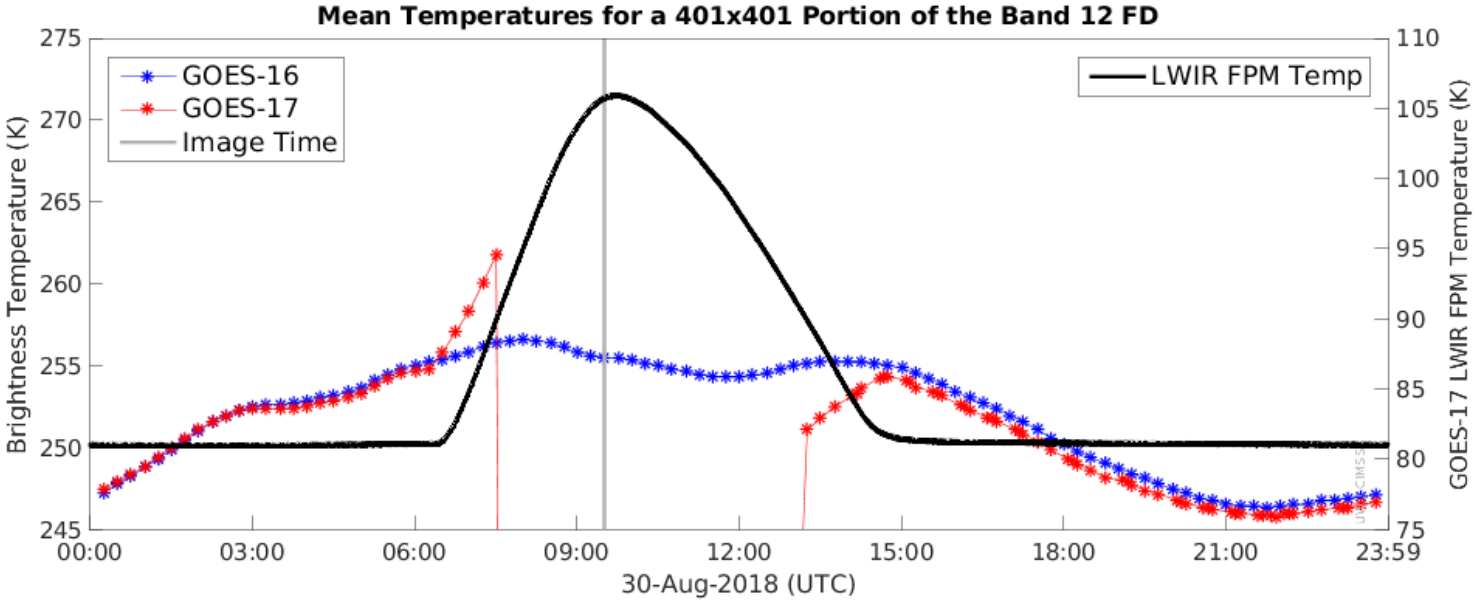
GOES-17 Preliminary / Non-Operational



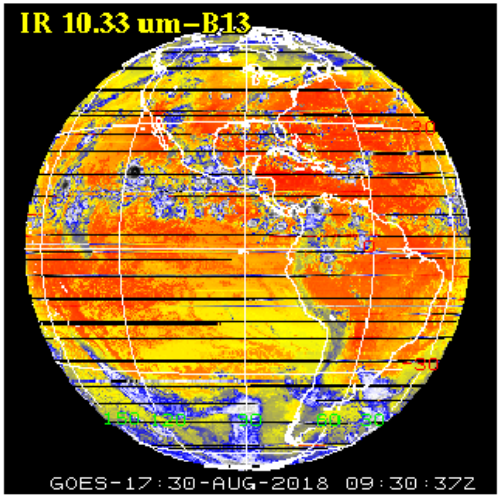
GOES-17 ABI Band 12 (9.61 μm) 30-Aug-2018 09:30:37 UTC



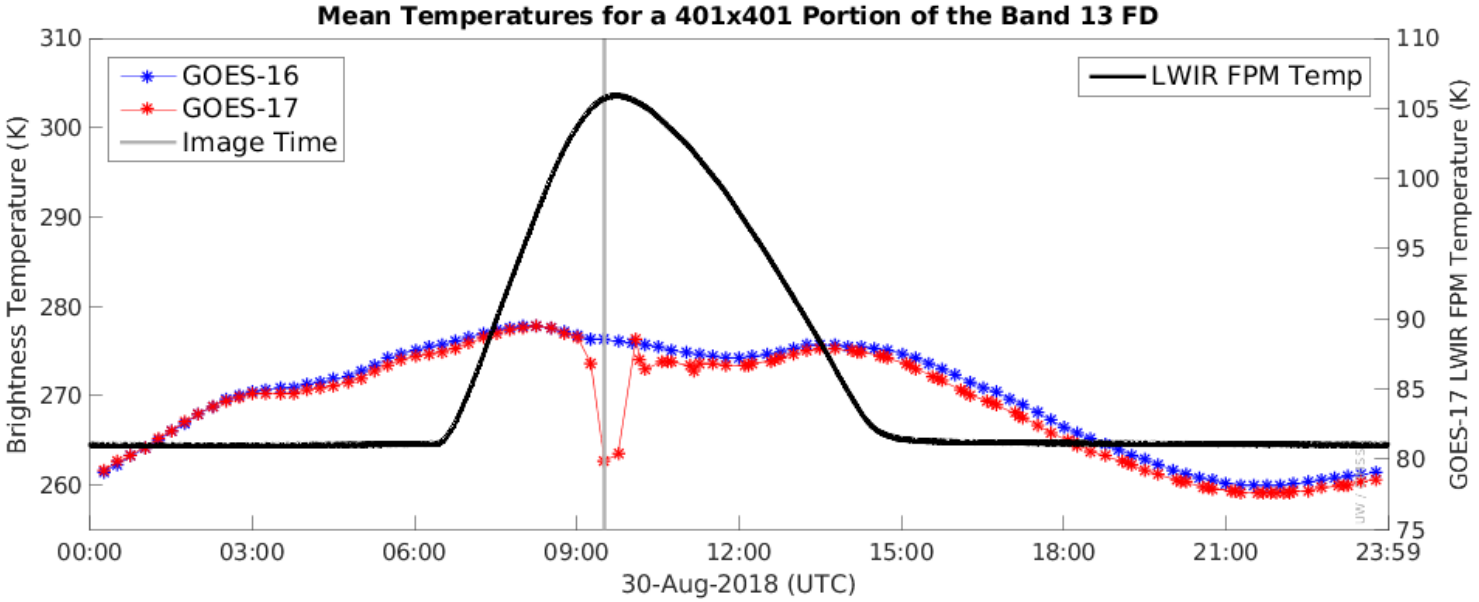
GOES-17 Preliminary / Non-Operational



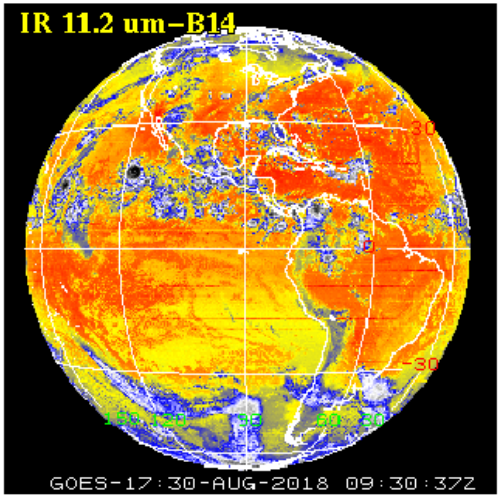
GOES-17 ABI Band 13 (10.33 μm) 30-Aug-2018 09:30:37 UTC



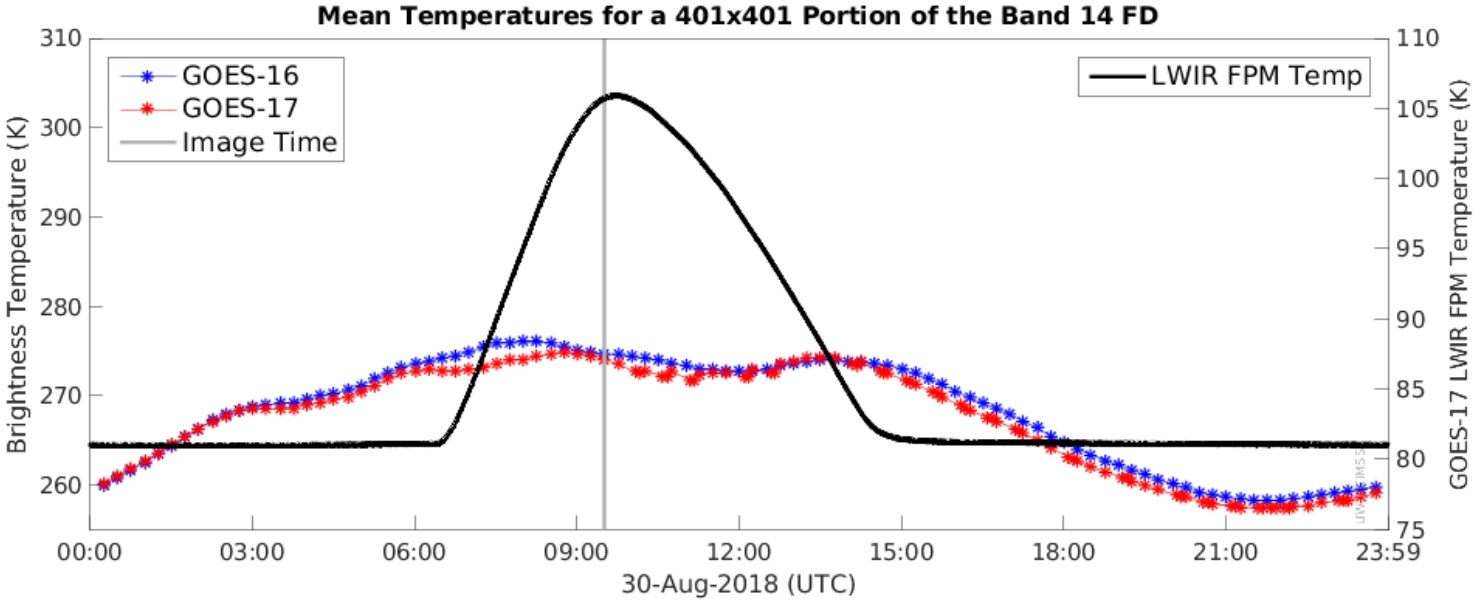
GOES-17 Preliminary / Non-Operational



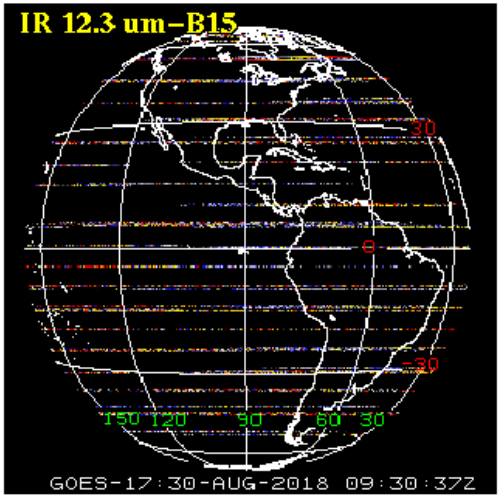
GOES-17 ABI Band 14 (11.2 μm) 30-Aug-2018 09:30:37 UTC



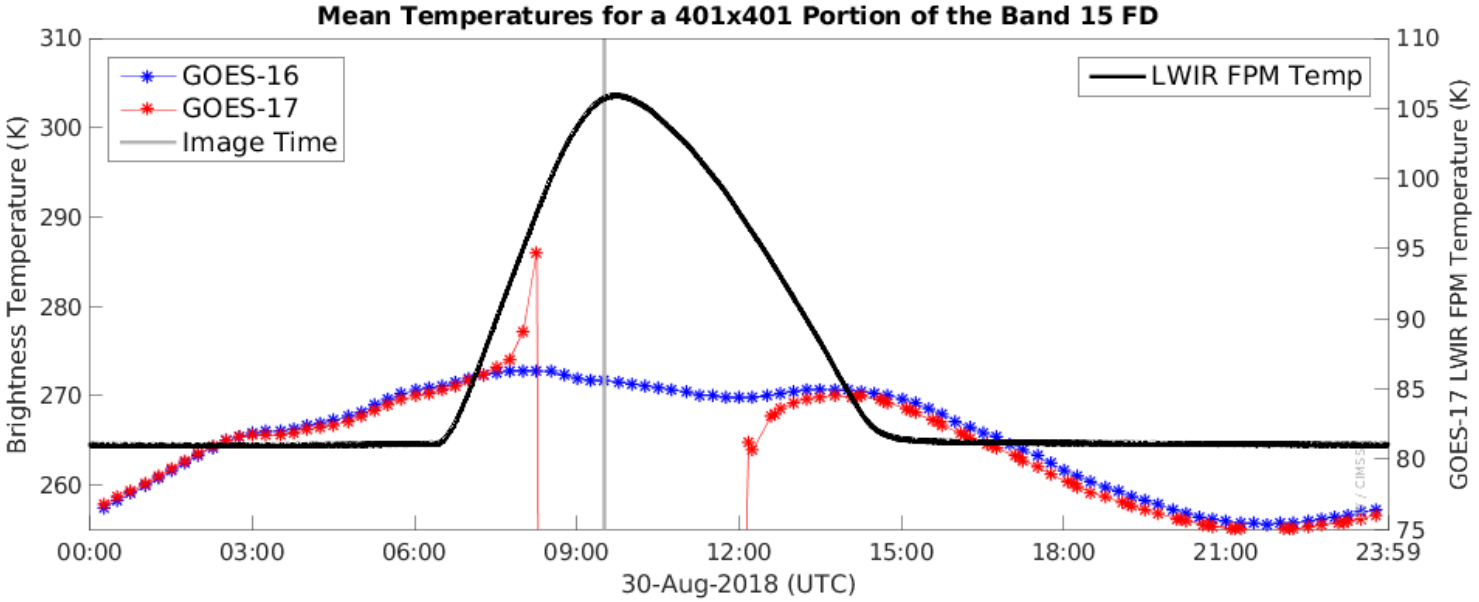
GOES-17 Preliminary / Non-Operational



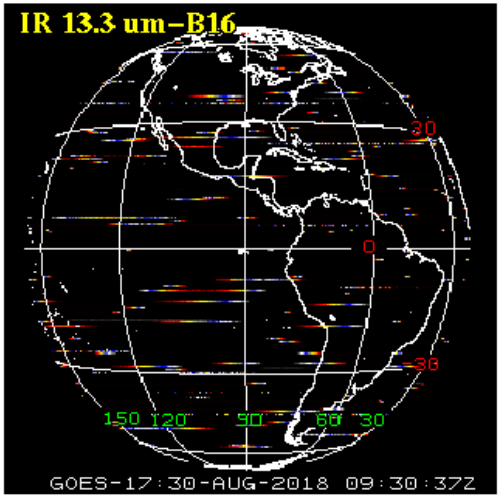
GOES-17 ABI Band 15 (12.3 μm) 30-Aug-2018 09:30:37 UTC



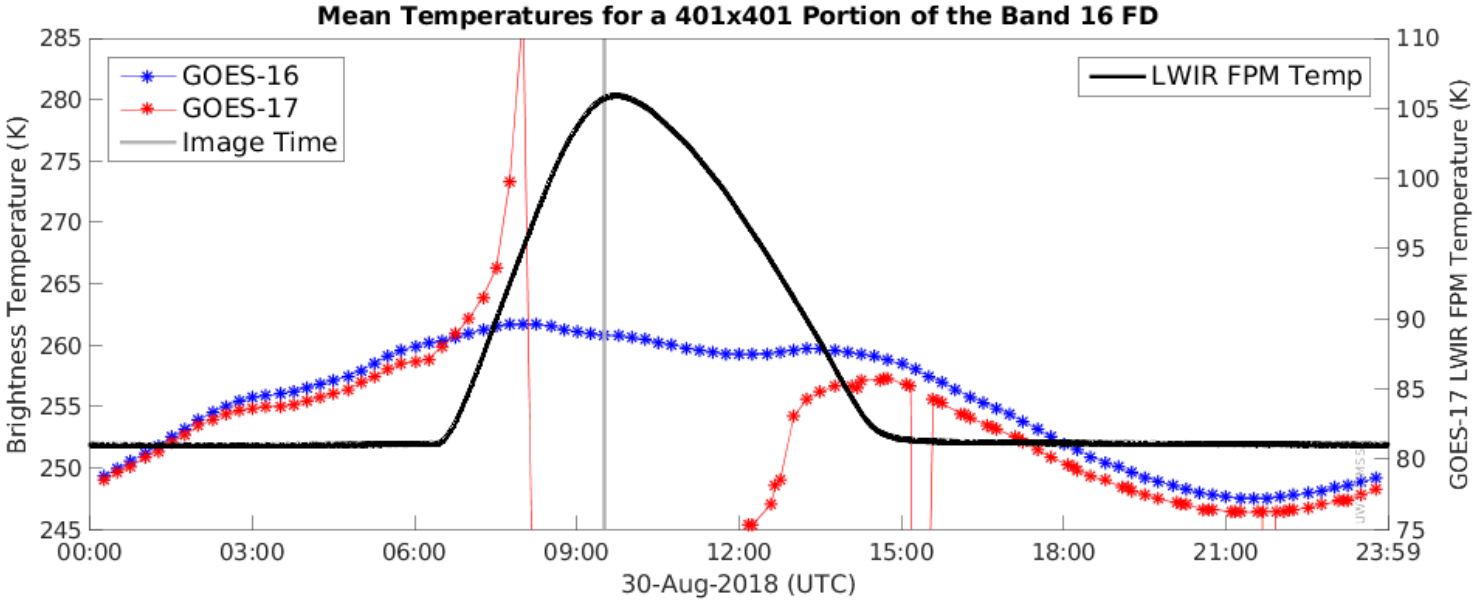
GOES-17 Preliminary / Non-Operational



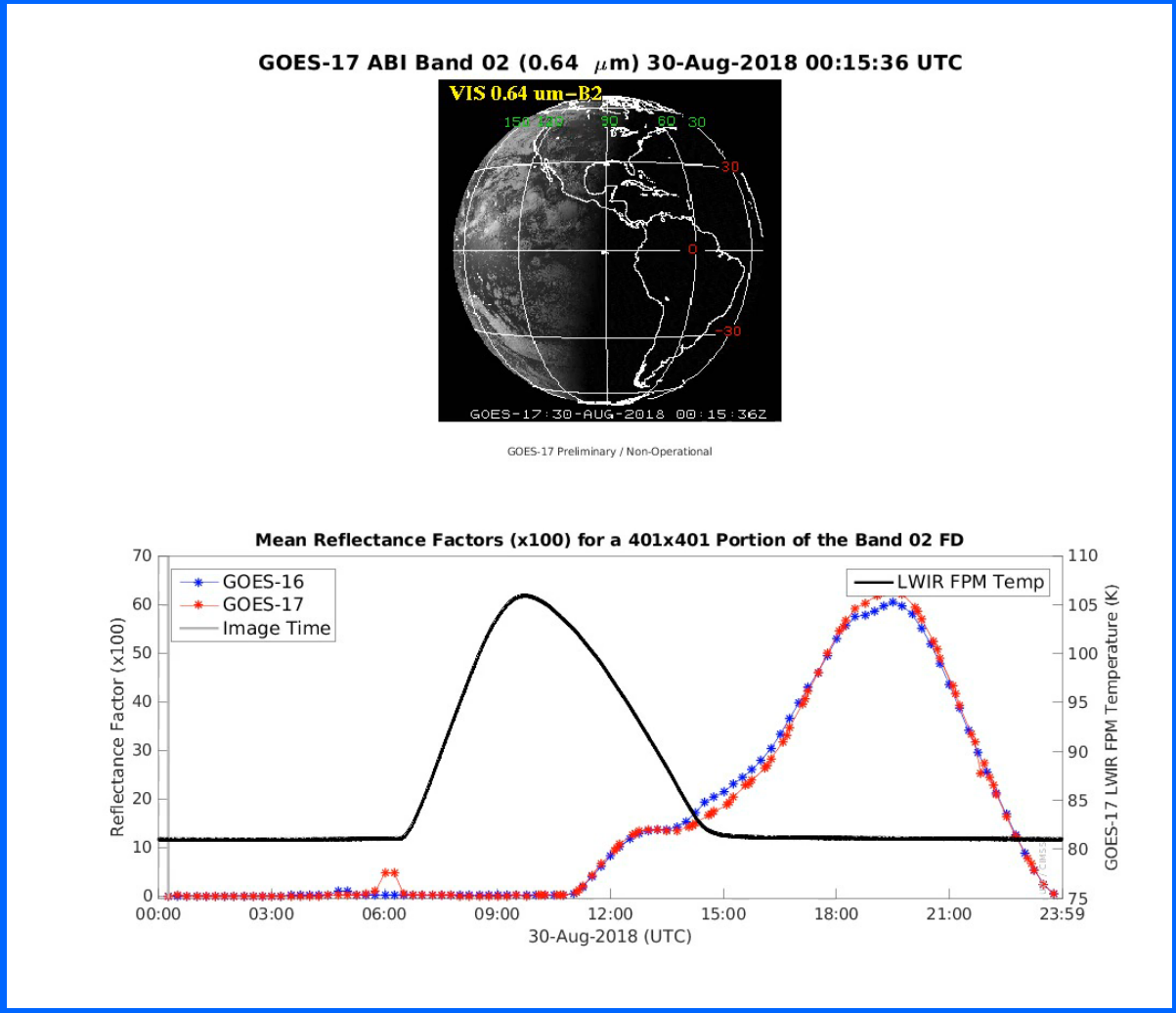
GOES-17 ABI Band 16 (13.3 μm) 30-Aug-2018 09:30:37 UTC



GOES-17 Preliminary / Non-Operational

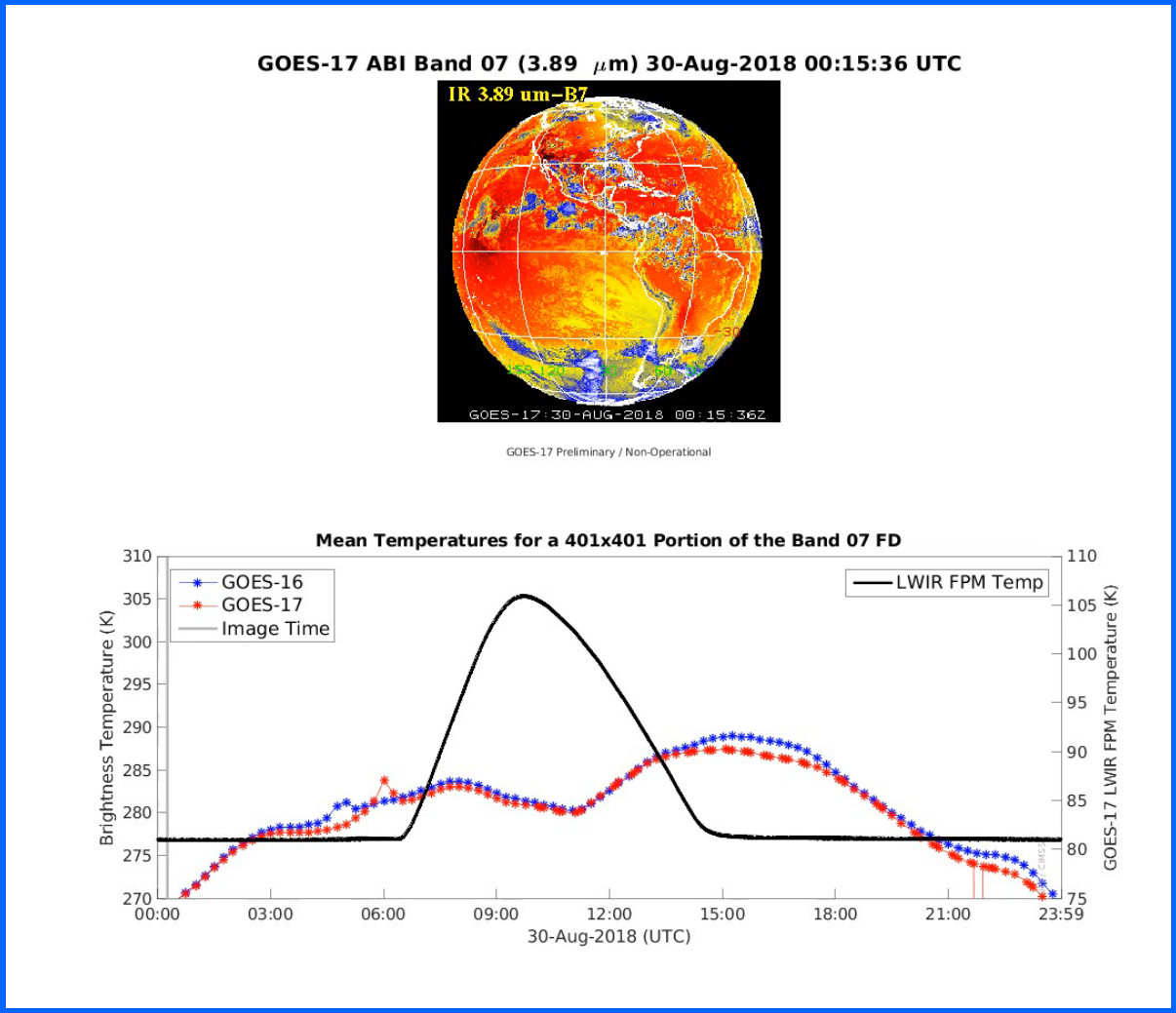


ABI Band 2: Worst Day



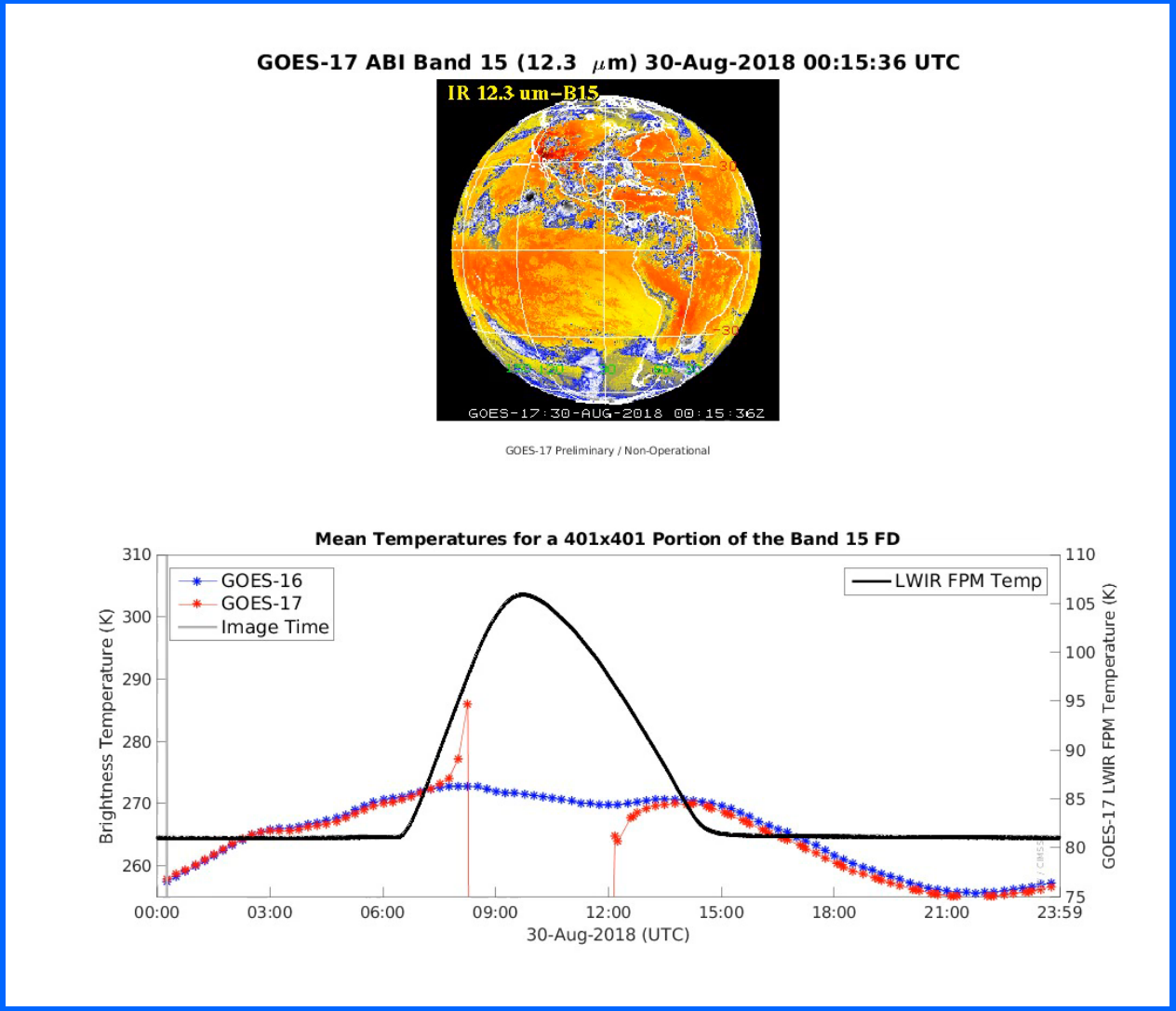
Animation

ABI Band 7: Worst Day



Animation

ABI Band 15: Worst Day



Animation

Way Forward

Outcomes from the Anomaly Teams this Fall:

- ✓ Provide recommendations on changes to GOES-T and GOES-U to address the Loop Heat Pipe issue
- ✓ Provide recommendations for the operation of GOES-17 to maximize mission performance
- ✓ Provide recommendations for the best constellation options for incorporating GOES-17, including potential changes to the operational usage of other assets (i.e. Himawari-8)

Notional Plan:

- ✓ Move GOES-17 to the GOES-West position in the Late Fall 2018
- ✓ Prepare to operate in tandem with GOES-15 for an extended period of time

Combining GOES-17 with Legacy

- Demonstrate how the legacy GOES imager can help fill in the missing images when the GOES-17 ABI detectors are too warm

- As a start, used GOES-15 and GOES-17 is there current orbital positions.

- No final decision about operating GOES-legacy with GOES-17

Paul Menzel, Elisabeth Weisz, Bill Smith, Sr., CIMSS

GOES Imager and ABI Fusion

Starting with good ABI and Imager IR data at time t0, establish a set of Imager IR bands colocated with ABI IR bands. At time t0 use ABI 4um to remap 4 Imager IR bands

(1) convert 4 Imager IR bands from 4km to 2km resolution using ABI 4um 2km radiances in k-d tree search at time t0

At time t, use ABI 4um to remap 4 Imager IR bands

(2) convert 4 Imager bands from 4km to 2 km using ABI 4um 2km radiances in k-d tree search at time t

Use Imager IR bands at time t to rearrange ABI IR bands from time t0

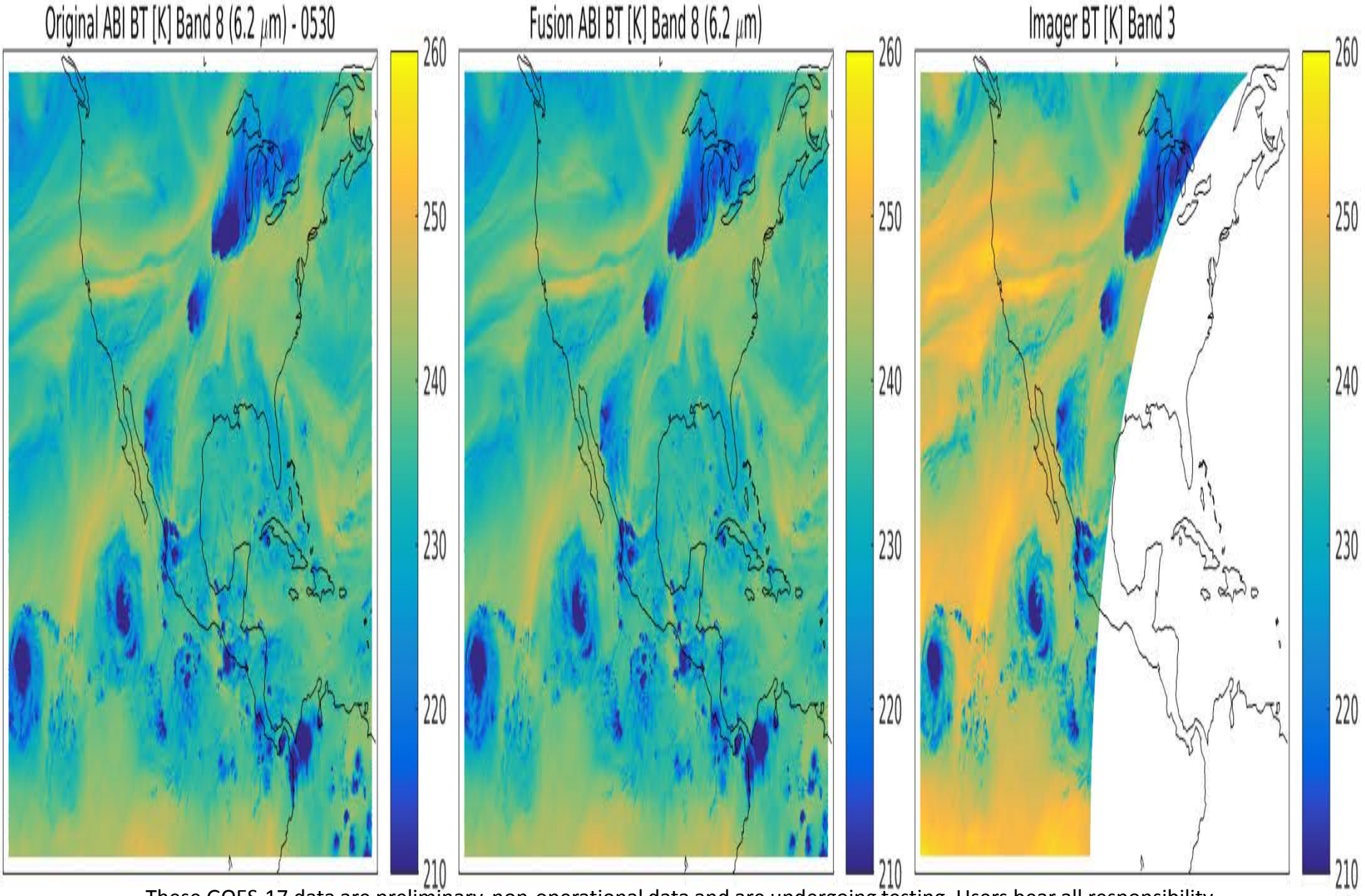
(3) use radiance k-d tree search to find best 5 Imager 2km fovs from time t0 matching each Imager 2 km fov at time t (searching for 5 fovs at time t0 that best match radiances in all four Imager IR bands of each fov at time t)

(4) average associated (through same fov location) ABI IR bands in those 5 fovs at time t0 to get fusion ABI IR bands at time t

Establish time series of fusion ABI IR Imager bands

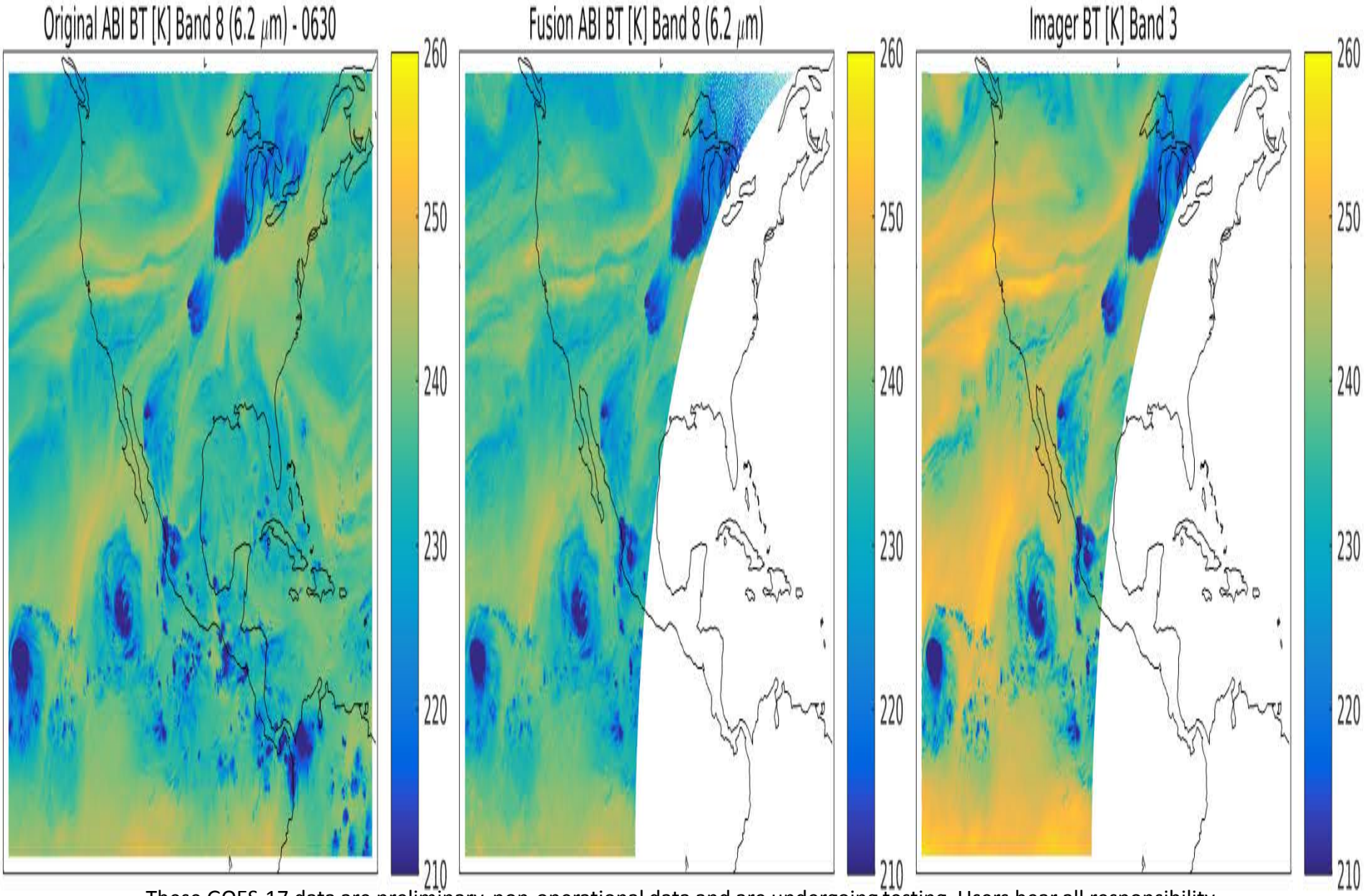
(5) use t0 = 530 UTC to create t = 630 UTC, repeat for t = 730 UTC, repeat for t = 830 UTC, and repeat for t = 930 UTC.

Band 8 – 6.2 µm 530 UTC

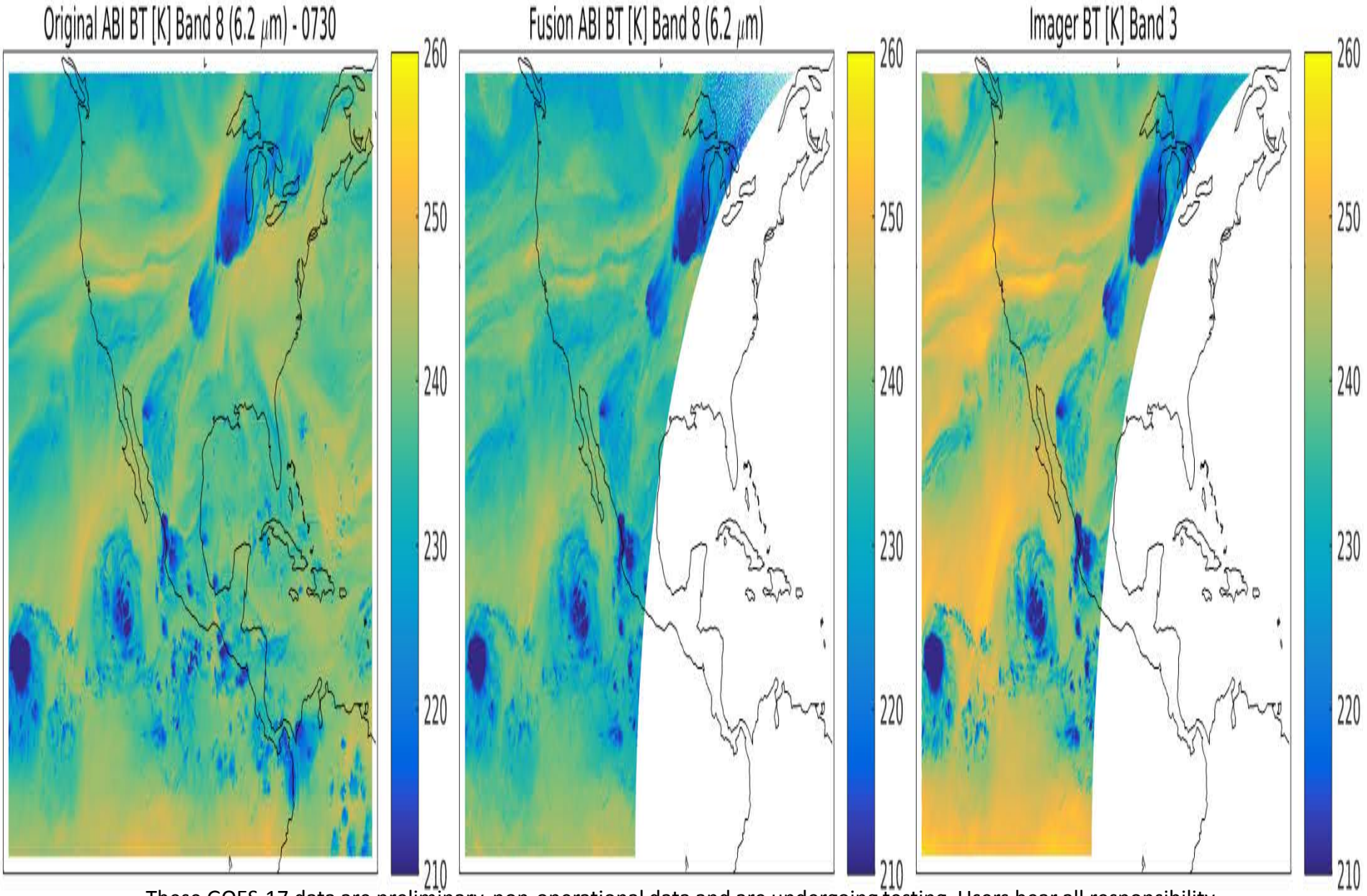


These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

Band 8 – 6.2 µm 630 UTC

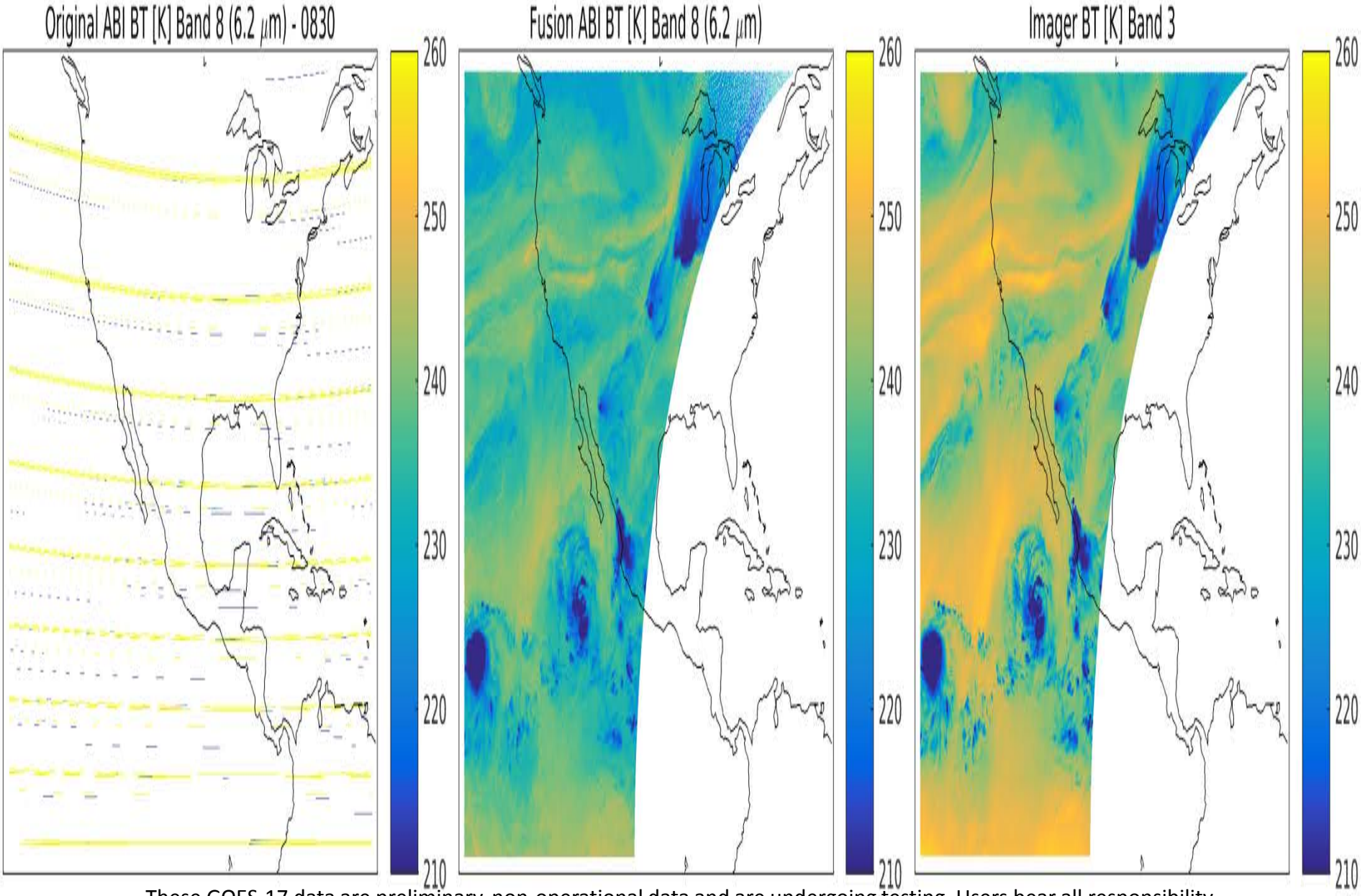


Band 8 – 6.2 µm 730 UTC



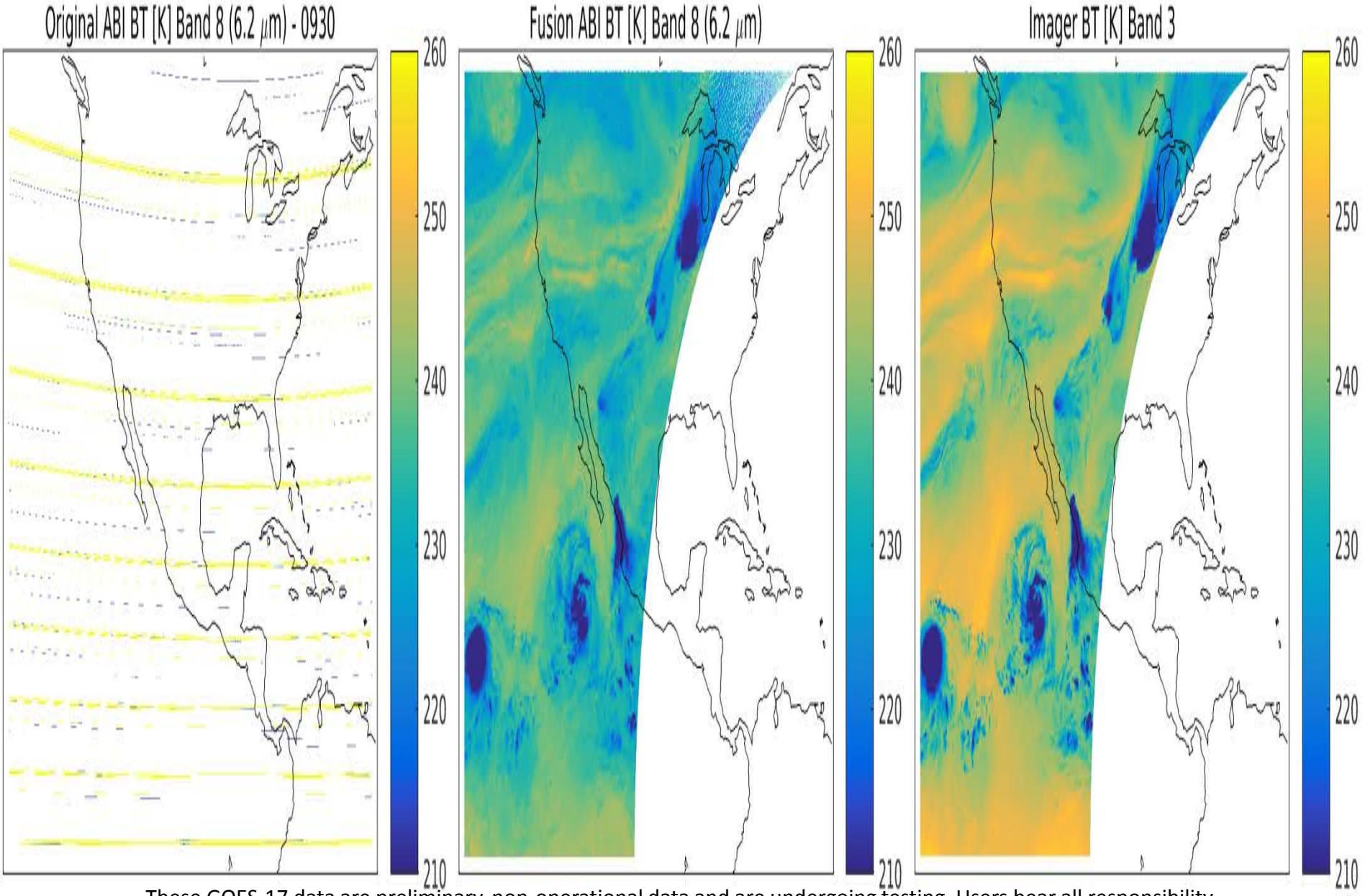
These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

Band 8 – 6.2 µm 830 UTC

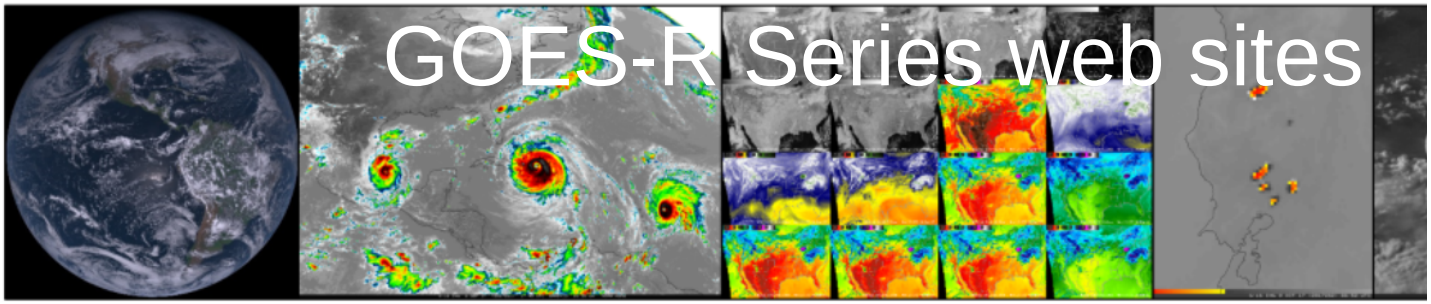


These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

Band 8 – 6.2 µm 930 UTC



GOES-R Series web sites



These are links for NOAA's GOES-16 (-17) imagery

http://cimss.ssec.wisc.edu/goes/goesdata.html

- NOAA STAR ABI Image Viewer *(can save animated gif)*
- SSEC Geo Browser Color hybrid with GOES-16 and Suomi NPP *(can save animated gif)*
- SSEC Geo Browser All bands, Meso1 Meso2 and CONUS and Full Disk, plus a "spectral" (all channels) loop *(can save animated gif)* and **GOES-17 (prelim, non-op)**
- geo imagery (SSEC Real Earth TM) All bands, CONUS and Full Disk and both meso-scale sectors *(can save animated gif or mp4)* and **GOES-17 (prelim, non-op)**
- UW-Madison AOS Many sectors (including Southern Wisconsin) and several enhancements
- RAMMB Slider GeoColor, all bands and all sectors *(can save URL)* and **GOES-17 (prelim, non-op)**
- GOES ABI imagery (CIRA) Meso-scale sectors plus Colorado and Central Plains
- College of DuPage Select bands for the three domains, plus sub-regional and localized sectors *(can save animated gif)*
- weather.us US view, several options
- Earl's Satellite Page FD, CONUS, Meso, etc.
- Meteo-Chile 16 bands and RGB images over Chile and 1-page band fact sheets
- Brazil's CPTEC All ABI bands in animation over South America.
- Environment Canada Several sectors and animations.
- SMN (Mexico) Several sectors.
- UNAM (Mexico) Several sectors.
- NASA's Marshall Space Flight Center CONUS and Full Disk sectors. **GOES-17 (prelim, non-op)**
- NOAA NESDIS Full Disk view .
- Embry-Riddle Aeronautical University - Daytona Beach Meteorology Many sectors, several bands.

GLM (Geostationary Lightning Mapper)

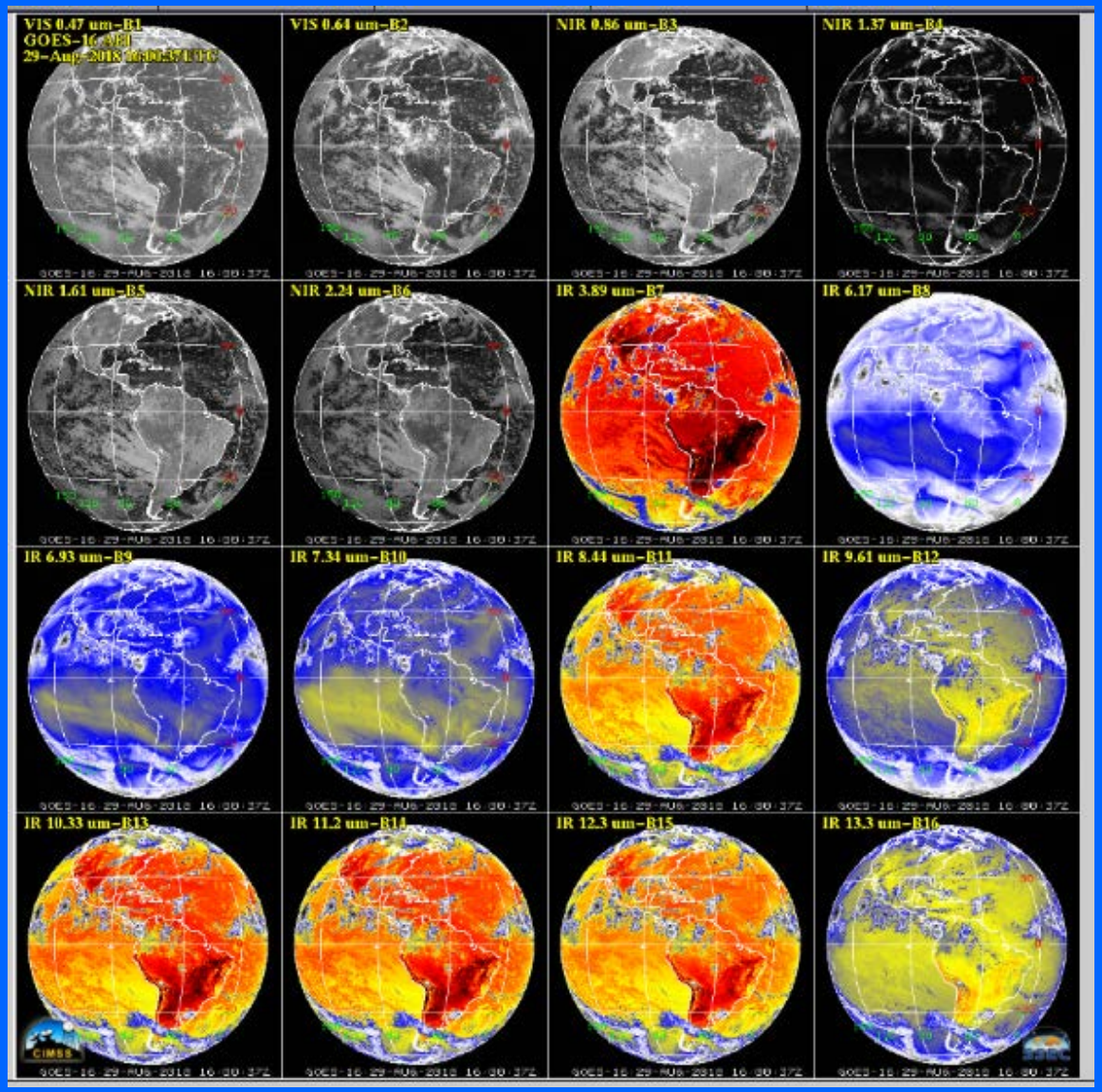
- GLM realtime data (SPORT)
- GLM and ABI realtime data (SSEC Real Earth TM) for Groups and Group Density
- GLM near realtime data (CICS-MD)
- Weathernerds ABI (2 bands) and GLM, *can save animated gifs*.

GOES Calibration

- NOAA STAR GOES-16 calibration page
- CIMSS Imagery 16-band; times difference images 16-panel of the ABI at both CONUS and Full Disk and **GOES-17 (prelim, non-op)**
- GOES Spectral Response functions Plots and files: GOES-16 and other GOES; plus Planck coefficents
- GOES-16 ABI Weighting functions both static and realtime

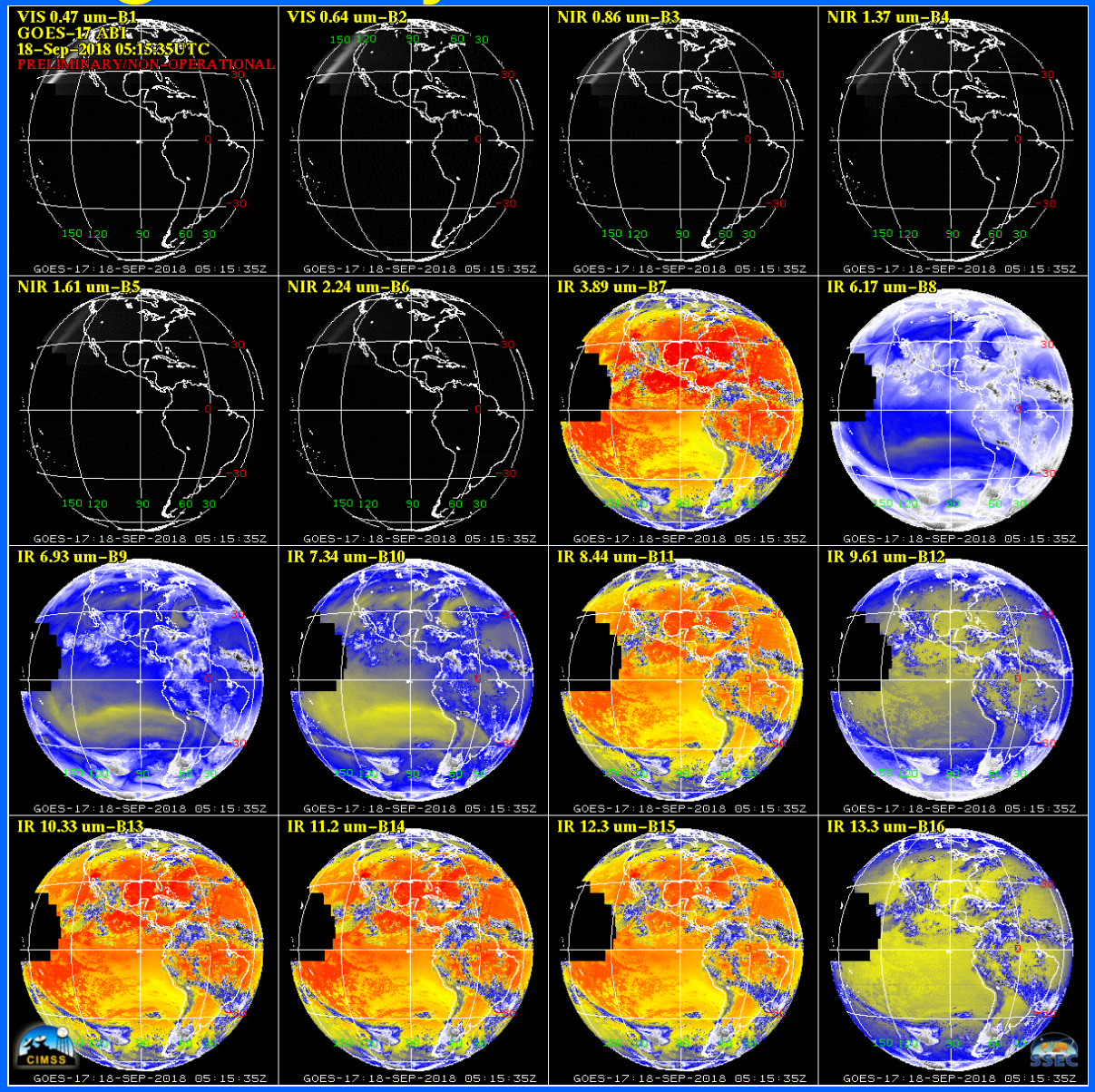
GLM
Calibration
GOES-16 ABI Data
(Free) Software
(Free) Phone apps
GOES-R/16 ABI Training / Education
GOES-R/16 ABI Info
Level 2 -- Derived Products, etc.

GOES-17 ABI



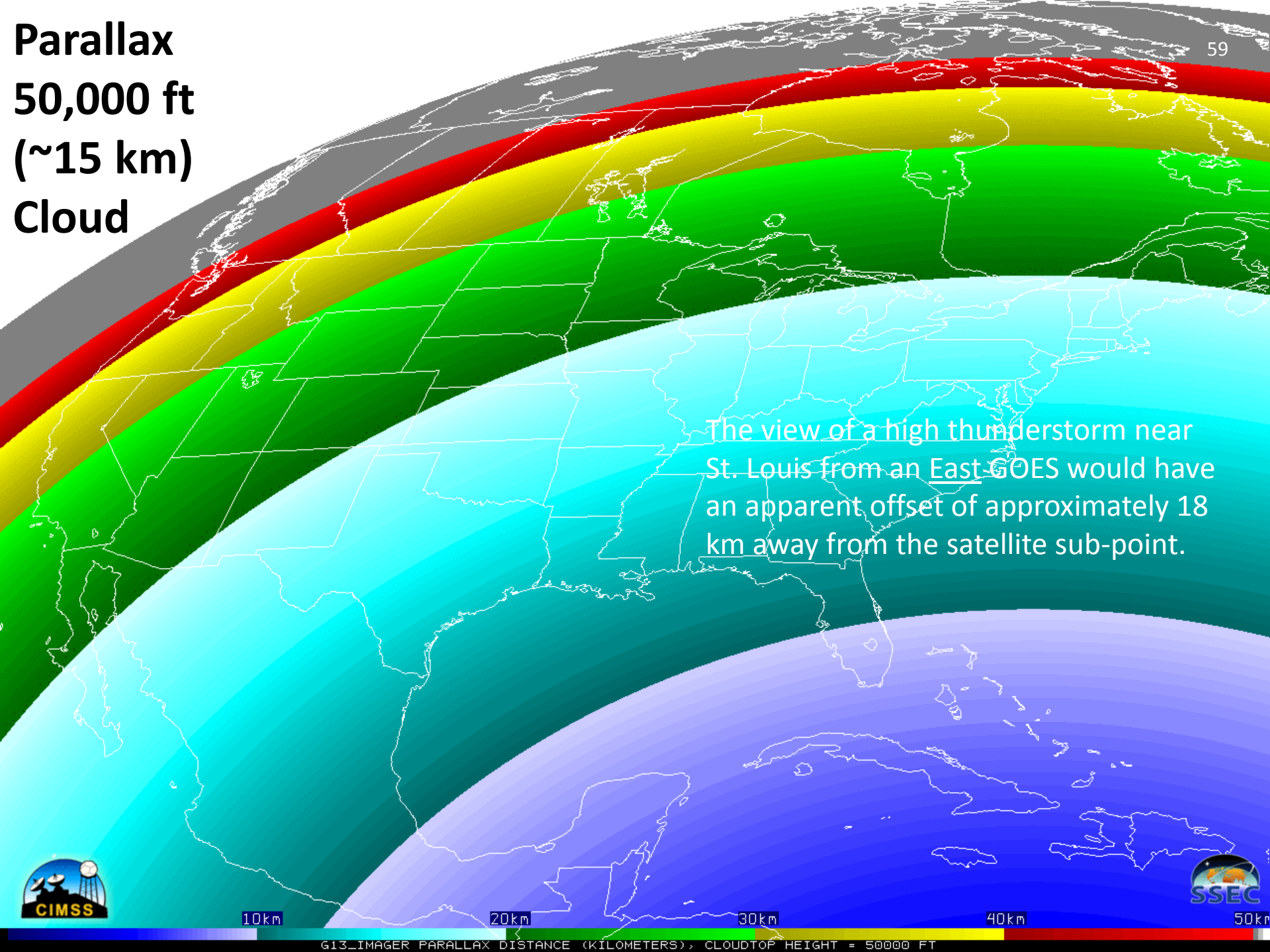
These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

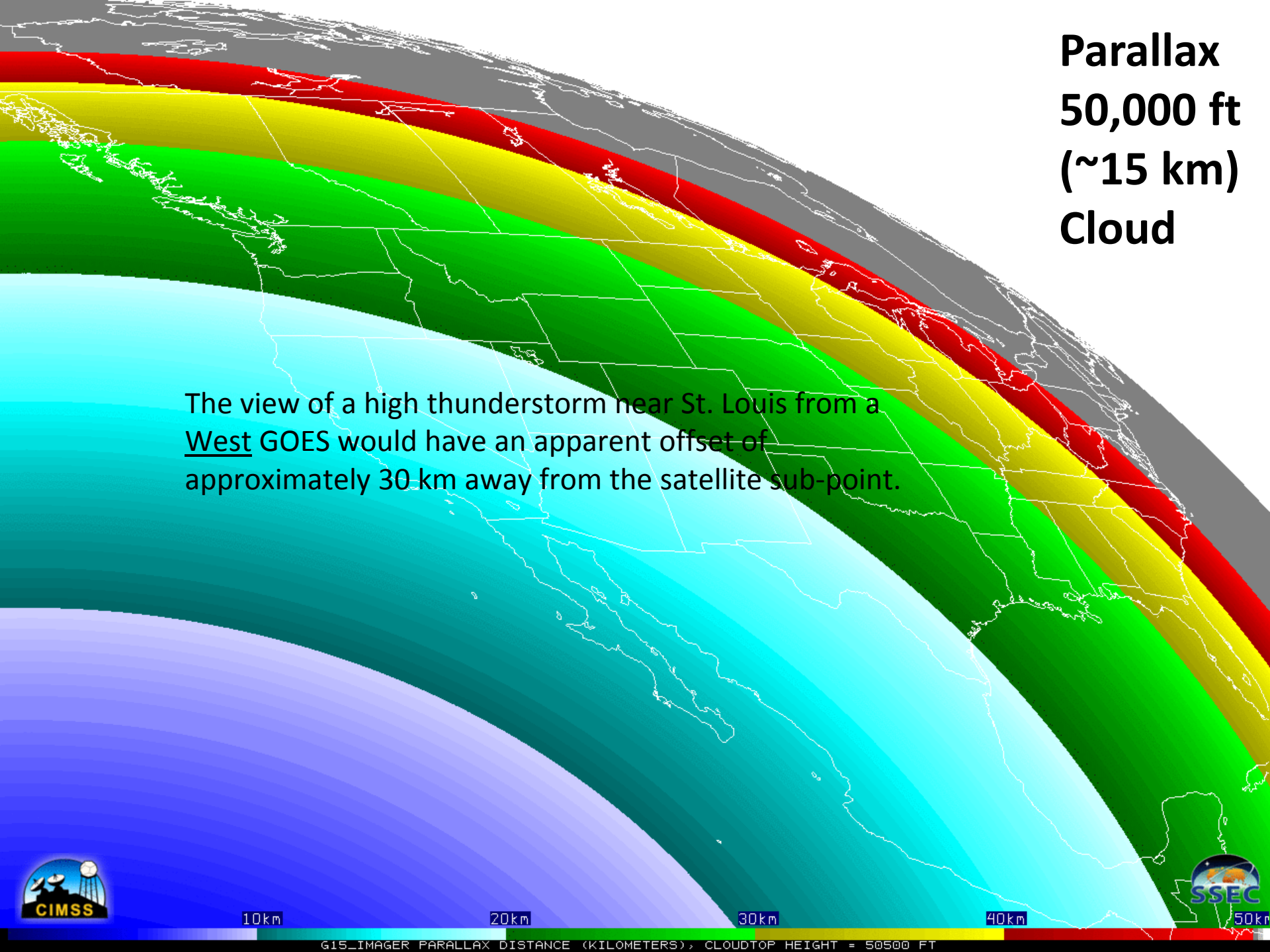
Bright Object Avoidance



These GOES-17 data are preliminary, non-operational data and are undergoing testing. Users bear all responsibility for inspecting the data prior to use and for the manner in which the data are utilized.

Parallax 50,000 ft (~15 km) Cloud




Parallax
50,000 ft
(~15 km)
Cloud
The view of a high thunderstorm near St. Louis from a West GOES would have an apparent offset of approximately 30 km away from the satellite sub-point.
CIMSS
SSEC
10km
20km
30km
40km
50km
G15_IMAGER PARALLAX DISTANCE (KILOMETERS), CLOUDTOP HEIGHT = 50500 FT

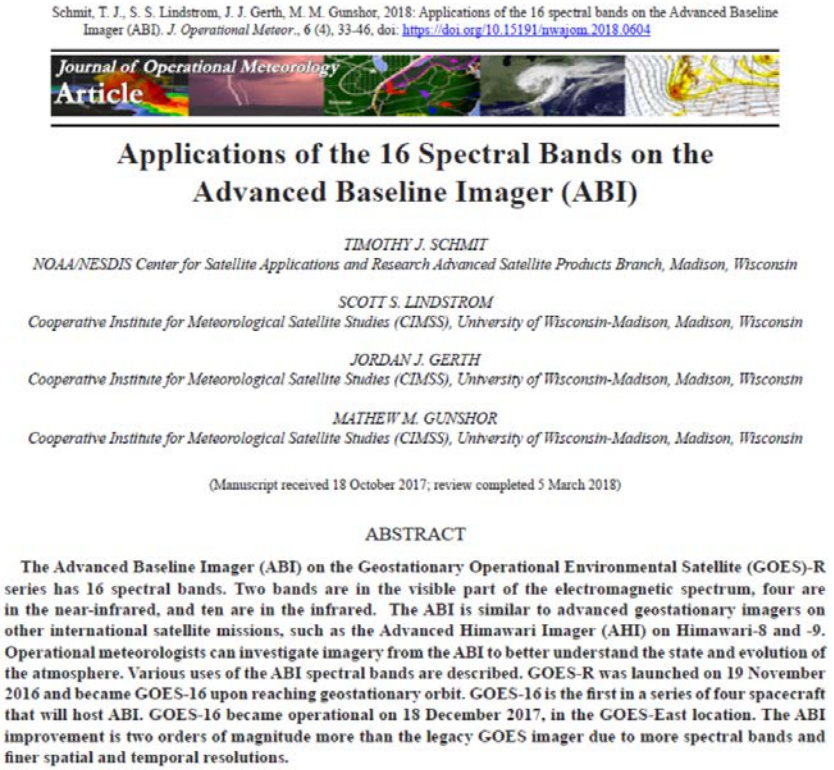
GOES-17 ABI Mode 6 Test

- Similar to the “flex” mode, but with 10-min Full Disk imagery (not 15-min)
- Still acquire 5-min CONUS and two 1-min meso-scale sectors
- GOES-17 test:
  - September 10-11, 2018
  - Rescheduled to start 9/25

http://nwafiles.nwas.org/jom/articles/2018/2018-JOM4/2018-JOM4.pdf

2018 Journal of Operational Meteorology (NWA)

Schmit, T. J., S. S. Lindstrom, J. J. Gerth, M. M. Gunshor, 2018: Applications of the 16 spectral bands on the Advanced Baseline Imager (ABI). J. Operational Meteor., 6 (4), 33-46, doi: https://doi.org/10.15191/nwajom.2018.0604



Schmit, T. J., S. S. Lindstrom, J. J. Gerth, M. M. Gunshor, 2018: Applications of the 16 spectral bands on the Advanced Baseline Imager (ABI). *J. Operational Meteor.*, 6 (4), 33-46, doi: https://doi.org/10.15191/nwajom.2018.0604

Journal of Operational Meteorology Article

Applications of the 16 Spectral Bands on the Advanced Baseline Imager (ABI)

TIMOTHY J. SCHMIT
NOAA/NESDIS Center for Satellite Applications and Research Advanced Satellite Products Branch, Madison, Wisconsin

SCOTT S. LINDSTROM
Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin-Madison, Madison, Wisconsin

JORDAN J. GERTH
Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin-Madison, Madison, Wisconsin

MATHEW M. GUNSHOR
Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin-Madison, Madison, Wisconsin

(Manuscript received 18 October 2017; review completed 5 March 2018)

ABSTRACT

The Advanced Baseline Imager (ABI) on the Geostationary Operational Environmental Satellite (GOES)-R series has 16 spectral bands. Two bands are in the visible part of the electromagnetic spectrum, four are in the near-infrared, and ten are in the infrared. The ABI is similar to advanced geostationary imagers on other international satellite missions, such as the Advanced Himawari Imager (AHI) on Himawari-8 and -9. Operational meteorologists can investigate imagery from the ABI to better understand the state and evolution of the atmosphere. Various uses of the ABI spectral bands are described. GOES-R was launched on 19 November 2016 and became GOES-16 upon reaching geostationary orbit. GOES-16 is the first in a series of four spacecraft that will host ABI. GOES-16 became operational on 18 December 2017, in the GOES-East location. The ABI improvement is two orders of magnitude more than the legacy GOES imager due to more spectral bands and finer spatial and temporal resolutions.

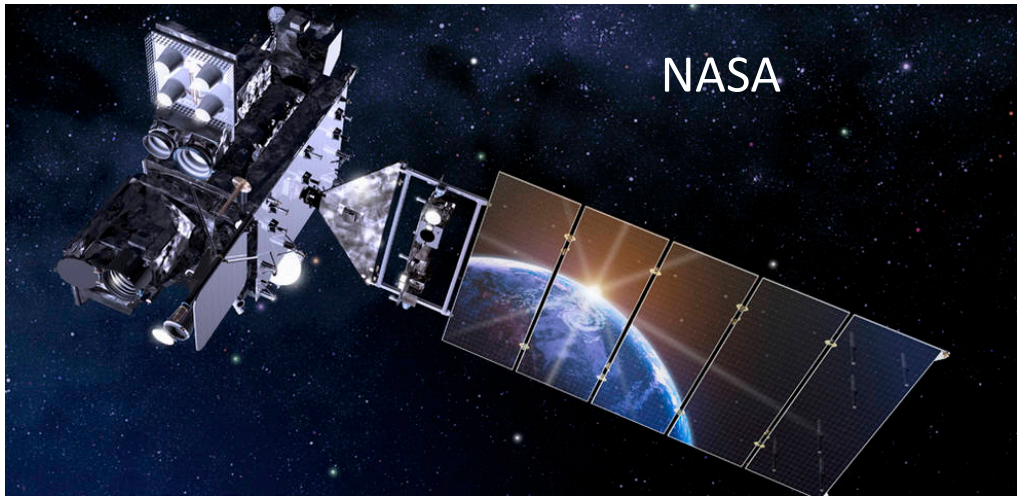
Questions? Comments?

Feel free to contact me : Tim.J.Schmit@noaa.gov

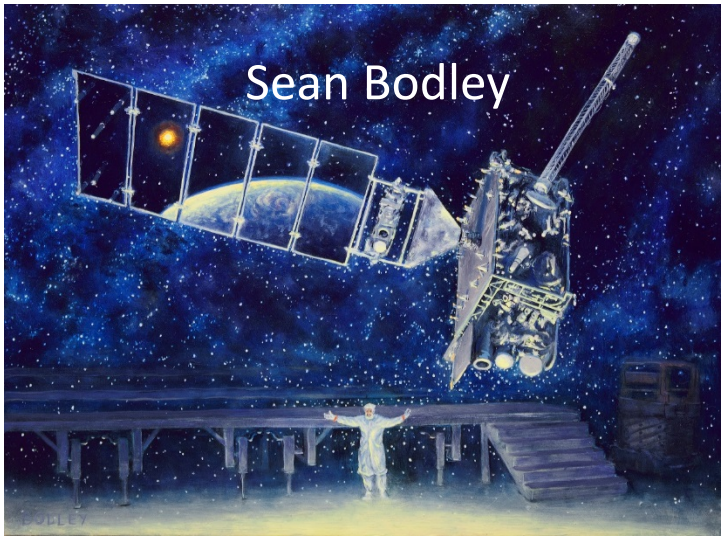
http://cimss.ssec.wisc.edu/goes/goesdata.html

Tim.J.Schmit@NOAA.GOV

+



=



UW-Madison

Conclusions

The next generation advanced geostationary imager continues the critical continuity of geostationary imagers and will have huge positive societal impacts, given its improved temporal, spatial, spectral and radiometric attributes.

Impact areas include, but are not limited to: weather (clouds, winds, temperature), Numerical Weather Prediction (forecasts), severe weather, hazards (volcanic ash plumes), aviation, environmental (fires), health (smoke), oceanographic, cryosphere (ice), land, etc.

GOES-17 ABI. The ABI on GOES-17 has a serious heating issue, which is being addressed. GOES-17 may be operated in tandem with a legacy GOES

Thanks to…

- A. Scott Bachmeier, Paul Menzel, Steven J. Goodman, Robert M. Rabin, Kristopher M. Bedka, John L. Cintineo, Christopher S. Velden, Scott S. Lindstrom, Chris Schmidt

- Jim Nelson, Mike Pavolonis, Kaba Bah, Joleen Feltz, Tom Whittaker, Margaret Mooney, Andy Heidinger, William Straka, Jun Li, Steve Ackerman, Bob Aune, Don Hillger, Tony Schreiner, Justin Sieglaff, Jim Jung, Brad Pierce, Wayne Feltz, Jean Phillips, Linda Hedges, Gary Wade, Don Hillger, Jinlong Li, Jing Zheng, Allen Huang, the SSEC data center, ASPB, STAR, NESDIS, NSSL, MUG, Kevin Ludlum, GOES operators, GOES shift supervisors, and many others!

- GOES-R Program Office, Tim Walsh, Mike Stringer, Pam Sullivan, Greg Mandt, NASA, Exelis Industries, Lockheed Martin, and other industry partners, etc.

- You!